LNG is leading the diversity of marine fuels

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Singapore

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- Driving force for cleaner marine fuels
- LNG takes the leading role
- Diversification is emerging

Global and regional sulphur caps

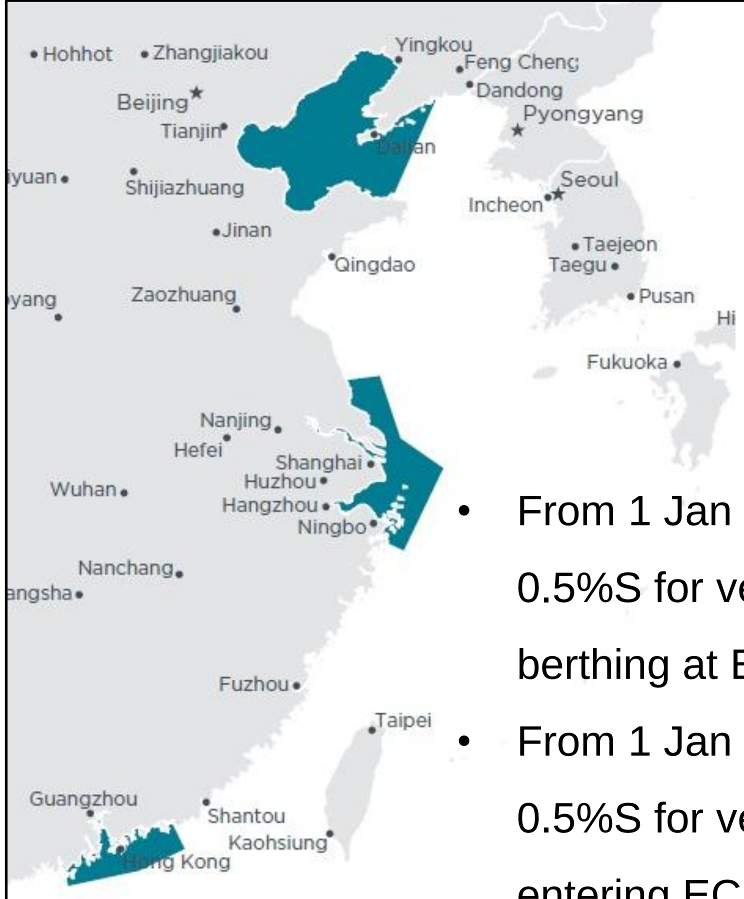
- There is no turning back.

  — *Secretary-General Kitack Lim*
- Debate has been concluded and the best thing is for the industry to move on.

IMO global sulphur cap

- From Fair Winds Charter to mandatory requirements effective from 1st July 2015
- Berthing ocean-bound vessels to use oil with sulphur content <0.5%

Hong Kong



- From 1 Jan 2018, 0.5%S for vessels berthing at ECA ports
- From 1 Jan 2019 , 0.5%S for vessels entering ECAs

China Domestic ECAs

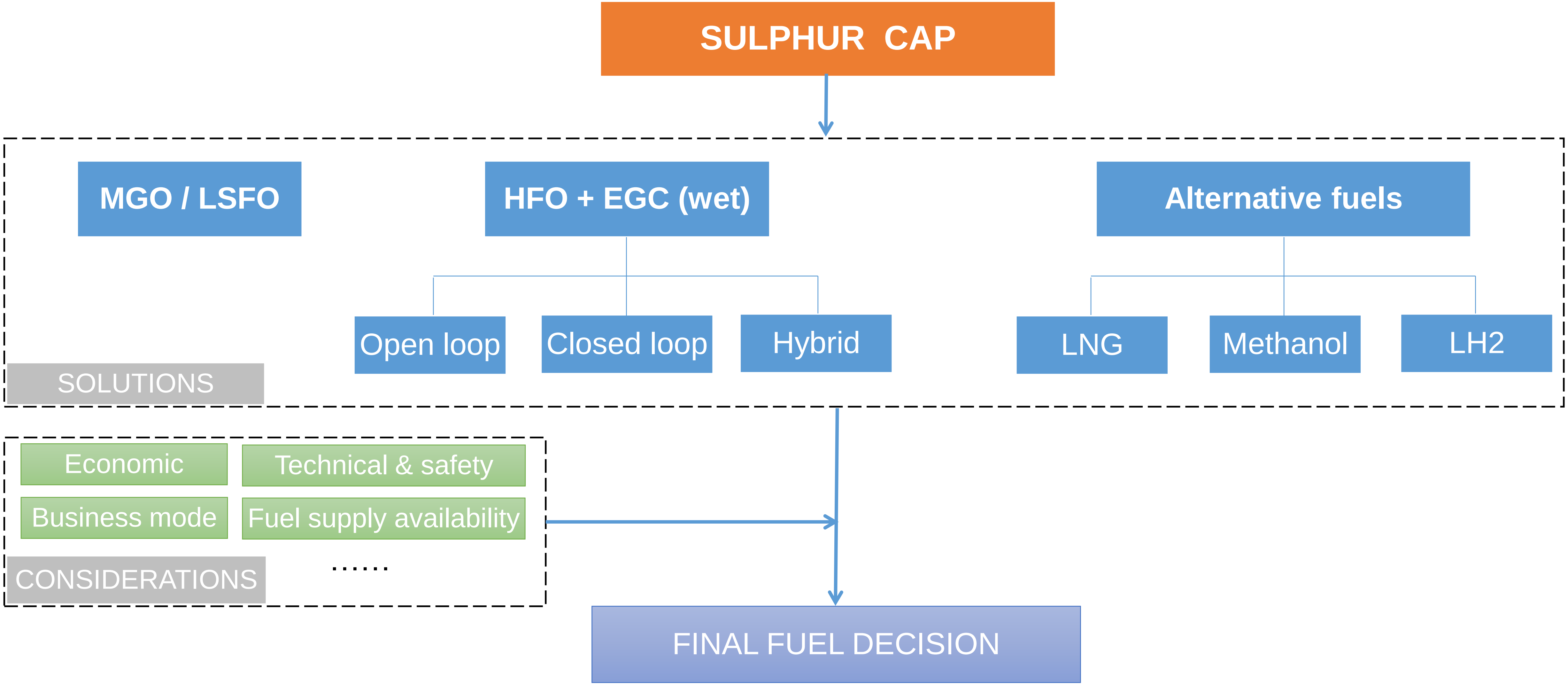
- Voluntary application, 25% reduce of port dues;
- Fuel oil with sulphur content <1%;
- using approved abatement / scrubber technology ;
- Using LNG or other clean fuel.

