



大连船舶重工集团有限公司  
DALIAN SHIPBUILDING INDUSTRY CO.,LTD.

# Green Technology Development Alternative Fuel

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# OUTLINE

01

**Our Perspective on Green Technology**

02

**DSIC Green Technology Activities**

03

**Ammonia Fuel Solution for 23,000TEU**

# 1. Our Perspective on Green Technology

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## □ Alternative Fuel Technology

- Alternative fuel technology is most effective way to achieve IMO mid-term target
- In 2050, abt. 64% of the total amount of CO2 reduction is contributed to by use of alternative fuels
- Considering marginal cost of alternative fuel is relatively high, energy-saving solution is also critical for future shipping.

## □ Energy Saving Technology

- Wind Propulsion
- Air Lubrication
- Low Friction Hull Coating
- Energy-saving device for rudder & propeller and etc.

### Future Shipping

- Low Energy Consumption
- Low carbon fuel



## 2. DSIC Green Technology Activities – Delivered Project

### ❑ World First VLCC with Wind Sailing System Delivered on Nov. 2018

- 12knots, Laden Condition, Middle East - Far East
- Considering global wind resources
- Average energy saving abt. 5%



### ❑ Second Generation, to be Delivery on Sep. 2022

- Two pairs, energy saving abt. 10%
- Composite material applied, cut 30% weight
- Real-time analysis system and structure healthy monitoring system applied
- Optimized control strategy

## 2. DSIC Green Technology Activities – Ongoing Project, to be delivered in 2021

### ❑ World First VLCC with LNG Power

- Innovative collaboration with COSCO Shipping
- Equipped with 2 Type C Tanks: 3500m<sup>3</sup> x 2
- Endurance: 24,000 nm (12,000 nm LNG as fuel)
- Attained EEDI Phase III

Research  
on

- Propulsion System
- Fuel Gas Supply System
- Gas Storage System
- Auxiliary System



