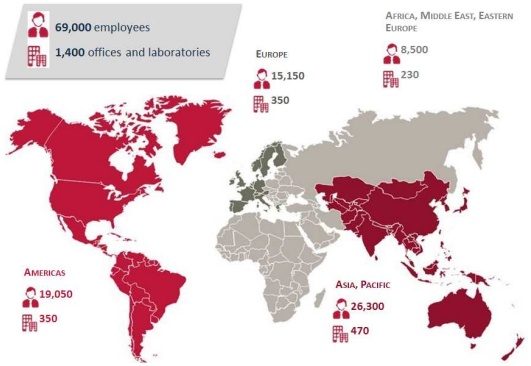
FUELLING 4D
FUTURE

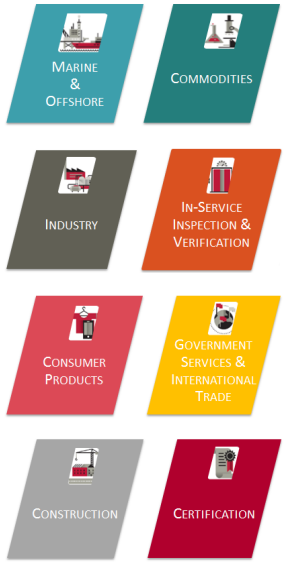
YOON Jang Yong, FICS
25 October 2017

BUREAU VERITAS GROUP AT A GLANCE

A world leader

- Eight global business, an extensive footprint
- 2016 group revenue: € 4.55 billion
- 189 years of expertise, experience and client trust
- The world's largest testing, inspection and certification company involved in ship classification





AGENDA

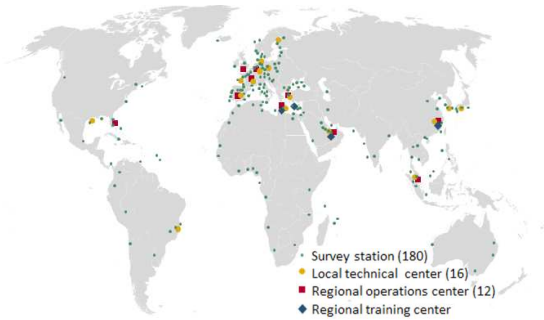
BUREAU VERITAS MARINE & OFFSHORE

A growing, young and diversified fleet

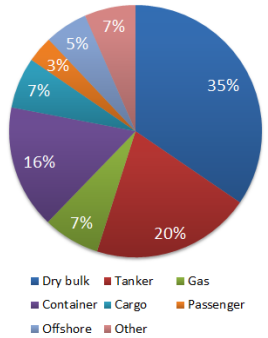
- 11,366 ships - 116.5m GT in class register
- 1,550 ships - 13.6m GT on order
- Average ship age 13.6 y

Ready to support you: whenever, wherever

- 2,650 maritime professionals around the world
- More than 130 flag state delegations



Bureau Veritas classed fleet (GT breakdown)



AGENDA

Introduction

LNG Fuelled vessels

Alternative Fuels

Hybrid vessels and fully electric ships

WHY LNG AS FUEL?

Current regulation issues

Issue	Regulation	Overview	Latest Position
Emission Control Areas (ECAs)	MARPOL Annex VI "Regulations for the Prevention of Air Pollution from Ships"	Vessels operating within ECAs are subject to stricter emission limits (SOx, NOx and PM)	**Current IMO ECAs:** Baltic Sea (SOx, May 2006; NOx, January 2021), North Sea (SOx, Nov 2007; NOx, January 2021), North American Sea (SOx, PM, Aug 2012; NOx, January 2021), US Caribbean Sea (SOx, PM, January 2014; NOx, January 2016). China has also introduced three domestic ECAs.
NOx Emissions	MARPOL Annex VI	NOx emission limits are set in three tiers for diesel engines >130 kW, depending on the engine maximum operating speed and year of build	**Tier I** - 2008 Global limit for ships built 2000-2010 **Tier II** - Global limit for ships built 2011-2015 **Tier III** - Limit for ships with a keel laid from 1st January 2016 onwards operating in North American and US Caribbean Sea ECAs; 1st January 2021 onwards in Baltic Sea and North Sea ECAs.
SOx Emissions	MARPOL Annex VI	Limits on the sulphur content of fuel to reduce SOx emissions and, indirectly, particulate matter (PM)	**ECAs** - 0.1% sulphur limit in fuel (%m/m) **Global limit** - 3.5% sulphur limit in fuel (%m/m), this is to be reduced to 0.5% from 1st January 2020 onwards.
CO_2	MARPOL Annex VI	Energy Efficiency Design Index (EEDI) for newbuildings > 400 GT, with an aim to reduce vessels' CO_2 emissions per capacity mile, and a Ship Energy Efficiency Management Plan (SEEMP) for existing ships, so as to improve operational efficiency	As of 1st January 2013, EEDI for newbuildings & SEEMP for existing vessels mandatory. Reduction of EEDI reference line in three stages (2015, 2020, 2025).
Greenhouse Gases (GHGs)	Monitoring, Reporting and Verification (MRV)	MRV aims to quantify GHG emissions, allowing regulators to establish limits and introduce emission reduction intitiatives such as emissions trading schemes	EU regulation on MRV mandatory in EU ports from 2018 onwards. The IMO is currently working on a MRV system and GHG reduction 'roadmap' for ships >5,000 GT, MRV expected strategy to be adopted in 2023.

Source: Clarksons Research, August 2017

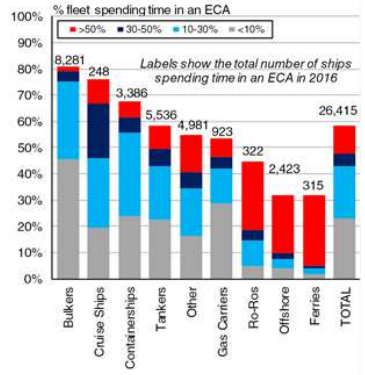
WHY LNG AS FUEL?

Who's in the Zone?

Graph of the Month

Vessel Emissions: Who's In The Zone?