Singapore Green Port Programme

- From1 Jan 2019, all vessels entering ports are to use oil with sulphur content < 0.5%;
- Administration grant a subsidy to ships making the change to lower-sulphur fuels before 1 Jan 2019

Tai Wan

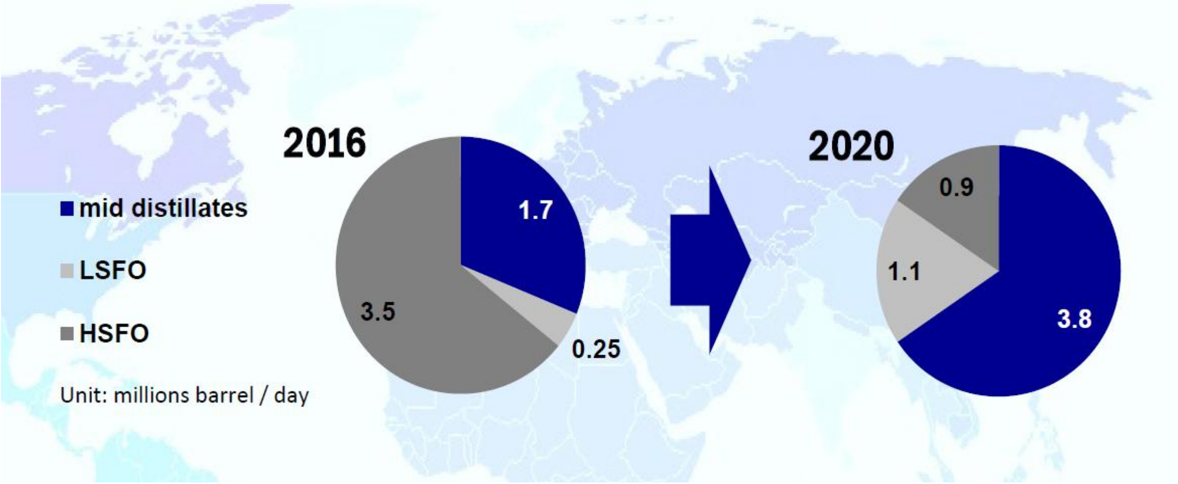
Compliance strategies for sulphur cap



MGO / LSFO solution

Distillate fuel

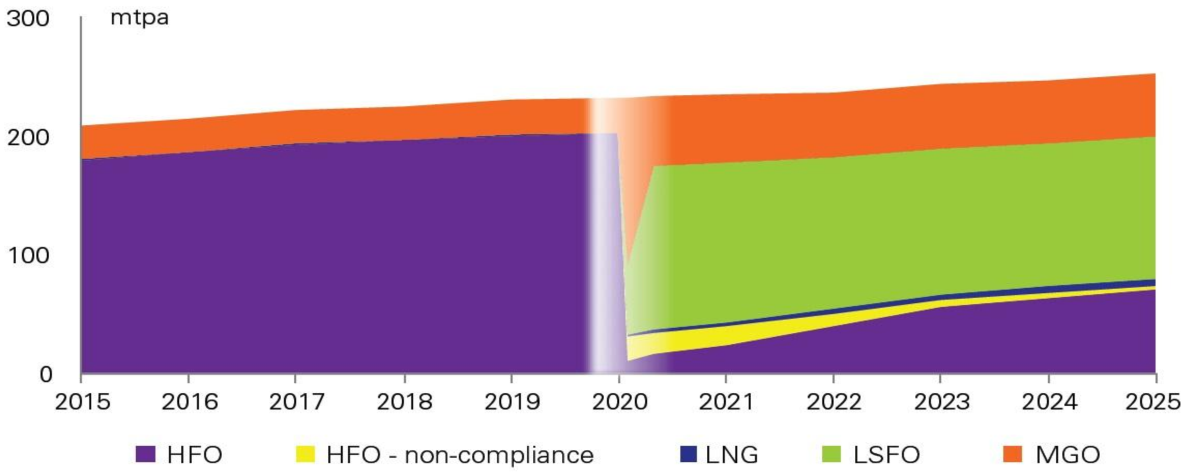
- MGO is widely available and operationally tested.
- If the shipping industry switches from HFO to MGO, it would require significant adjustments in the refining industry to meet demand for more distillate based MGO and a reduction in output of heavy fuel oil.



IMO projections:
MGO demand to increase by 125% to 3.8 Mio barrels/day by 2020

LSFO

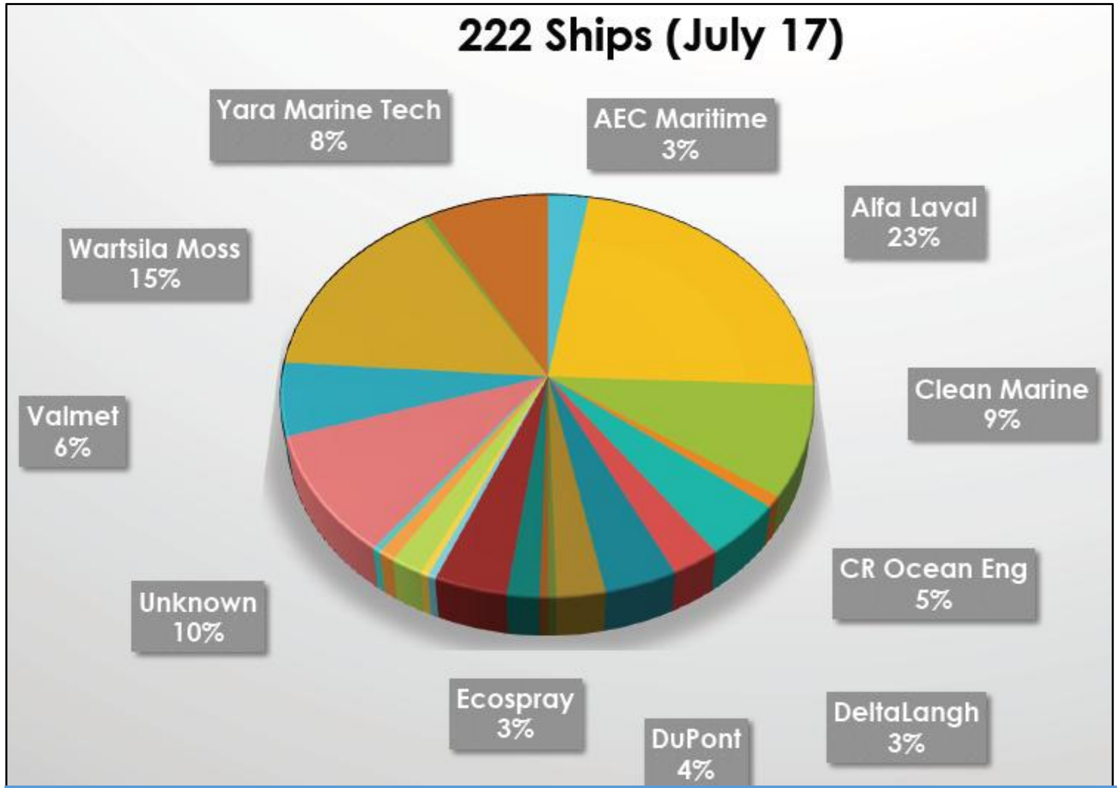
- 0.5%S LSFO is expected to be produced by following methods:
  - blending HFO with distillates;
  - desulfurizing of HFO;
  - producing from sweeter crude oil with enough low sulphur.
- Official sources indicate that compliant fuels will be sufficiently available by 2020.



