



THE LNG VALUE CHAIN: How far will it grow?

FEB.2025



BUREAU
VERITAS

PRESENTERS



Bureau Veritas M&O

Ulrik FRORUP

Chief Commercial Director Bureau
Veritas Marine & Offshore



Bureau Veritas M&O

Jose ESTEVE OTEGUI

Offshore Gas & Power Market Leader



Bureau Veritas M&O

Benoit GROVEL

Gas Expertise Team Director



Bureau Veritas M&O

Carlos GUERRERO POZUELO

Global Market Leader Gas Carriers

SUMMARY



Introduction and context

FLNGs: market update and case studies

FSRUs: market update and case studies

LNGCs: market developments & trends

LNG BVS: update on a booming segment

LNG as fuel: one of the solutions?

Q&A



MARINE &
OFFSHORE

INDUSTRY



N°1 MARINE RO TIC TWO DEDICATED DIVISIONS FOR OIL & GAS INSTALLATIONS

N°1 Class in number of vessels

12,083

Vessels in
BV-classed fleet

82,000

BV employees
worldwide

€5.9bn

Revenue in 2023

265

LNGC Classed

47

FS(R)Us & FLNGs

150

Flag Recognitions



BUREAU
VERITAS

RO: Recognized Organization by Flags
TIC: Testing Inspection and Certification

6

Marine operations
Centers

8

Remote survey
Centers

267

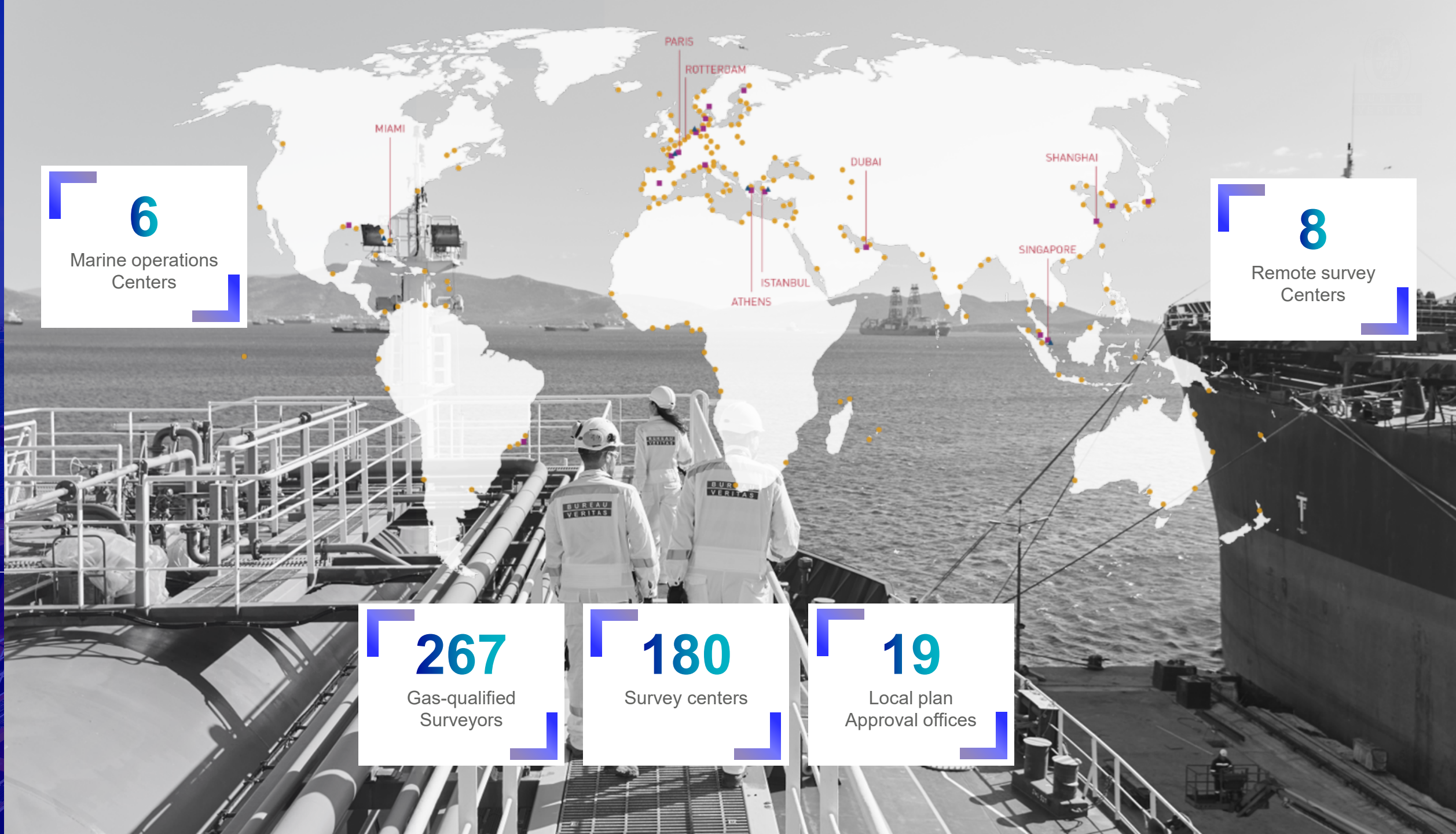
Gas-qualified
Surveyors

180

Survey centers

19

Local plan
Approval offices



ENERGY TRANSITION DIRECT EFFECTS

LNG is picking up speed as transition fuel

SURGING LNG

“Europe has to attract 230 LNG cargoes more this year, to go back to a 90% storage level,”

Anders Opedal, Equinor.

Global gas demand: +20% by 2040

LNG production capacity:

x1.5 by 2030

x2.5 by 2035?

66 FSRU projects

25 FLNG projects

LNGCs order book (341): Will it be enough?