### 3. Ammonia Fuel Solution for 23,000TEU

#### □ Development Story

◆ Kick-off in March 2019

◆ AiP certificate granted by LR in Shanghai Dec. 2019

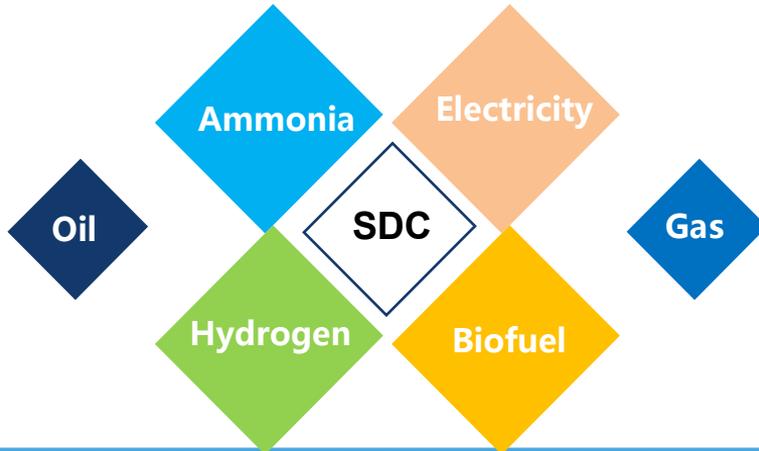
◆ Design further developed in 2020



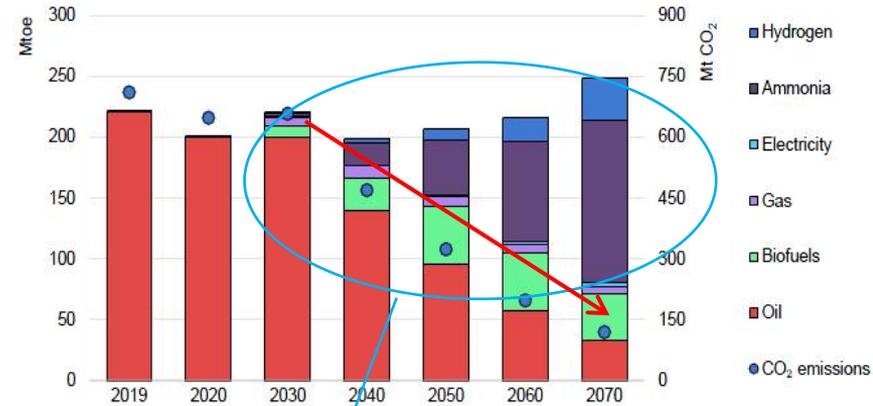
### 3. Ammonia Fuel Solution for 23,000TEU

#### □ The Closest Alternative to an Ideal Fuel , Ammonia

- Carbon free, Easily reformed to H<sub>2</sub> and N<sub>2</sub>
- Can be stored and transported as liquid at relatively low pressure or high temperature
- Low flammability risk —15-25 % in air
- Higher energy density than Hydrogen per cubic meter



Global energy consumption and CO<sub>2</sub> emissions in international shipping in the Sustainable Development Scenario, 2019-2070



Source:IEA

Ammonia as fuel is most promising solution

### 3. Ammonia Fuel Solution for 23,000TEU

#### □ Main propulsion

- Based on MAN 11G95ME-C10.5-LGIP(A)
- Biodiesel for pilot and standby
- *(Crack ammonia to get hydrogen to ignites)*

#### □ Electricity

#### Generator burning NH3/Biodiesel

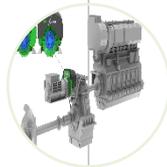
- Assuming there will be marine generator burning NH3 soon later
- Use biodiesel for Generator sets

#### Shaft generator + CPP

Shaft generator combined with CPP to use the power of main engine from low load to high load.

#### Shaft generator + gearbox + FPP

Shaft generator combined with gearbox to use the power of main engine from low load to high load.