The graph shows estimates of the proportion of time spent operating in current IMO emission control areas in 2016 by vessels in each sector (2,000+ dwt/GT). This analysis is based on data from the *Clarksons SeaNet* vessel tracking system, and takes into account the daily positions recorded for each vessel in the fleet at the end of the year (daily positions based on the first recorded position each day or the most recent daily position where no position was recorded in the day). It excludes vessels for which no daily positions were recorded during the year, taking total coverage to 86% of total fleet numbers.

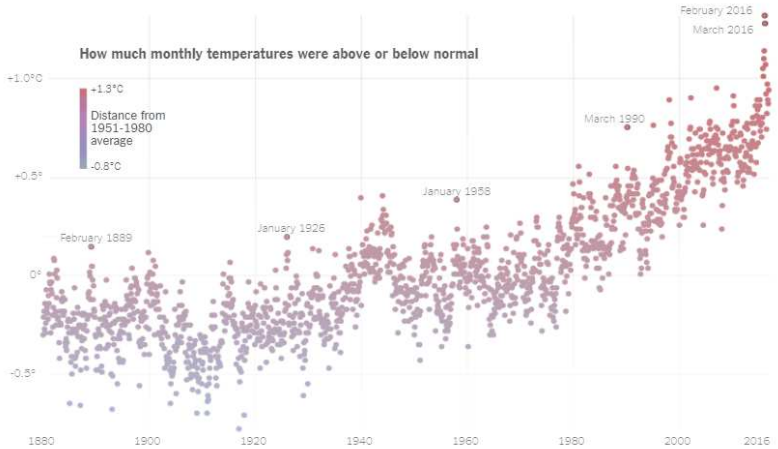


Source : Clarksons Research

Source: Clarksons Research, September 2017

WHY AM I SWEATING?

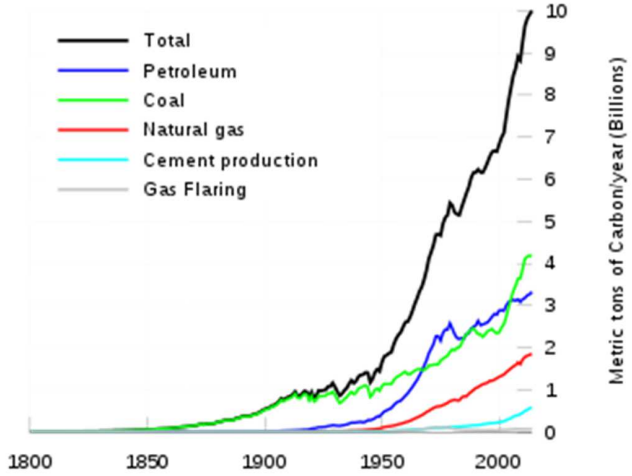
Our planet earth is heating up



Source: https://www.nytimes.com/interactive/2017/01/18/science/earth/2016-hottest-year-on-record.html

WHY AM I STILL SWEATING?

Environmental impact of the energy industry



https://en.wikipedia.org/wiki/Fossil_fuel#Environmental_effects

I AM STILL SWEATING…

Earth's oceans are warming 13% faster than thought, and accelerating

Our new study improves estimates of the rate of ocean warming - a critical component of climate change

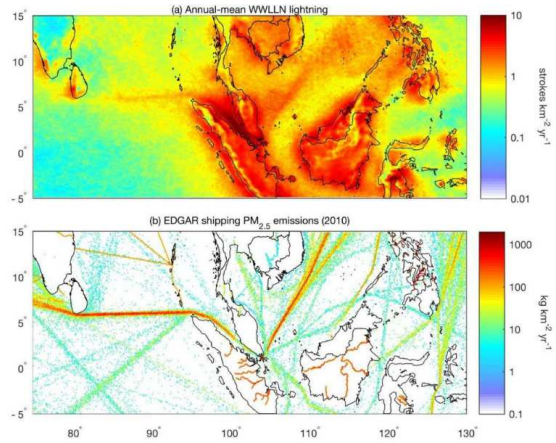
An Argo float is deployed into the ocean Photograph: CSIRO

New research has convincingly quantified how much the Earth has warmed over the past 56 years. Human activities utilize fossil fuels for many beneficial purposes but have an undesirable side effect of adding carbon dioxide to the atmosphere at ever-increasing rates. That increase - of over 40%, with most since 1980 - traps heat in the Earth's system, warming the entire planet.

Source: https://www.theguardian.com/environment/climate-consensus-97-per-cent/2017/mar/10/earths-oceans-are-warming-13-faster-than-thought-and-accelerating

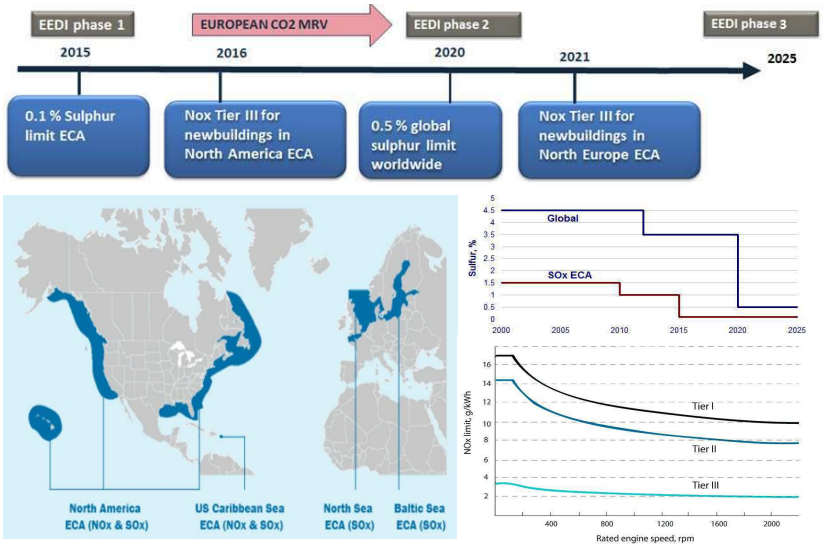
OUR EMISSIONS ARE DANGEROUS…

Ship exhaust makes oceanic thunderstorms more intense

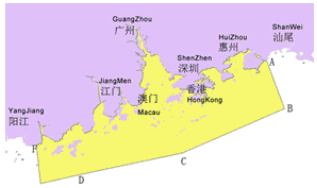


The top map shows annual average lightning density at a resolution of about 10 kilometers (6 miles), as recorded by the WWLLN, from 2005 to 2016. The bottom map shows aerosol emissions from ships crossing routes in the Indian Ocean and South China sea from 2010.
Credit: Thornton et al/Geophysical Research Letters/AGU.