Sources: IEA

LNG AS FUEL

VESSELS

Current LNG-fueled* vessel fleet: 636 → 5-6 MT

On-order LNG-fueled vessels: 636 → 5-6 MT

TRUCKS

Current LNG-fueled trucks: 900 000 (China) → ~23 MT

New LNG-fueled fleet >2m (China and India) → ~45 MT

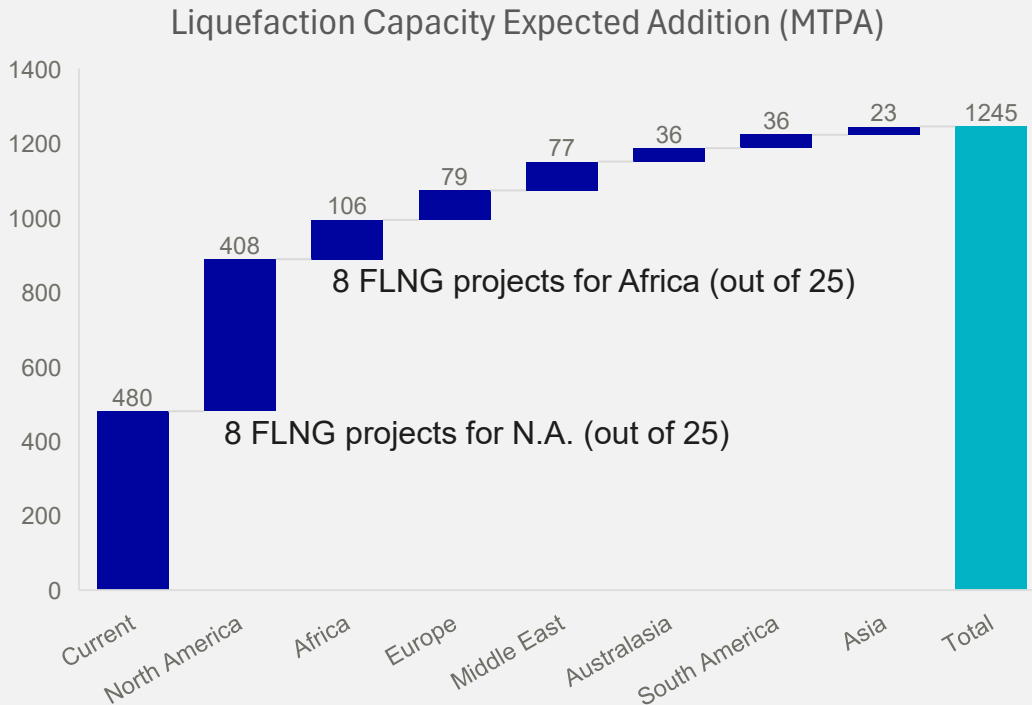
*Note: LNGC not included

Sources: Rystad, Sea-LNG, IEA

LNG IS GAINING TRACTION AS TRANSITION FUEL

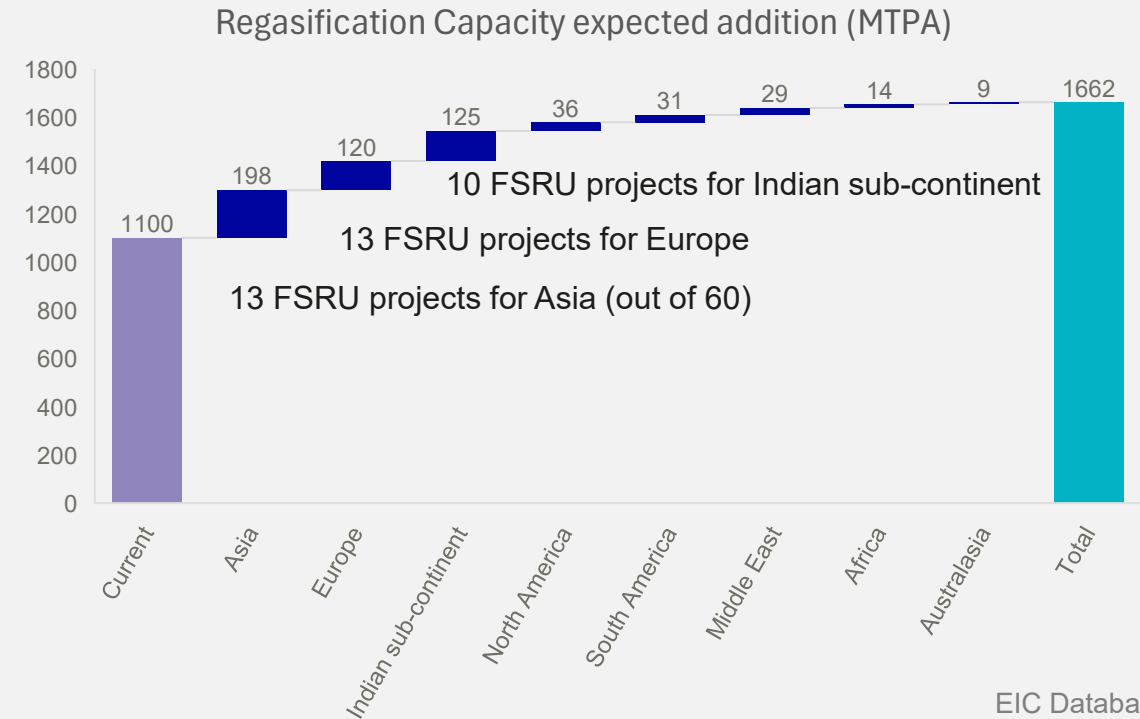
LIQUEFACTION PROSPECTS X2.5

North America and Africa have the highest potential also in terms of FLNG prospects