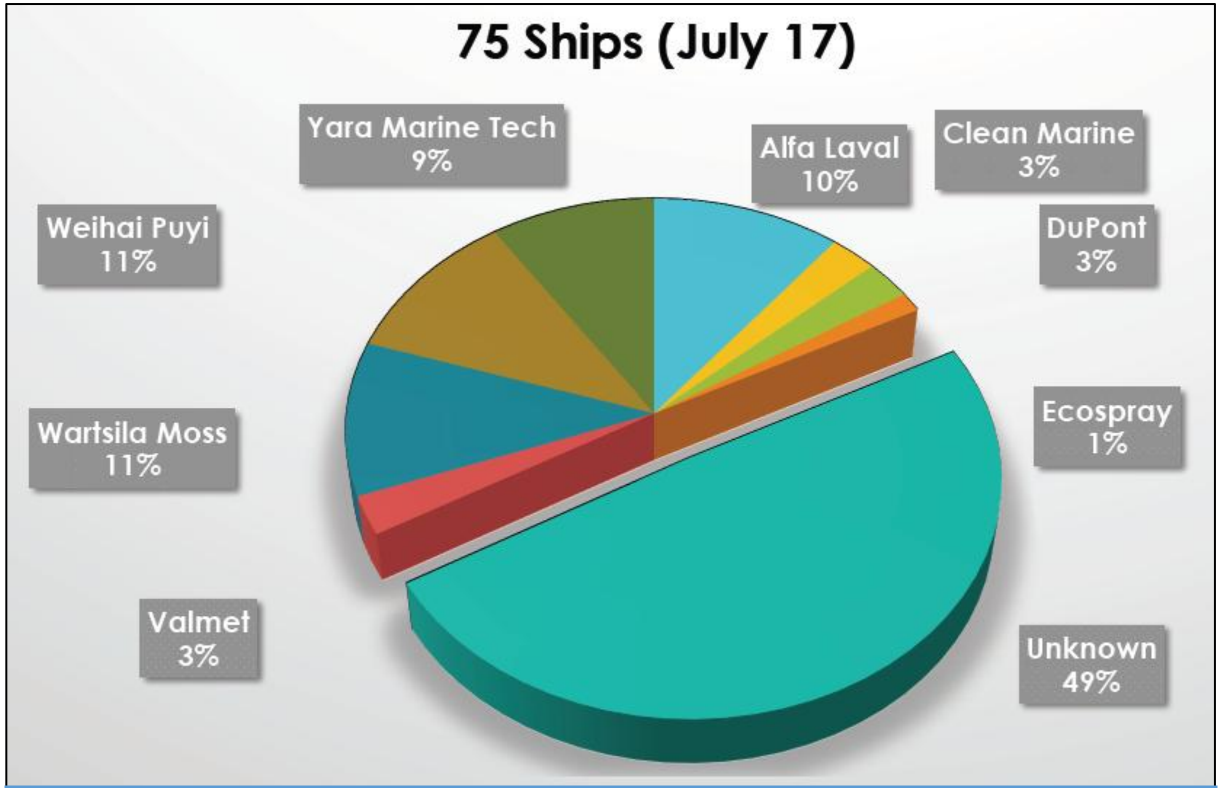
The 0.5%S LSFO will supply over 50% of the market after 2020