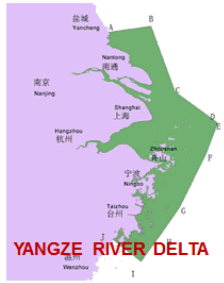
RULES OF THE GAME, EMISSION CONTROLLED AREA



CHINA, 3 EMISSION CONTROL AREAS



PEARL RIVER DELTA



YANGZE RIVER DELTA

BOHAI SEA

From 01/01/2016: 3,5% m/m max (possible request from core ports for max 0,5% during berthing)

From 01/01/2017: 0,5% m/m max during berthing excluding 1hour after arrival at core port and 1hour before departure from core port

From 01/01/2018: 0,5% m/m max during berthing at core ports

From 01/01/2019: 0,5% m/m max when entering to core ports

From 01/01/2020: 0,1% m/m max during berthing at core ports

To comply with the new requirements, vessels use fuel oil with a sulphur content of no more than 0.5% m/m, or other equivalent measures to reduce emissions including exhaust gas scrubbing, alternative clean fuels and shore power (cold ironing).

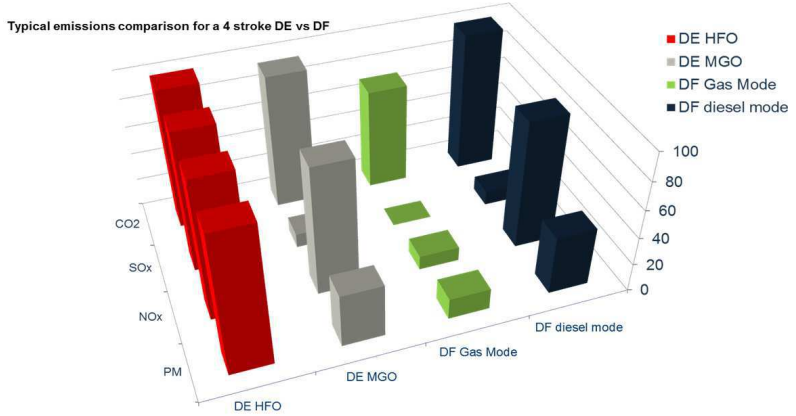
AFTER 2020?

LIKELY AREAS OF SULFUR EMISSIONS ENFORCEMENT AFTER 2020

Source: Platts

ADVANTAGES / GAS AND DUAL FUEL ENGINES

LNG as fuel significantly reduce air emissions (SOx, NOx, CO2, PM)

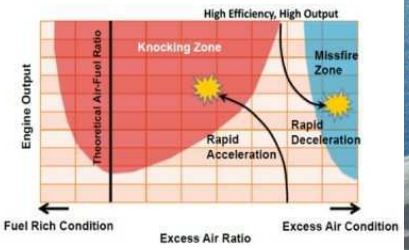


ADVANTAGES / GAS AND DUAL FUEL ENGINES

LNG as fuel significantly reduce air emissions (SOx, NOx, CO2, PM)

However some concerns are still to be considered:

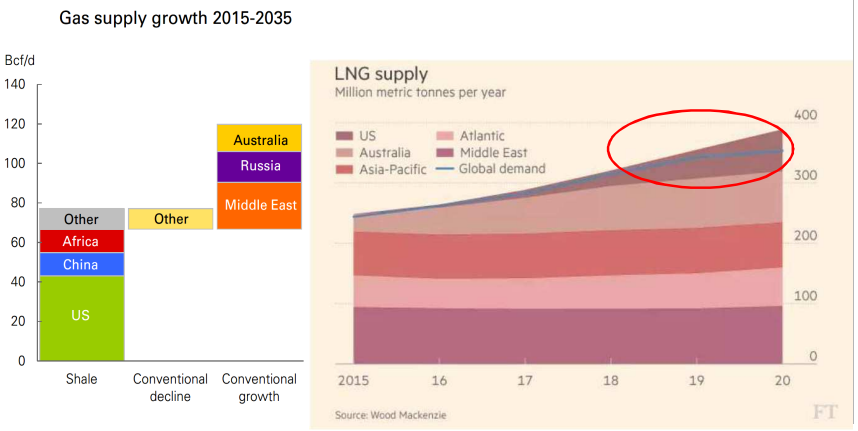
- Methane slip
- Knocking & misfiring



Note: However methane slip which aggregate unburned methane specifically in Otto cycle and possible limited gas vent after engine stop should be taken into account as it might reduce significantly the CO2 reduction advantage.

AMPLE LNG SUPPLY IN 2020?

Strong growth in gas supply led by US shale gas with possible oversupply of LNG in 2020:



LNG BUNKERING FACILITIES ARE DEVELOPING FAST

Global development of the LNG bunkering infrastructure with the highest density in Europe is encouraged by state financial and regulatory support of LNG initiatives

Launch of LNG infrastructure is planed in the key ports

Now with 124 LNG Bunkering Locations

- 60 Operational (39 in Europe)
- 28 to proceed
- 36 under discussion

Existing LNG Bunkering

LNG Bunkering infrastructure Planned or Under consideration

1	Norway & Sweden	4	Yangtze River	7	Tokyo bay	10	Port Fourchon	13	Great Lakes
2	North Europe	5	Shanghai	8	Singapore	11	Los Angeles	14	Buenos Aires
3	South Europe	6	Incheon/Busan	9	New York	12	Seattle/Vancouver/Tacoma		

WELL DONE, MR RUSSIA

18 NEWS TradeWinds 22 September 2017

LNG

Russia earmarks $1.63bn to spur its ships to switch to LNG fuelling

Ambitious plan projects use of gas will quadruple over five years as modern fleet becomes more efficient

Roderick Craig
Oslo

Moscow aims to stimulate use of LNG as fuel by seagoing and inland waterway vessels as part of a strategy to boost natural gas transition across the transport spectrum.