LNG-TO-POWER IS CHANGING THE SEASONALITY OF FSRUs

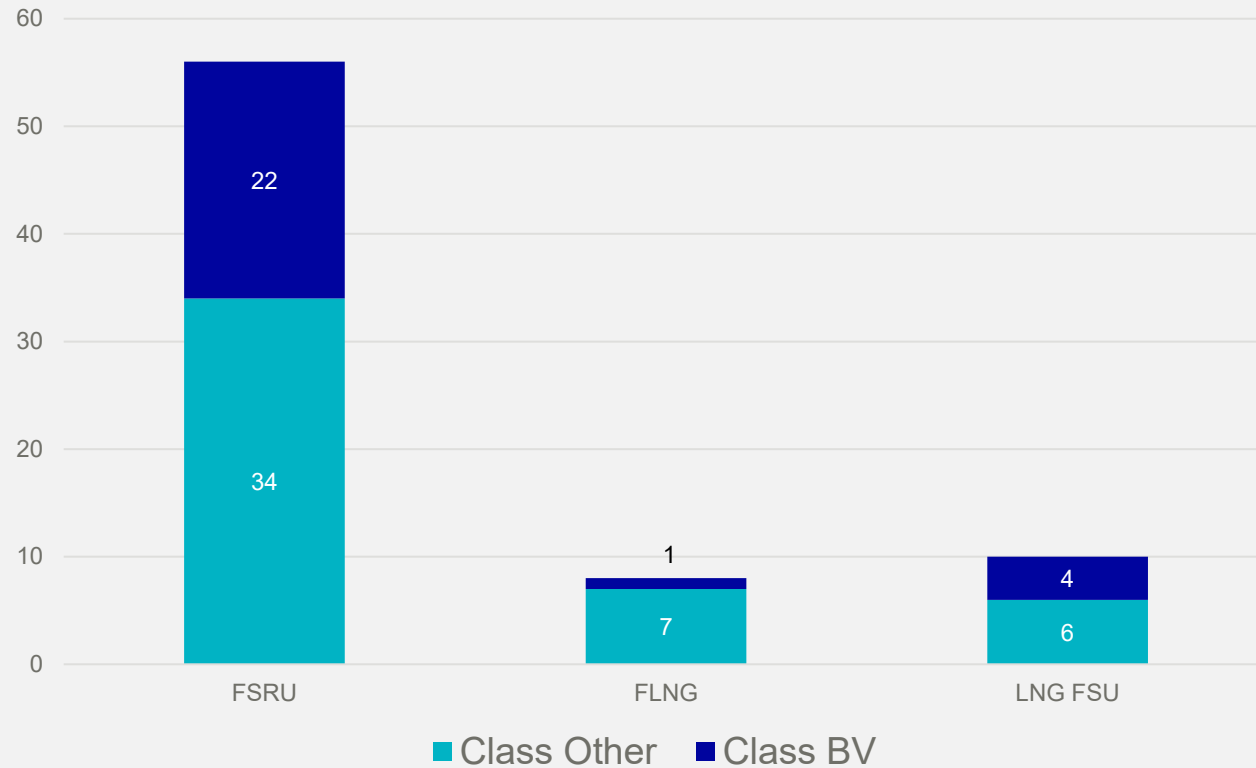
FSRUs are now often included as source in an onshore power plant development, particularly in Asia



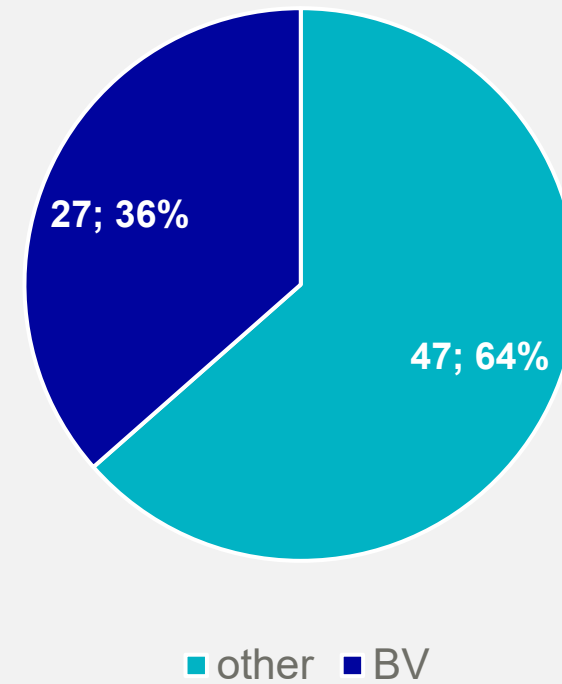