Source: BP

HFO + Scrubber solution



Retrofits

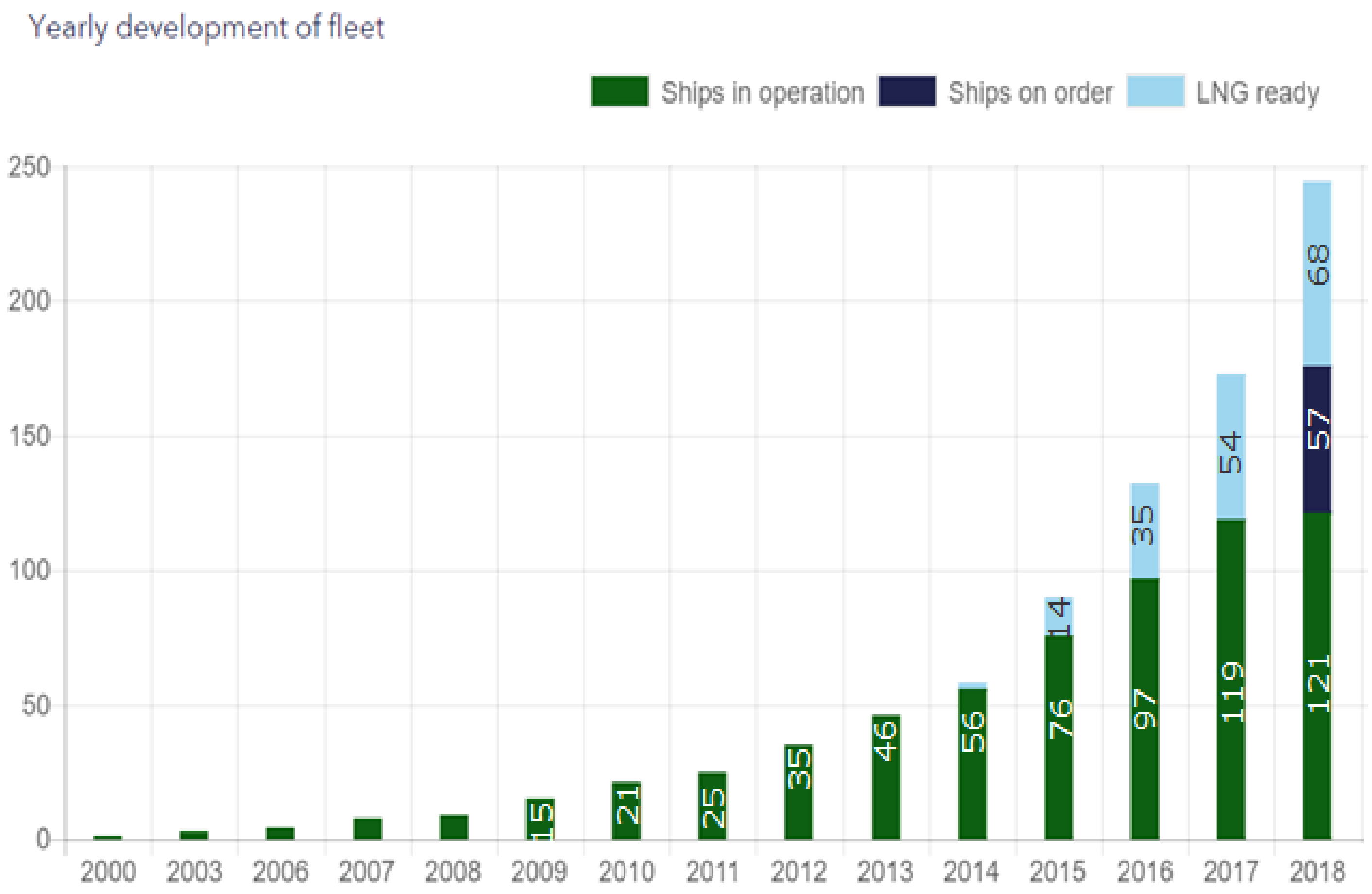


New orders

Source: Clarksons Research

LNG solution

- The last year or two have definitely been notable for the number of gas-fuelled vessels delivered and ordered.
- Last year was a seminal period in the advance of LNG as a marine fuel, in terms of number and ship types.
  - one new LNG-fuelled vessel ordered almost every week.
  - Of the ordered vessels, only a handful are tugs or domestic ferries and by number the largest groups are container ships followed by cruise vessels.
- Bunker Infrastructure slowly growing, now 150 locations worldwide where LNG can be obtained in bulk..



Updated 1 Mar, 2018 *Source from: DNV-GL*

What’s the Industry preference at present ?

- It seems most shipowners and operators still prefer to “wait and see” approach;
- A scrubber installation may prove more economic;
- Although both LNG EGC will achieve cleaner exhaust emissions, it would seem that organisations such as the EU are more in favour of the former;
- Shipping giants, such as Maersk, is currently not in favour of the scrubber systems, which strongly affects the industry sentiment;
- Residual fuel production will be in even greater distress and it is likely that the spread between compliant fuels and residual bunkers will increase. On one hand, this will create even more post-2020 impetus to install scrubbers, but on the other hand, refiners with no financially viable outlet for residual production will make immediate and drastic decisions that may even lead to some marginal refineries being shut down.
- The whole scrubber decision may be moot; if only a few install them we may very quickly have little or no residual production.

Source: *Alfa Laval*

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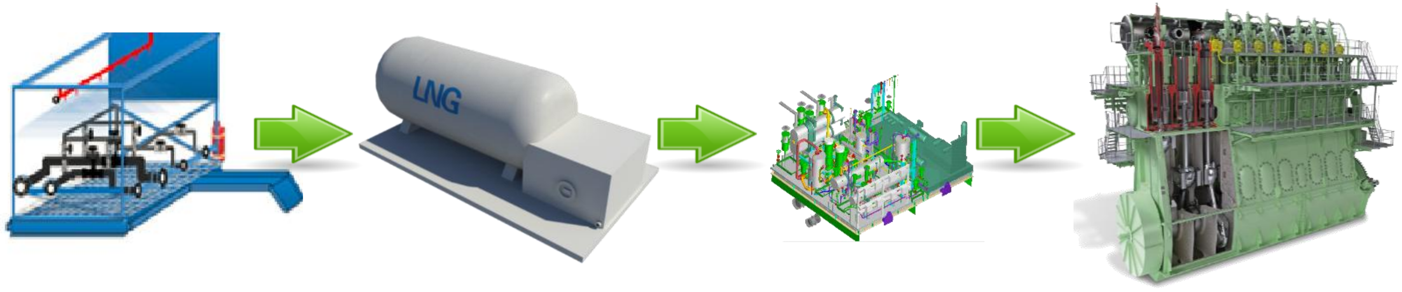
LNG technology is well proven

Key parts	Technical points
Gas engine	• Ignition (spark/pilot fuel) • gas admission(pre-mix/direct injection/individual port) • thermodynamic cycle (Otto cycle/Diesel cycle) • ER configuration（gas safe/ ESD protected）
FGSS	• low pressure • high pressure
Storage tank	• self-support type(A, B & C) • membrane
Bunkering system	• leakage protection • monitoring & alarm • safety control