Russia's objective is to cut transport costs by 15% from 2018 to 2022, ensure the efficient use of energy resources, and limit the impact on the environment and public health by reducing harmful emissions by 30%.

The ministry of transport projects that the use of natural gas as a fuel will quadruple over five years, with its share of the federation's total fuel consumption rising from 0.5% (490 million cbm) to 2% (1.34 billion cbm) in 2022. Feedstock gas will primarily come from reserves in the resource-rich Far East.

The value of the sea and river transport component of the federal plan is projected at RUB 94.69bn ($1.63bn) from 2018 to 2022, comprising a total direct budget allocation of RUB 21.27bn supplemented by RUB 73.4bn from subordinate entities.

The programme will be co-ordinated by the Federal Marine and River Transport Agency.

The goal is to see LNG adopted by 25% of the Russian-flag seagoing and river fleet, with the amount of LNG used as marine fuel projected to rise from 20.6 million cbm in 2018 to 166.9 million cbm by 2022.

The ministry of transport details that about 50% of the federation's existing seagoing fleet and the bulk of river vessels, including passengerships, need to be replaced on the basis of age, with some 34% of the fleet over 30 years old.

The switch will be driven by financial incentives, including reimbursement subsidies for owners investing in LNG-fuelled vessels as well as VAT and customs duty exemptions on LNG-related marine equipment.

Russia is also mulling giving preference to LNG-vessel owners when awarding public contracts and introducing a long-term pricing policy to counter any sharp increase in LNG prices.

Subsidies will also be available for retrofitting, although the government notes that is not economically viable for older ships, considering it costs about $5m per vessel.

Other measures include increasing the capital base of the State Transport Leasing Company (GTLK) to finance the building of inland waterway vessels.

The government believes the transition to LNG will boost waterway competitiveness compared with road and rail. Pilot regions will be the Tatarstan, the Central Federal district around Moscow and the north-west, where there are significant existing cargo and passenger flows.

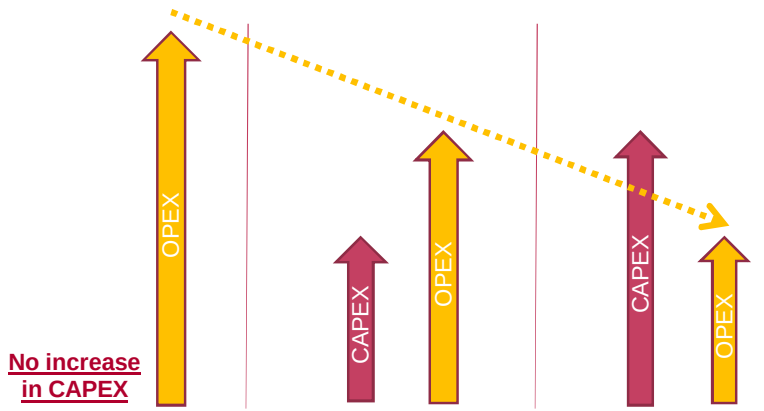
The programme also includes measures to spur the development of LNG storage and bunkering infrastructure at seaports and inland, research and development of new LNG-powered vessels to be built at domestic yards, and training of specialised seafarers and bunkering personnel.

By 2022, the programme projects three LNG bunkering and storage facilities in operation at seaports and up to three facilities on inland waterways.

The primary focus will be the Baltic basin, as it is a sulphur emission control area. But the government notes that bunkering bases are also planned on the Black Sea, in Sabetta on the Yamal peninsula and Vladivostok in the Far East.

COST-CUTTING: Russian president Vladimir Putin
Photo: Scanpix

ORDERING A NEW SHIP TODAY: WHICH TYPE OF FUEL?



No increase in CAPEX

Option A)
Usage of low sulphur HFO (0.5%) and treatment unit in EU ports and ECA for 0.1% compliance (or MGO)

Option B)
Usage of Scrubbers: HFO fuel (3.5% sulphur) with exhaust gas treatment units

Option C)
Usage of LNG as fuel

WHY BV AND LNG?

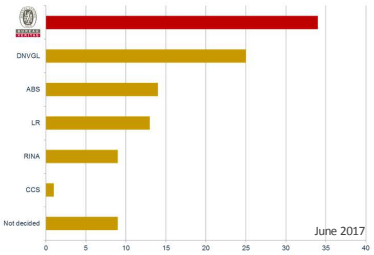
BV and LNG – more than 55 years at sea

- 1962 – Supervision of the prototype tests of the experimental LNG carrier “BEAUVAIS", and first Rules for LNG Carriers published by BV.
- 1965 – Classification of "JULES VERNE", 25,000 m3 LNG ship.
- 1971 – Classification of "DESCARTES", 50,000 m3 LNG carrier, Technigaz type
- 2006 – “GAZ DE FRANCE ENERGY”, 75,000 m3 first ever DFDE LNG C
- 2014 – YAMAL 15 x 170,000 m3 Arctic LNG carriers at DSME
- 2015 – Largest LNG ferry for Tallink at Meyer Turku
- 2016 – First ever LNG Bunkering Vessel for ENGIE, Mitsubishi Corporation and NYL Line at HHIC

GAS FUELED SHIPS

BV leadership

- Total fleet and orderbook above 200 ships
- BV leads orderbook for LNG fueled ships
- Wide coverage of ship types and sizes
  - → Tankers (product, gas)
  - → Container ships
  - → Cruise & ferries
  - → Workships (tugs, dredgers)



LNG BUNKERING CHAIN EXPANSION

Since 2002, Truck to Ship / Bunkering station

- Typically less than 200 m3

Shore to Ship

Since 2012, Small Scale Terminal

- Typically less than 1000 m3

Terminal to Ship

Since 2017, Purposely built LNG Bunker Vessel

- Limited to vessel’s dimensions

Ship to Ship

LNG BUNKERING CHAIN EXPANSION

(Purposely-built) LNG Bunker Ships

- NYK / ENGIE / Mitsubishi Corp / Fluxys delivered, BV Classed
- Sirius Veder delivered, BV Classed
- Multi-fuel bunker ships (HFO/MGO/LNG) under construction, BV Classed
- GTT membrane designs (4000, 5000, & 6500 M3), AiP by BV

5.100 m3 LBV built at HHIC
Courtesy of Engie

HFO/MGO/LNG
Courtesy of Suazdiaz

Courtesy of Sirius Veder

Courtesy of GTT

LNG BUNKERING CHAIN EXPANSION

Multipurpose Bunkering Ships

- Conversions of 4,000 dwt fuel oil bunker ship, BV Classed
  - → Schedule for conversion in 2017, GAINN4MOS EU Project

Courtesy of GAINN4MOS EU

BUREAU VERITAS CLASSED PROJECTS

Anthony Veder

- In service ***CORAL STAR*** and ***CORAL STICHO*** are 4700 M3 LNG/LEG/LPG carriers for Anthony Vender, built by AVIC Dingheng

- In service ***CORALIUS*** is the first European built LNG bunker and distribution vessel. LNG bunker capacity of 5800 M3. Catered to serve in all harbours in Nordic countries.