Note: the figures include both onshore and floating terminals projects prospects

OFFSHORE GAS FLOATING UNITS

Class Positioning by Unit Type

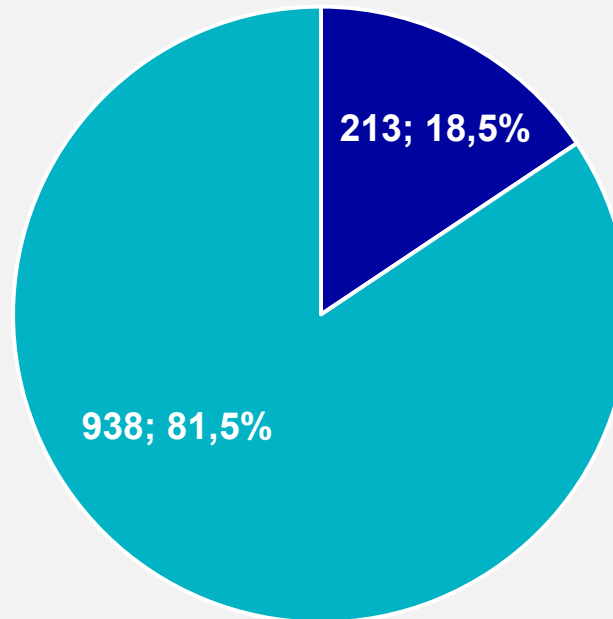


N° of Units



LNG CARRIERS AND BUNKERING VESSELS

N° of vessels
(fleet + orderbook)