Bunkering system **LNG storage tank** **Fuel gas supply system** **Gas engine**

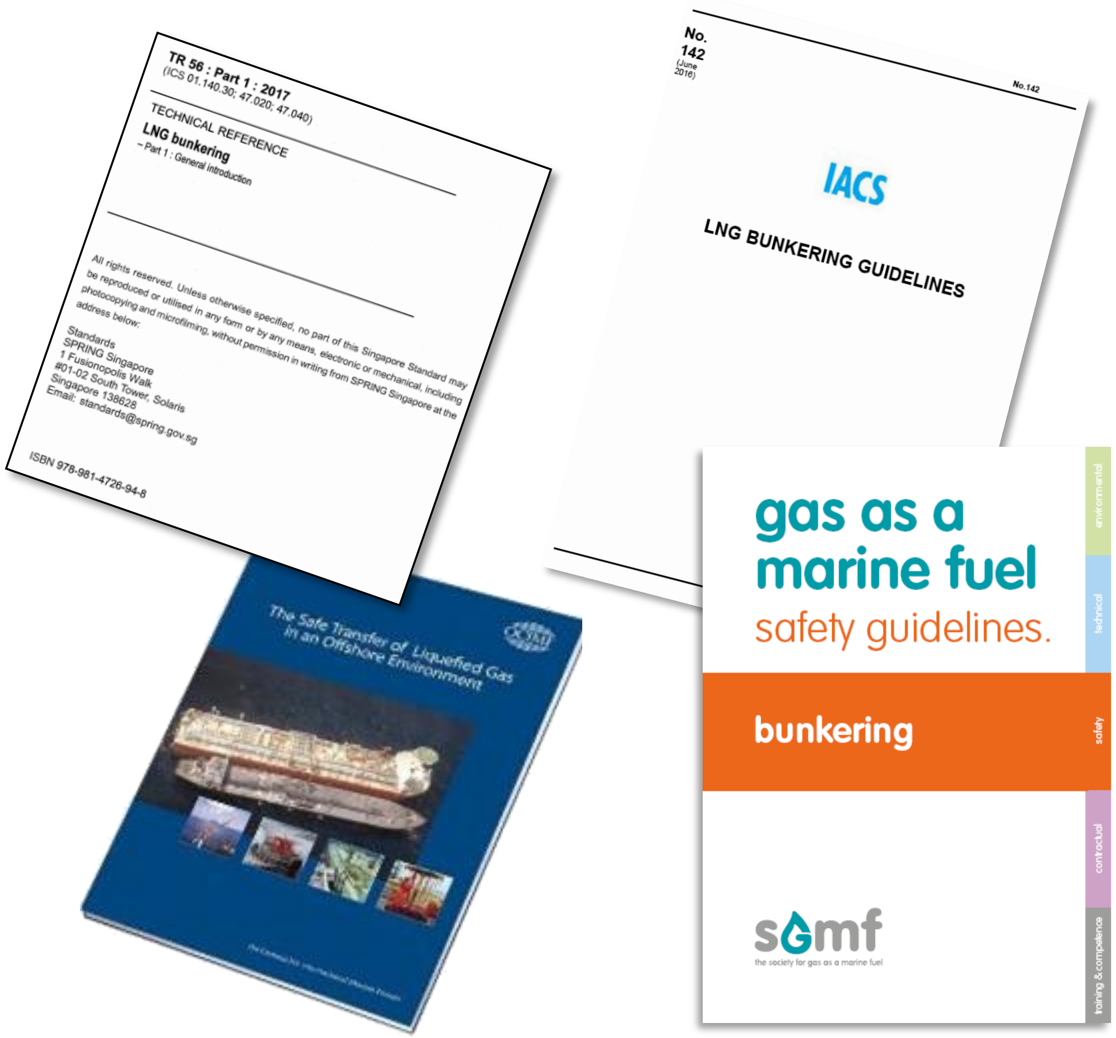


- LNG technology is well proven with 40 years experience in LNG carrier;
- LNG used as marine fuel already cover almost all ship types, growing experience with new applications of the fuel technology will further strengthen the confidence of shipping industry.

Regulations, Rules and Industry standards are all in place

- IMO IGF Code
- Class Rules
- IACS Rec.142, SGMF Bunkering Guidelines, MPA TR 56
- ISO 118683, etc

International Code for Ships Using Gases and other Low Flashpoint Fuels (the IGF Code), effective from Jan 1, 2017