Evergas

- In service, eight 27,500 M3 LNG/LEG/LPG carriers for Evergas, built at Sinopacific and Yangzijiang

BUREAU VERITAS CLASSED PROJECTS (CONT.)

Bergen Viking

- Conversion of 3,750 dwt Oil/Chemical tanker

Terntank

- 4 x 16,400 dwt Oil/Chemical tanker "TERNSUND"
- Wartsila DF 2-stroke low pressure
- Type C LNG fuel tanks on deck
- Built in AVIC Dingheng

Fure West

- 3 x 17,770 dwt Oil/Chemical tanker
- Dual fuel main engine MAK 7M46DF of 6300 kW
- Caterpillar 3508 auxiliary engine(s)
- Type C LNG storage tanks on deck (2 x 255 M3 capacity)

BUREAU VERITAS CLASSED PROJECTS (CONT.)

DEME

- Dual fuel Dredgers "Scheldt River" and "Minerva"
- Powered by Wartsila engines, have a 'Green Passport' and a 'Clean Design' notation, complying and exceeding with the strictest international emission requirements.

Brittany Ferries

- HONFLEUR, to be built by Flensburger Shipyard
- Plans to switch its entire fleet to LNG power

MSC

- Mega plans for the Cruise industry
- 11 newbuildings by 2026
- To be built in STX France

BUREAU VERITAS CLASSED PROJECTS (CONT.)

Tallink

- 49000 GT / 212m LOA / 2850 Pax & 150 Crew
- Werft Yard Turku built

Sirocco

- In service, SIROCCO is 2700 M3 LNG/LEG/LPG carriers for inland navigation

LNG-Hybrid

- 75m LOA LNG-powered electric supply barge
- Five gas fuelled generator sets to produce in Hamburg port to supply cruise vessels and municipal grid
- LNG ISO tank containers + Caterpillar generator sets

BUREAU VERITAS CLASSED PROJECTS (CONT.)

Seaspan

- 2 x Wartsila 9L 34DF generators
- Single 200 CBM Type C tank below the main deck
- Hybrid battery pack power supply for low load operation

Desgagnes Group

- 3 x Asphalt Tankers, Polar class
- Wartsila DF 2-stroke low pressure
- Wartsila DF 4-stroke gensets
- Built in Betsiktas yard

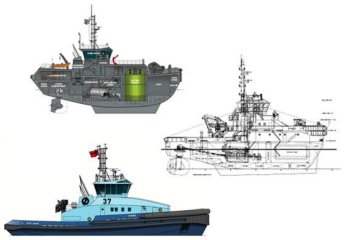
Sovcomflot

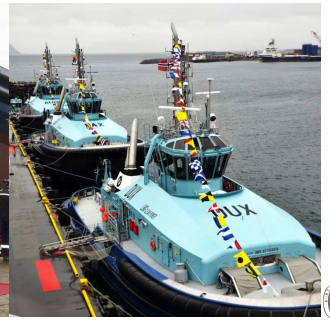
- 15 x 172,000 M3 LNG, Polar Class
- Year-round with ice upto 2.5m thick
- Wartsila DF 4-stroke
- Built in DSME

BUREAU VERITAS CLASSED PROJECTS (CONT.)

Tugs

- AiP granted to RAL designs (RANGLer 3600; RAstar 4000 DF)
- Highly sophisticated and powerful tugs
- Three orders confirmed for Ostensjo Rederi (Norweign Flag) Built in Gondon Shipyard
- BV involved in some other designs for European and Asian tugowners

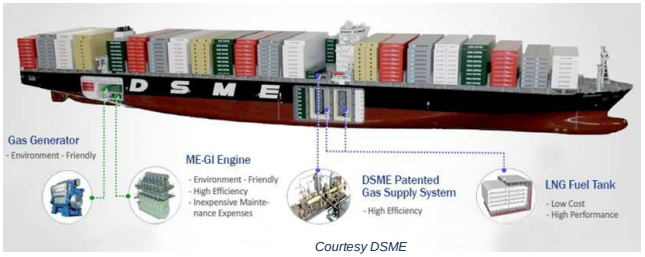




BUREAU VERITAS CLASSED PROJECTS (CONT.)

CMA CGM

- Ultra Large Container Ship (14,000 teu and above)
  - → 2-stroke dual fuel propulsion engine supplied with high pressure gas
  - → Auxiliary engines supplied with low pressure gas
  - → LNG storage in aluminum type B tanks below the accommodation
  - → Innovative gas supply system patented

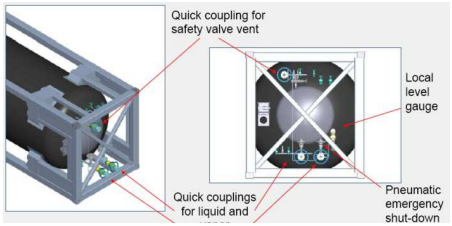


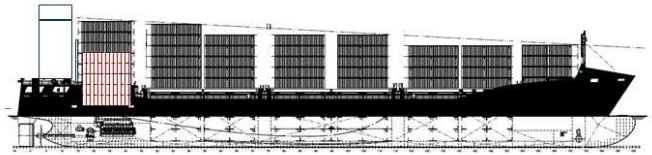
Courtesy DSME

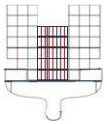
BUREAU VERITAS CLASSED PROJECTS (CONT.)