FASS

CSSC  
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MAIN ENGINE

MAN  
MAN Energy Solutions

SHAFT GENERATOR

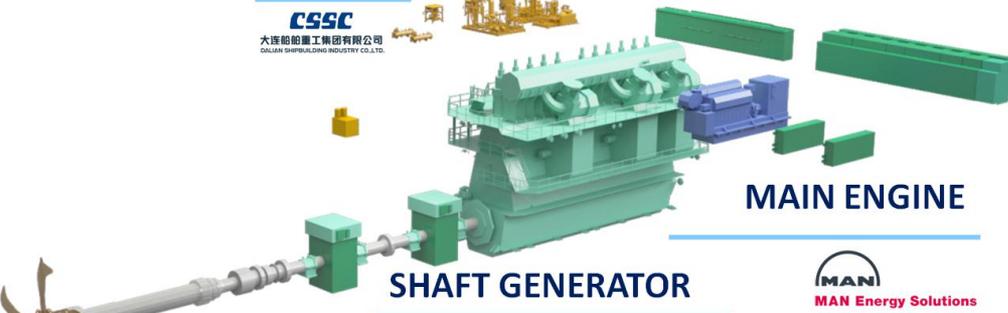
SIEMENS  
Marine Solutions

WÄRTSILÄ

CPP

MAN  
MAN Energy Solutions

WÄRTSILÄ



### 3. Ammonia Fuel Solution for 23,000TEU

#### □ Endurance for NH<sub>3</sub> as Fuel

##### Voyage from Asia to Europe

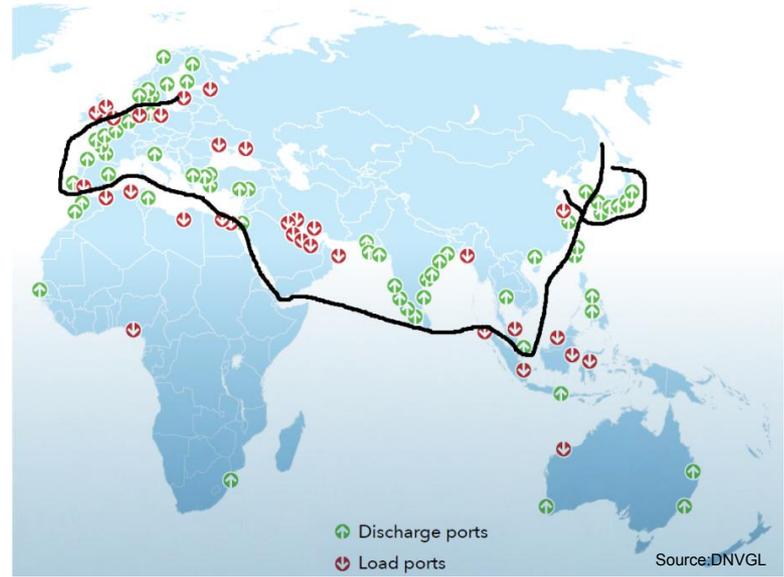
- Multiple refueling can be realized along route in near future
- Maximum container intakes
- Cost efficiency

Speed	20.5 knots
Capacity	19,500 m <sup>3</sup>



Satisfy with single trip endurance

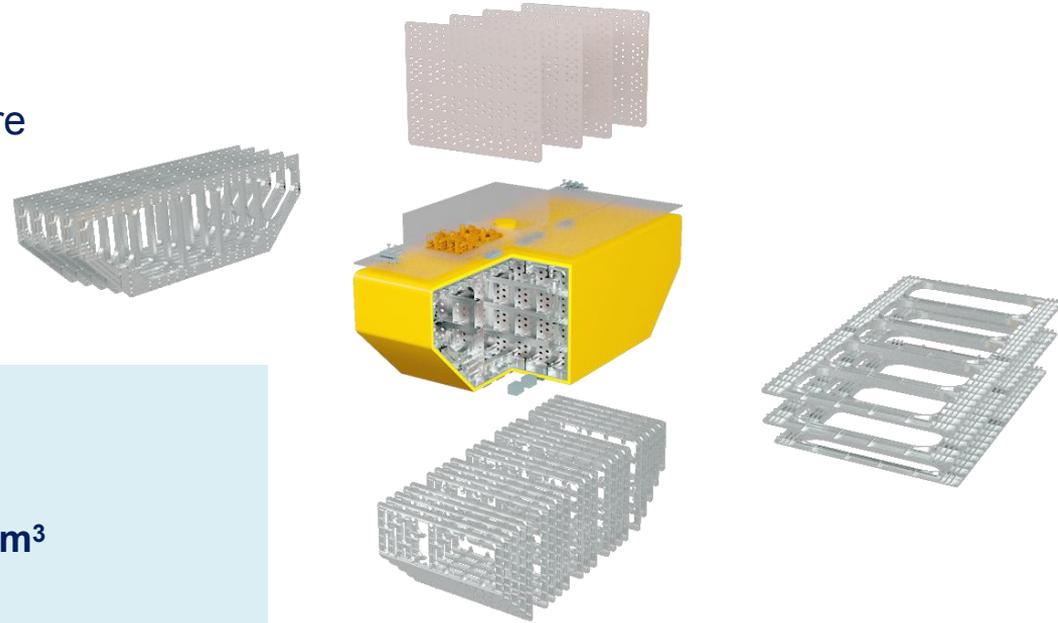
#### ● NH<sub>3</sub> Load & Discharge Ports