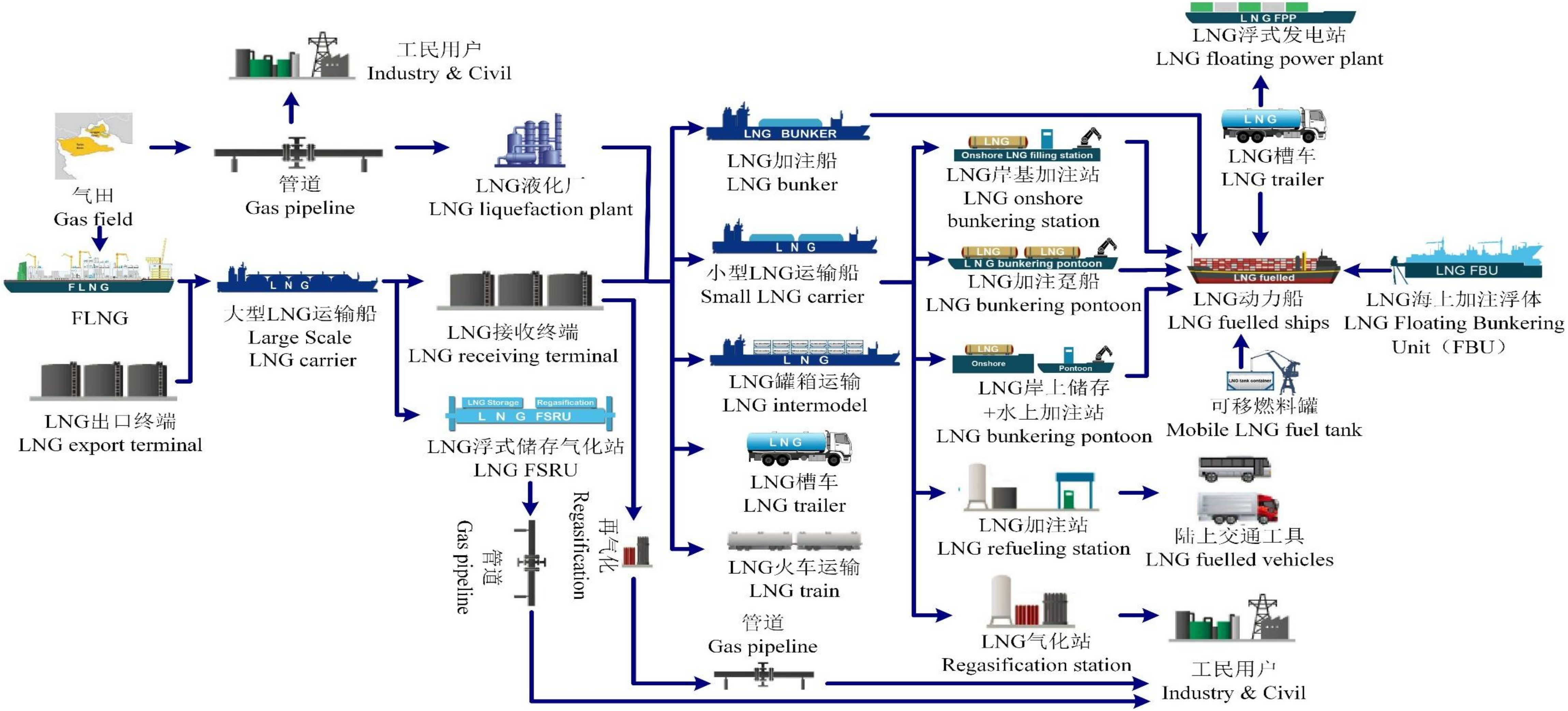
LNG bunkering availability is growing

No.	Delivery	Name	Owner	Description	Base	Capacity	Tank type
1	2013	Seagas	Viking Line	Refuel Viking Grace	Stockholm	180m3	type-C
2	2017	ENGIE Zeebrugge	JV of ENGIE/Gas4Sea	world's first purpose-built LNG bunkering vessel	Zeebrugge	5000m3	type-C
3	2017	Cardissa	Shell	Transfer rate about 1,000 m^3/h	Rotterdam	6500m3	type-C
4	2017	Coralius	Skangas	first European built LNG bunker	Kattegat and Baltic Seas	5800m3	type-C
5	2017	*Oizmendi*	Itsas Gas	• Spain's first LNG supply vessel • Converted from a 3,200 dwt pollution control vessel; • Deck mounted tanks	Bilbao, Spanish	2×300 m3	type-C
6	2018	Clean Jacksonville	CME (U.S.)	• Non-propelled • transfer rate 50 ra0 m^3/h	US Florida	2200m3	GTT Mark III
	2018 Q3	*FlexFueler1*	Titan LNG	• Pontoon, fuel IWW and small seagoing vessels	Amsterdam	2×380 m3	Type C
7	2018 Sep	TBN	Babcock Schulte Energy	• Transfer rate of up to 1,250 m^3/h; • store returned gas in a CNG tank prior to FGSS.	Klaipeda in Lithuania	7500m3	type-C

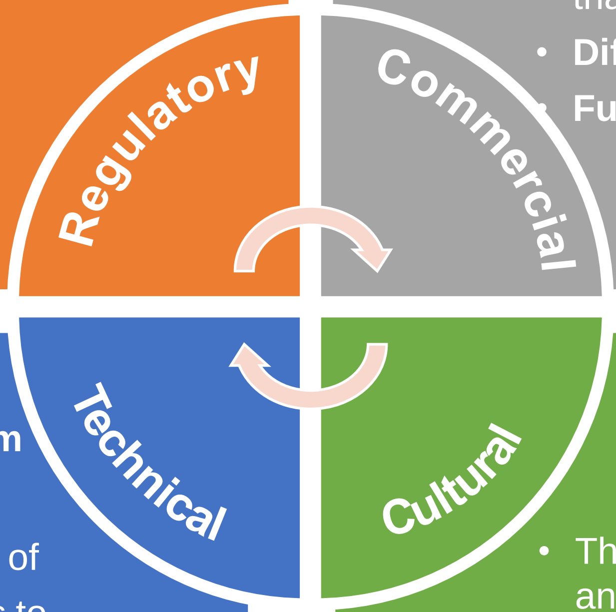
LNG bunkering availability is growing

No.	Delivery	Name	Owner	Description	Base	Capacity	Tank type
8	2018	*Coral Methane*	Chatered by SHELL	• converted from Anthony Veder's 7,500 m^3 *LNGC*	southern part of the North Sea and the Mediterranean	7500m3	type-C
9	2020	TBN	TMFGS/MOL	• largest LNGBV, built in Hudong SY • Refuel CMA CGM mega box ships	northern Europe	20,000m3	GTT Mark III
10	2019	TBN	Victrol/CFT	Chatered by SHELL	Rotterdam	3,000 m3	4 type-C tanks
11	2020	TBN		• Chatered by SHELL • built for Quality LNG Transport (Q-LNG) to the articulated tug/barge design.	US southeast coast	4,000m3	type-C
12	2019	TBN	Stolt-Nielsen	• built at Keppel Singmarine • 2 sister ships		7,500m3	type-C
13	2017	*TBN*	Korea Line	built at Samsung Heavy Industries	Korea	7,500m3	KC-1 membrane

Waterborne LNG value chain is forming and strengthening



Challenges still exist for LNG used as marine fuel



- **Confusing regulatory landscape:** many jurisdictions still do not have enough experience with the marine use of LNG, resulting in convoluted approval processes, or absent guidelines for deployment .
- **Regional inconsistencies**

- **Access to capital:** initial investment for LNG conversions and new-build vessels is higher, than for conventionally fuelled ships.
- **Diffuse Benefits**
- **Future fuel price uncertainty**

- **Bunkering availability remains a problem**
- **"First Mover Tax":** the first movers face higher costs; however, a significant portion of the benefits from their investments accrues to the public and their followers.
- **New technology and safety concerns**

- The cultural resistance to a less familiar fuel and technology is contributing to some of the perceived barriers.