VEGA Reederei

- Feeder Container Ship (1,000 teu)
  - → Dual fuel main engine 4 strokes and generator sets
  - → Low pressure gas supply
  - → 38 M3 vacuum insulated containerised storage tanks



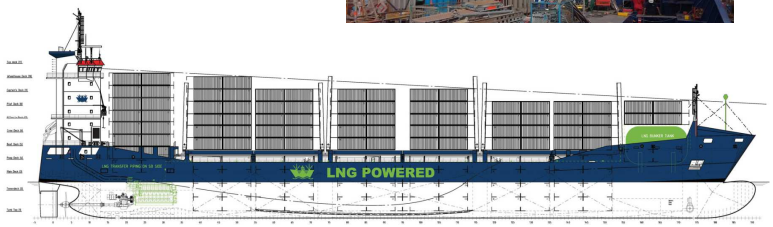




BUREAU VERITAS CLASSED PROJECTS (CONT.)

Wes Amelie

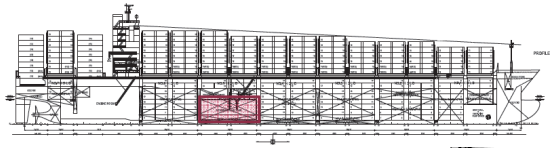
- First ever retro-fitted LNG fuelled Feeder Container Ship (1,000 teu)
  - → BV + 1 HULL AND MACH INWATER SURVEY AUT - UMS ICE 1A CONTAINERSHIP

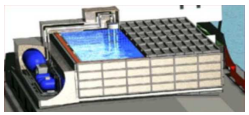


BUREAU VERITAS CLASSED PROJECTS (CONT.)

Membrane Tanks

- Ultra Large Container Ship (16000 teu)
  - → 2-strokes / DF low pressure engine + DF gensets; LNG tank 14000 M3
- Feeder Container Ship (4800 teu)
  - → High pressure ME-GI engine + DF gensets; LNG tank 7000 M3
- Aframax Tankers
  - → High pressure ME-GI engine + DF gensets; LNG tank 4000 M3





BUREAU VERITAS CLASSED PROJECTS (CONT.)

World's largest LNG cutter suction dredger

- DEME
  - → Dutch shipbuilder and maritime equipment supplier, Royal IHC was contracted to build a 44,180 kW LNG-powered cutter suction dredger

ARE WE READY FOR GREATER QUANTITY OF LNG DELIVERY?

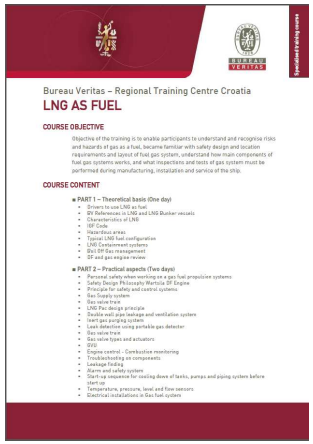
Yes!

- Bureau Veritas supported the adoption of clean fuel LNG through the classification of both vessels in the world's first ship-to-ship LNG bunkering operation between two independent ocean-going vessels. On September 3, 2016, Terntank Rederi's M/T Ternsund bunkered LNG at the entrance to the port of Gothenburg from Coral Energy, a Dutch small scale LNG vessel owned by Anthony Veder and chartered by Skangas.
  - → The 16,400 dwt Ternsund is the world's first LNG-fuelled newbuilding oil/chemical tanker. It was built under BV class at Avic Dingheng, China.
  - → Coral Energy, which has a capacity of 15,600 m3, is also built to BV class, **delivered 2013.**
  - → This Ship-to-ship bunkering is considered by the industry as the key to adoption of LNG as a marine fuel.

ARE WE REALLY READY FOR LNG BUNKERING?

Ah… Maybe… Still can can…

- LNG as fuel training according to STCW requirements
  - → In partnership with Wartsila.
  - → In compliance with STCW requirements


Bureau Veritas – Regional Training Centre Croatia

LNG AS FUEL

COURSE OBJECTIVE

COURSE CONTENT

GLOBAL APPROACH FROM BV

Infrastructures, FSRU, LNGC

- BV as a group synergies (Infrastructure – Industry – M&O)

Risk analysis → Design studies → Procurement → Construction → Acceptance → Preparing exploitation

LNG Fuelled ships

- Binding regulation & statutory compliances – BV M&O

Free consultancy service at pre design → Risk analysis → Classification of the ship

LNG bunkering operations

- Safe LNG transfer operations

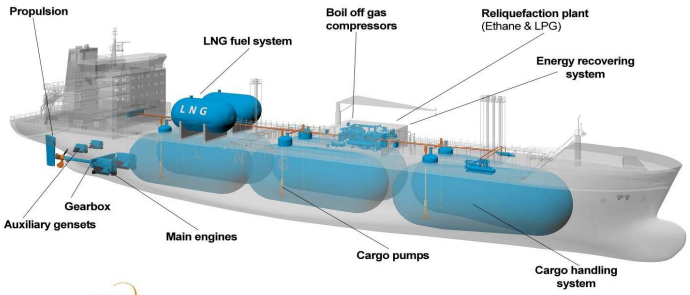
BV bunkering guidelines and others → Qualitative Risk Analysis → Permit delivered by Port Authorities

AGENDA

ETHANE AS FUEL IS THE NEW COMER

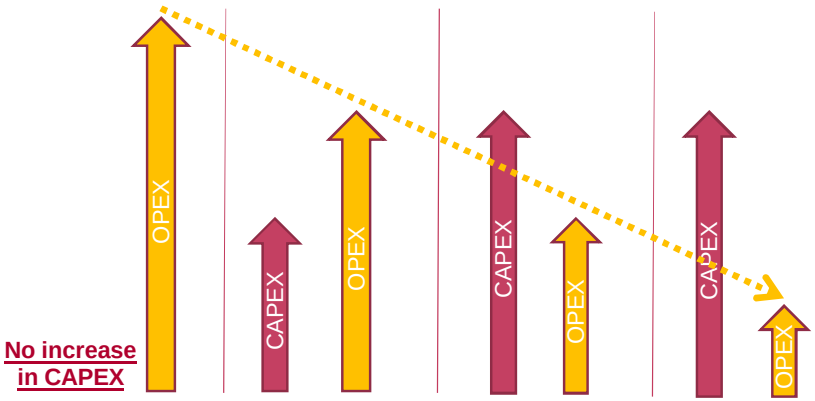
Evergas (Dragon Series)