### 3. Ammonia Fuel Solution for 23,000TEU

#### □ Storage tank of Type A

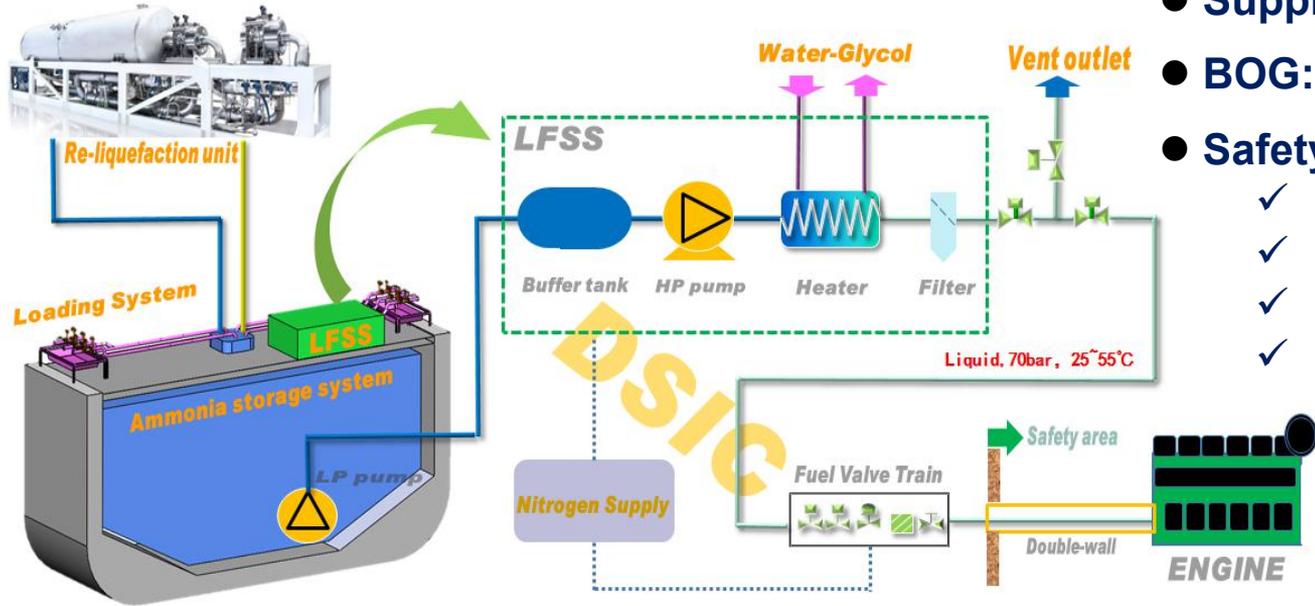
- High capacity utilization
- Suitable for  $-34^{\circ}\text{C}$  design temperature
- Low cost
- Widely used on LPG tankers



- **Design pressure: 0.7bar**
- **Design Temperature:  $-34^{\circ}\text{C}$**
- **Density at design temperature:  $700\text{kg}/\text{m}^3$**
- **Material: LT-FH32 or equivalent**
- **Net Volume:  $19,500\text{m}^3$**