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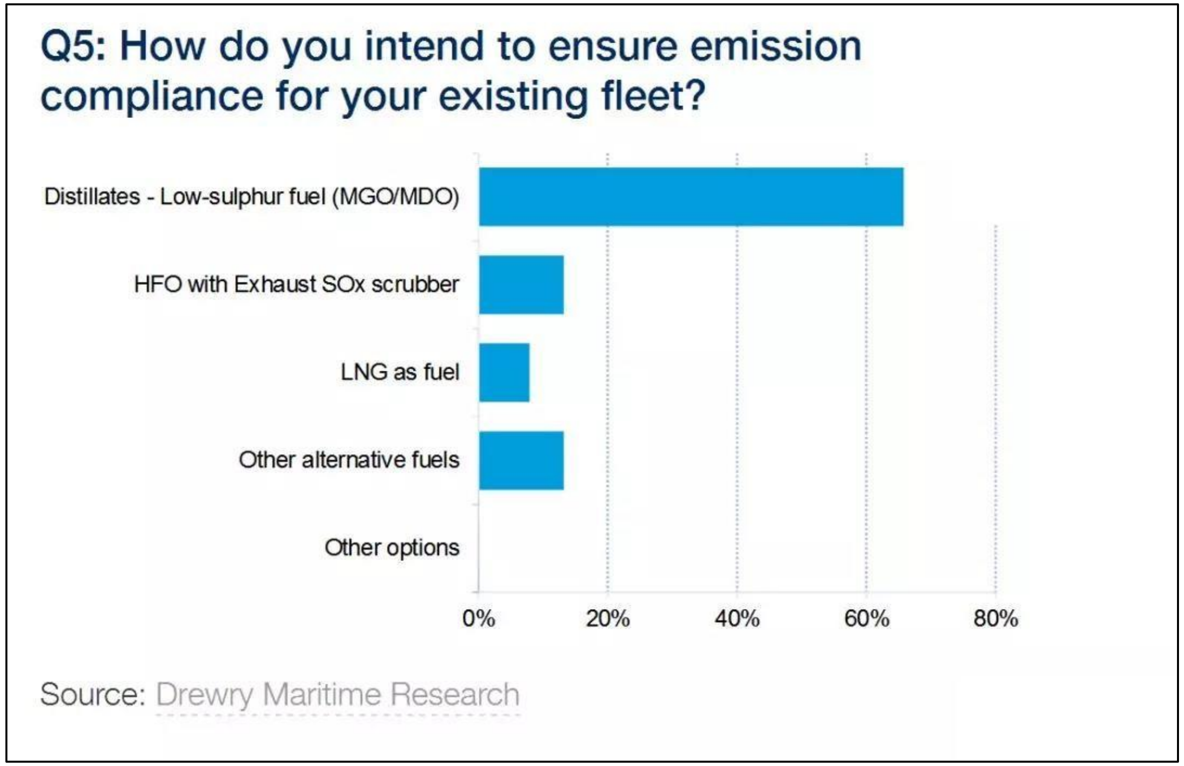
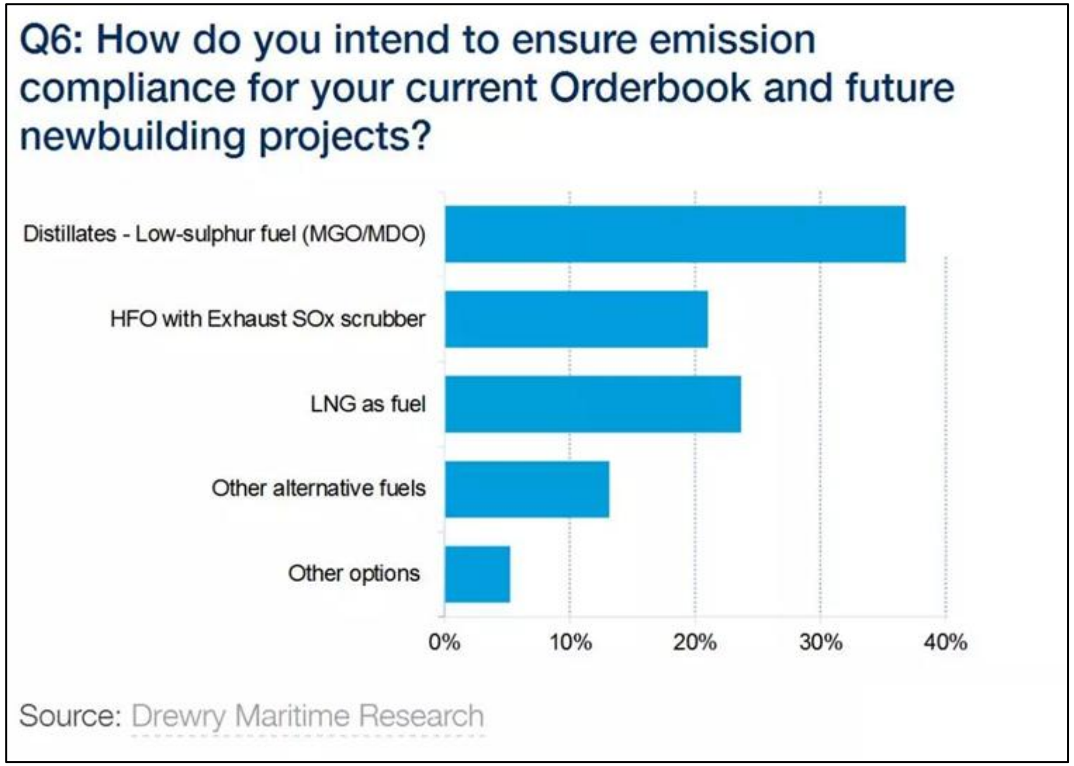
- Driving force for cleaner marine fuels
- LNG takes the leading role
- **Diversification is emerging**

Industry preference to cope with low sulphur cap





LSFO:	66%
HFO + EGC :	13%
LNG :	8%

LSFO:	37%
HFO + EGC :	21%
LNG :	24%

Methanol used as marine fuel

Project Name	Dates	Project Type, Coordinator	Fuels Tested	Ship Types
METHAPU Validation of Renewable Methanol Based Auxiliary Power System for Commercial Vessels	2006-2009	Prototype EU FP6 Project, coordinated by Wärtsilä Finland	Methanol in Solid Oxide Fuel Cell	Car Carrier (PCTC)
Effship Efficient Shipping with Low Emissions	2009-2013	Primarily paper study with some laboratory testing, coordinated by SSPA Sweden AB and ScandiNAOS	Methanol in laboratory trials, other fuels discussed in desk studies	General to most ship types, with case examples of a short-sea ro-ro vessel and a Panamax tanker
SPIRETH Alcohol (spirits) and ethers as marine fuel	2011-2014	Laboratory testing, on-board testing (DME converted from methanol) with an auxiliary diesel engine, coordinated by SSPA Sweden AB and ScandiNAOS	Methanol in a converted main engine (in a lab) DME (converted from methanol on-board) in an auxiliary engine	Passenger Ferry (RoPax)
Methanol: The marine fuel of the future (Also referred to as "Pilot Methanol" by Zero Vison Tool)	2013-2015	Conversion of main engines and testing on-board, project coordinated by Stena AB	Methanol	RoPax ferry *Stena Germanica*
MethaShip	2014-2018	Design study coordinated by Meyer Werft	Methanol and DME	Cruise Vessel, RoPax

Partial list of projects involving the use of methanol as marine fuel (source: EMSA)