- Ethane as fuel brings the same advantages for emissions compliance as LNG
- Due to her trade in Shale Gas / Europe trade, she is able to achieve lower fuel price than LNG



WÄRTSILÄ EVERGAS

EVERGAS USAGE OF ETHANE AS FUEL



Option A)
Usage of low sulphur HFO (0.5%) and treatment unit in EU ports and ECA for 0.1% compliance (or MGO)

Option B)
Usage of Scrubbers: HFO fuel (3.5% sulphur) with exhaust gas treatment units

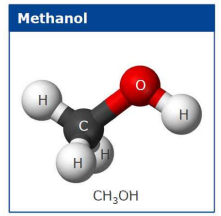
Option C)
Usage of LNG as fuel

Option D)
Usage of Ethane as fuel

METHANOL AS FUEL (BIO-FUEL)

High temperature Solid Oxide Fuel Cell (SOFC)

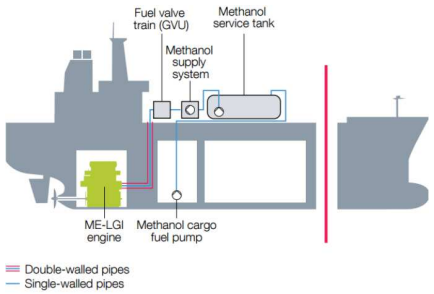
- Similar positive reductions as LNG in terms of Nox and Sox and particles matters (with no metane slip)
- Can be produced in many ways and used for many purposes
- Transport with regular tanker
- Infrastructure and safety similar to ethanol and oil
- Liquid – no high pressure, big commodity (55 million tons per year)
- Conversion of engines of existing vessel possible at low cost
- 5% diesel as pilot fuel to ignite – dual fuel engine
- Bio-degradable



METHANOL AS FUEL

Methanol using MAN B&W 2-stroke ME-LGI

- Waterfront Shipping Company, Marinvest / Skagerack Invest, Westfal-Larsen, and MOL took delivery of the first Korean and Japanese built methanol-fuelled ocean tankers “Lindanger”, “Mari Jone” and “Taranaki Sun”.
- All 7 Methanol-fuelled vessels entered service in 2016, totally more than 4500 operations hours on methanol.



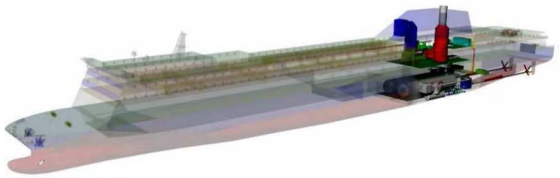
LPG AS FUEL

Ships using LPG as fuel

- 8 ethylene carriers built in 2007 under BV class (07915F)
- First use of LPG as fuel

GE LM2500 combined cycle

- The world's first LPG-fuelled ferry design to use GE's COGES system (Nov 2016).



HYDROGEN AS FUEL OR CARGO (LH2)

LH2 as cargo challenges

- Health Hazards (Personal Safety)
- Major Hazards – Fires and Explosions (Process Safety)

AGENDA

HYDROGEN AS FUEL CELLS

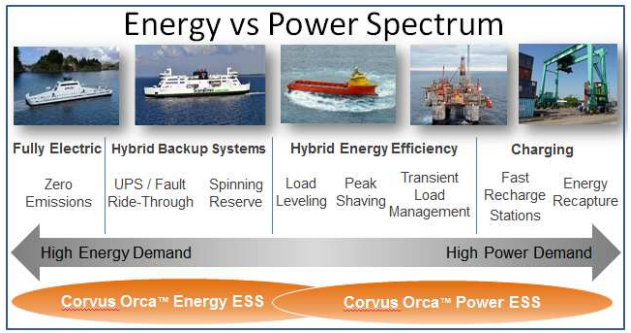
H2 as fuel feasibility proven

- Zero CO2 sailboat
- H2 Shuttle in La Rochelle and Nantes
- PEM fuel cells with high pressure storage tanks
- Fuel of the future when H2 is produced from renewable sources (Hydroelectricity, sun, wind)
- Associated by batteries buffer packs.

ELECTRIC HYBRID VESSELS

Corvus Energy ESS Selected by Rolls-Royce for Hybrid Vessel

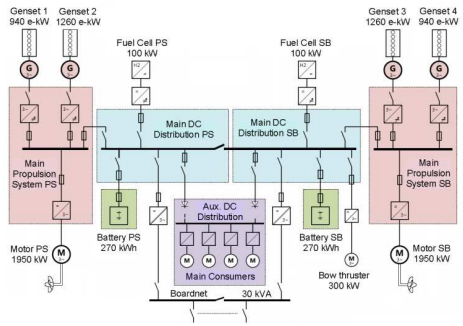
- Lithium ion based based energy storage system (ESS) for the Norwegian Coastal Administration's new multipurpose vessel OV Ryvingen.
- To have battery recharged during docking.
- Cutting noise and vibration level on board.
- Due to delivery towards end of 2018.



HYDROGEN AS FUEL

Green Tug

- Hybrid diesel electric power system of 2x 1260 e-kW and 2x 940 e-kW diesel generators, 2x 100 kW PEM FC and 2x 270 kWh batteries
- Three operational modes and power management settings
  - → Stand-by (73%) fuel cells + charging batteries
  - → Transit (12%) fuel cells + batteries
  - → Ship assist (15%) gensets + fuel cells + charging / discharging batteries (depending on power demand / dynamic power management)
- Zero-Emission endurance 1.5 h at 7 kn
- Hydrogen storage options
  - → Compressed gas (CGH2)
  - → Liquid Cryogenic Gas (LH2)
- Option for exhaust gas treatment



HYDROGEN AS FUEL

Green Tug

- Emission (reduction) profile

Emission reduction	Hybrid drive only	Hybrid drive with exhaust gas cleaning	Design target
CO_2	52%	52%	50%
NOx	69%	89%	90%
SOx	99%	99%	90%
PM	85%	99%	90%