### 3. Ammonia Fuel Solution for 23,000TEU

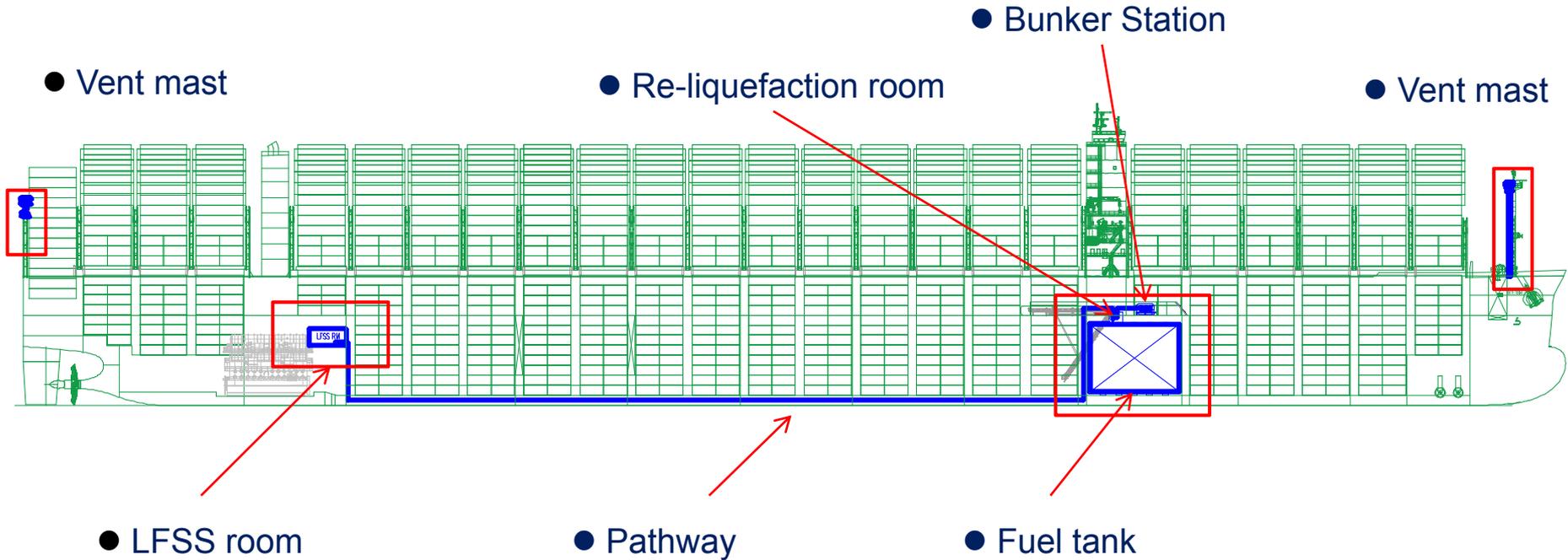
#### □ Low-Flashpoint Fuel Supply System(LFSS)



- Supply: Liquid 70bar, 25~55°C
- BOG: Reliquefaction plants
- Safety:
  - ✓ Monitoring
  - ✓ Ventilation
  - ✓ Water sparking system
  - ✓ Personal protection apps.

### 3. Ammonia Fuel Solution for 23,000TEU

#### □ Low-Flashpoint Fuel Supply System(LFSS)



### 3. Ammonia Fuel Solution for 23,000TEU

#### □ Economic Discussion

##### CAPEX:

ITEMS	LNG DUAL FUEL	C-FUTURE
MAIN ENGINE	12X92DF	11G95ME-C-LGI(A)
DIESEL GENERATOR	-	5000kWx1
LNG DF GENERATOR	3690kWx4	-
SHAFT GENERATOR	-	5000kWx2
FUEL STORAGE TANK	MEMBRANE OR TYPE B	TYPE A
FUEL SUPPLY SYSTEM	LOW PRESSURE LNG SUPPLY	HIGH PRESSURE NH3 SUPPLY
SHAFT AND PROPELLER	FPP	CPP

**-9,000,000 USD**

##### OPEX:

	Fuel (ton/day)	Fuel (ton/year)	Carbon Emission (ton/year)
LNG	129	33540	107530
NH3	301.1	78300	-

**Fuel consumption and carbon emission at 18 knots.**

**Depending on the fuel price and carbon emission cost.**

# Issues for Ammonia Fuel Application

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- ❑ Policy
- ❑ Rules and regulations
- ❑ Production capacity and scale
  - Enough to support energy consumption demand
- ❑ Bunkering flexibility
  - Bunkering facilities to be developed early
- ❑ Toxic and personal safety
  - Suggest to develop flexible protected equipment for human proximity
- ❑ NH<sub>3</sub> price
  - Decide investment in the short term.
- ❑ Difficult decision for ship owner
  - Build a ammonia fueled ship now or just ammonia ready for future conversion



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Thanks for your attention !