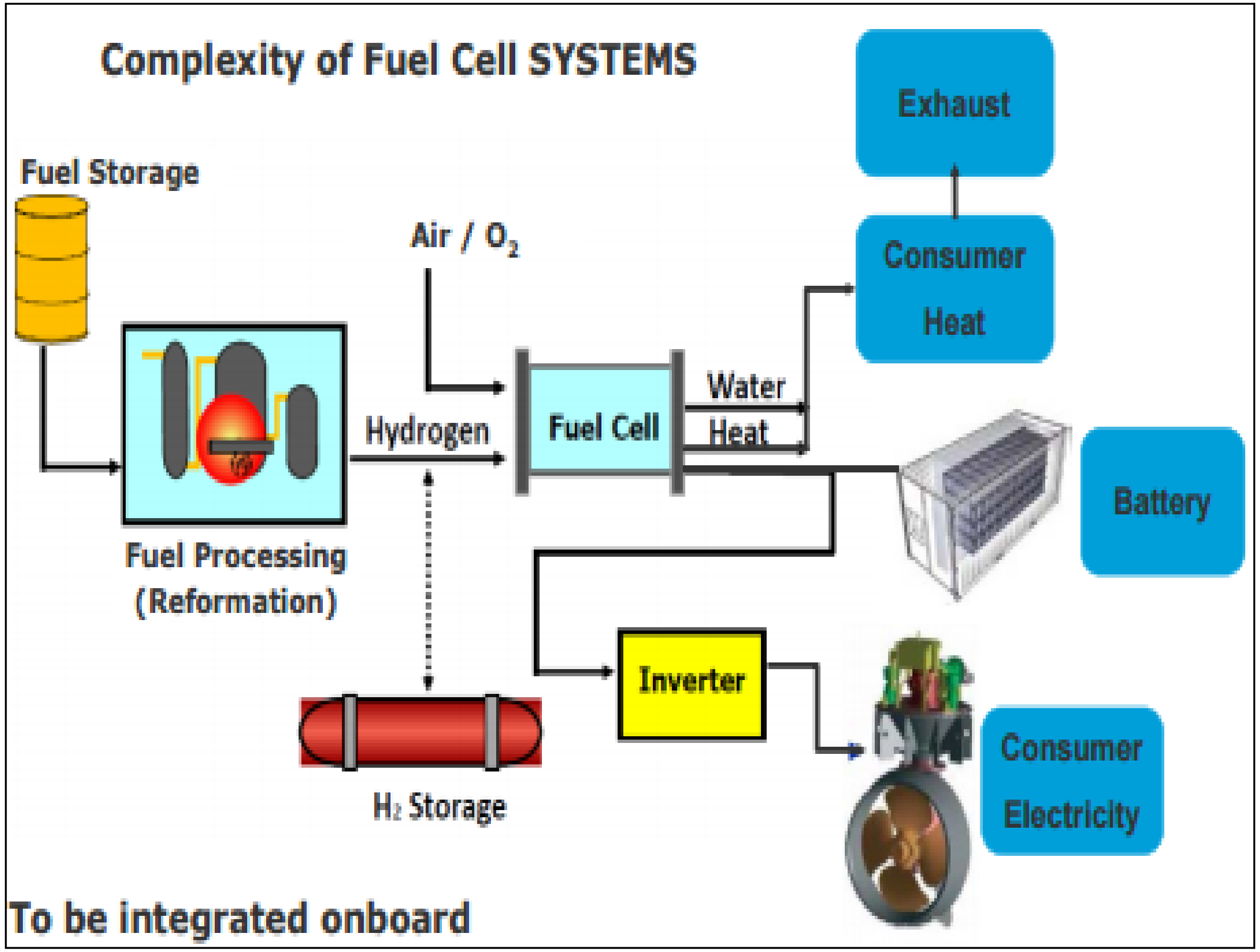
Delivered in 2005, 7 methanol carriers of 50k DWT are powered by its cargo — methanol

RoPax ferry Stena Germanica (24 MW), is the first of its kind to be converted to methanol

Fuel cell application onboard ships

Viking Lady, 1st commercial vessel to use FC technology, with FC operates at 650℃ and generates 320kW of power.

FC powered tramcar, 2x120kW, developed by China Railway Rolling Stock Corporation (CRRC), with compressed H2



Regulation for ships using alternative fuels is on the way

- IMO IGF Code phase II (requirements on Methyl / Ethyl alcohol, FC, etc) will be finalized this year;
- Some class Rules, such as CCS Rules for ships using alternative fuels is in place.
- Industry Guidelines is on the way.

DRAFT TECHNICAL PROVISIONS FOR THE SAFETY OF SHIPS USING METHYL/ETHYL ALCOHOL AS FUEL

Note: *Changes are indicated relative to annex 1 to document CCC 3/3. Deletions are indicated with a strikethrough line and insertions are underlined.*

1 PREAMBLE

(**NOTE**: This chapter should be kept for the purpose of the Interim Guidelines, but deleted for the purpose of amending the IGF Code)

The purpose of these interim guidelines is to provide an international standard for ships using methyl/ethyl alcohol as fuel.

The basic philosophy of these interim guidelines is to provide provisions for the arrangement, installation, control and monitoring of machinery, equipment and systems using methyl/ethyl alcohol as fuel to minimize the risk to the ship, its crew and the environment, having regard to the nature of the fuels involved.

Throughout the development of these interim guidelines it was recognized that it must be based upon sound naval architectural and engineering principles and the best understanding available of current operational experience, field data and research and development.

These interim guidelines address all areas that need special consideration for the ~~usage~~ <u>use</u> of the methyl/ethyl alcohol as fuel. These interim guidelines consider the goal based approach (MSC.1/Circ.1394). Therefore, goals and functional requirements were specified for each section forming the basis for the design, construction and operation.

The current version of these interim guidelines includes [regulations] to meet the functional requirements for methyl/ethyl alcohol as fuel.

2 GENERAL

2.1 Application

(**NOTE**: This section should be kept for the purpose of the Interim Guidelines, but deleted for the purpose of amending the IGF Code)

Unless expressly provided otherwise these interim guidelines apply to ships to which part G of SOLAS chapter II-1 applies.

DRAFT NEW CHAPTERS 16 AND 18 PROPOSES FOR INCORPORATION IN THE DRAFT TECHNICAL PROVISIONS FOR THE SAFETY OF SHIPS USING METHYL/ETHYL ALCOHOL AS FUEL

Note: *The draft chapters below were developed using chapters 17 and 18 of the IGC Code.*

16 DRILLS AND EMERGENCY EXERCISES

Drills and emergency exercises on board shall be conducted at regular intervals.
Exercises related to low flash point fuels, such as methyl/ethyl alcohol shall at least include following:

.1 tabletop exercise;

.2 review of fueling procedures based in the fuel handling manual required by <u>17.2.3</u>

.3 responses to potential contingences;

.4 tests of equipment intended for contingency response; and

.5 reviews that assigned seafarers are trained to perform assigned duties during fueling, operation and contingency response.

Methyl/ethyl alcohol related exercises shall be incorporated into periodical drills required by resolution A.741(18) (The ISM Code) <u>[SMS]</u>

Summary

- 2020 sulphur cap is a game-changer, IMO determination on implementing sulphur cap shall no longer be underestimated. Although the “wait and see approach” still rage, the best thing is to move on;
- LNG as fuel is expected to increase fast due to the proven technology, growing bunkering availability and solid regulatory framework, thus it takes the leading role of next generation marine fuels. However, there are still challenges exist;
- There is no one-size-fits-all solution for the shipping industry, and the best option depends on vessel type, size of vessel, operational profiles and which fuels are available in the short and long term, this results in the diversification of next generation marine fuels, which including LSFO, LNG, alcohol fuels, hydrogen, etc;
- CCS is poised to help our valuable customers to meet the challenges with our service and solutions.

Safety，Environmental protection，Create value for clients & society

For more details, please contact

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