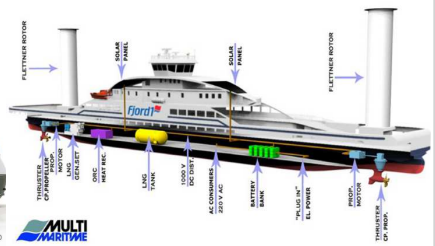
- Design reviewed by BV in accordance with "Guidelines for Fuel Cell Systems on-board Commercial Ships" (NI 547, 2009)

Project Leader & Designer: OFFSHORE SHIP DESIGNERS

Project Partners: BUREAU VERITAS, SMIT, Iskes Towage & Salvage, NedStack, Linde Gas, Linde, BAKKER SLIEDRECHT, MARIN

ELECTRIC HYBRID VESSELS

Current Electric Hybrid Vessels (non BV class)



ELECTRIC HYBRID VESSELS

Current Electric Hybrid Vessels (BV Class)

Courtesy of LDA

Courtesy of STQ

Courtesy of BC Ferries

Courtesy of Seaspan Ferries

LNG HYBRID RORO SEASPAN FERRY (SFC)

LNG Hybrid RO-RO SEASPAN Ferry (SFC)

MAIN PARTICULARS			PROPULSION MACHINERY		
Length overall	148.9 m	488'-6"	DF Main engines	2 x 4,320 kW	2 x 5,873 hp
Length waterline	145.2 m	476'-4"	Emergency generators	1 x 125 kW	1 x 170 hp
Breadth moulded	26.0 m	85'-4"	Bow thrusters	2 x 550 kW	2 x 748 hp
Depth main deck	7.0 m	22'-11"	Propulsion thrusters	2 x 2,200 kW	2 x 2,991 hp
Design draft	4.25 m	13'-11"	Battery system	1 x 410 kW	1 x 550 hp

LNG HYBRID RORO SEASPAN FERRY (SFC)

LNG Hybrid RO-RO SEASPAN Ferry (SFC)

- Corvas Lithium Ion Energy Storage System (ESS)
  - → Power Back Up for critical and high power operations
  - → "Peak Shaving" (reducing load fluctuations seen by engine)
  - → Zero-emission operations
  - → Improved dynamic response (DF engine response)
  - → "Spinning" reserve (reducing number of engine online)
- Main propulsion system / 9L34DF LNG-diesel dual fuel engines
  - → Combination produces 9 kW at 750 rpm

NUCLEAR POWER AS FUEL

Floating Russian nuclear power plant headed for Great Belt Bridge

- A mock-up of Akademik Lomonosov (photo: Rosatom)
- But we're told there's no need to panic

NUCLEAR POWER AS FUEL

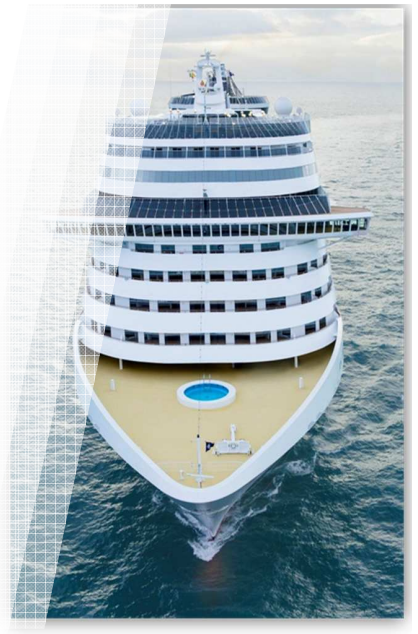
Fire aboard floating nuclear plant ignites fresh debate

- A fire broke out on the floating nuclear power plant being built at a shipyard in the center of St. Petersburg, but was extinguished before anyone was injured, Russia's emergency services ministry said yesterday. Published on July 5, 2017 by Charles Digges (charles@bellona.no)

BUREAU VERITAS

Move Forward with Confidence

THANK YOU VERY MUCH FOR YOUR KIND ATTENTION!



LNG / MGO SPOT PRICING

LNG-Fuelled Ship Sees 24% Bunker Cost Savings

Wednesday August 2, 2017

Share Share Tweet Follow 5,673 followers

An LNG-powered passenger ship operating out of the **South Korean** port of **Incheon** is achieving bunker cost savings of **24 percent** compared to diesel-fuelled vessels, Korea Bizwire reports.

The LNG-powered Econuri as presented in an IPA promotional video. Image Credit: IPA

The vessel, named *Econuri* and first launched in 2013, was built by the **Incheon Port Authority** (IPA) and said to be **Asia**'s first LNG-fuelled ship.

IPA officials last week presented information about the vessel at the **Fourth Annual LNG Bunkering Conference** in **Singapore**.

While the unit cost of the LNG bunkers was not revealed and LNG spot prices are notoriously difficult to obtain, in general LNG bunkers have the potential to offer large savings compared to the equivalent energy provided by MGO.

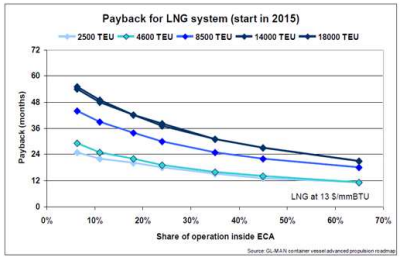
For example, at the port of **Vancouver** where Ship & Bunker provides exclusive energy equivalent spot LNG bunker prices, the ex-wharf LNG-MGOe price - that is, the price for an amount of LNG that delivers the energy equivalent of one metric tonne of MGO - is currently **$284.50**.

This compares to an MGO price in the port of **$589.50/mt**.

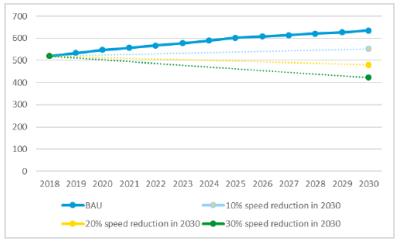
A video released by IPA explaining more about the vessel can be found here: https://www.icpa.or.kr/eng/article/view.do?articleKey=8332&boardKey=268&menuKey=1808&currentPageNo=1

Ship & Bunker News Team

To contact the editor responsible for this story email us at editor@shipandbunker.com



Regulating speed: a short-term measure to reduce maritime GHG emissions



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