■ BV ■ Other

POLL TIME



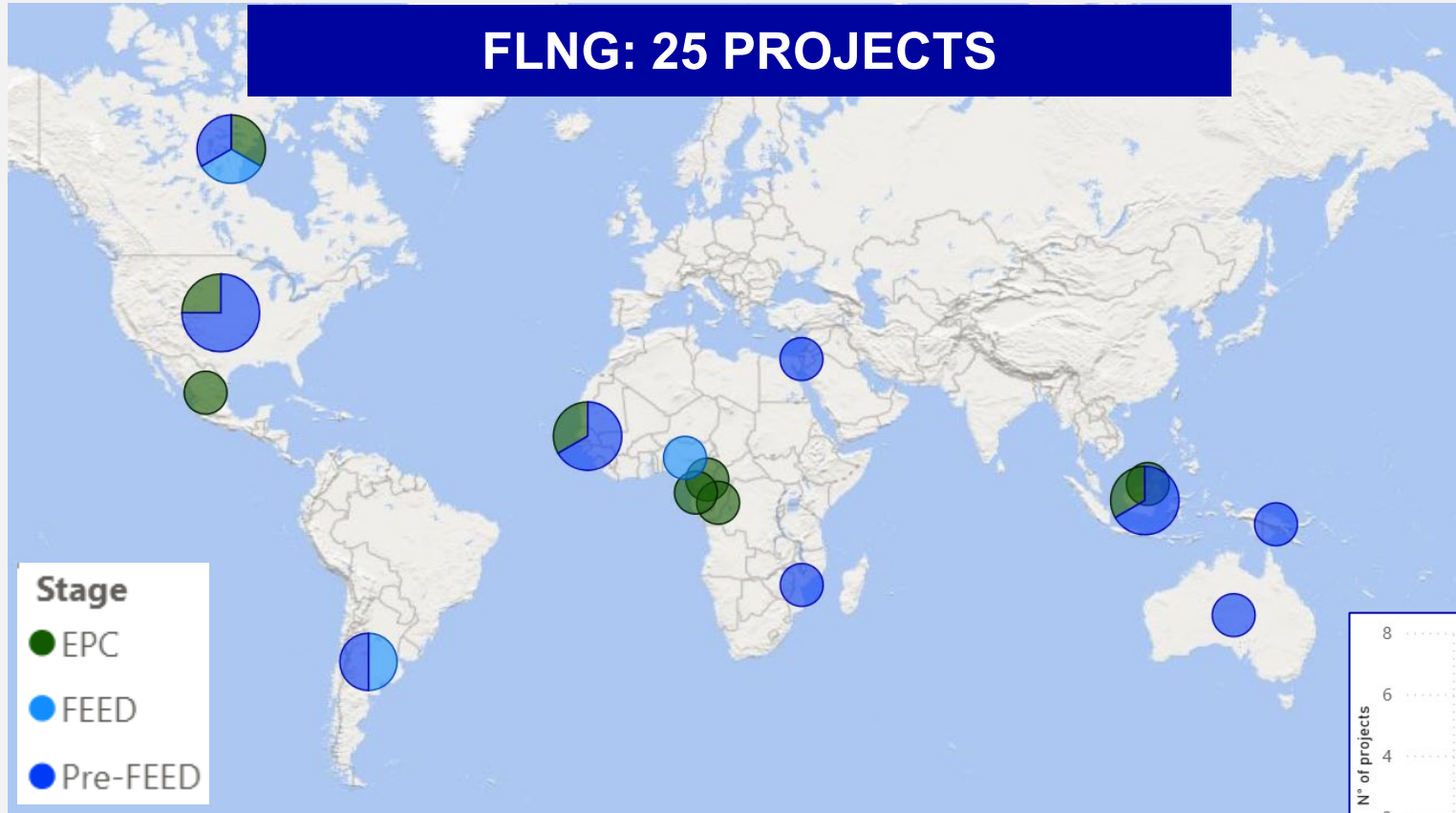
**BUREAU
VERITAS**



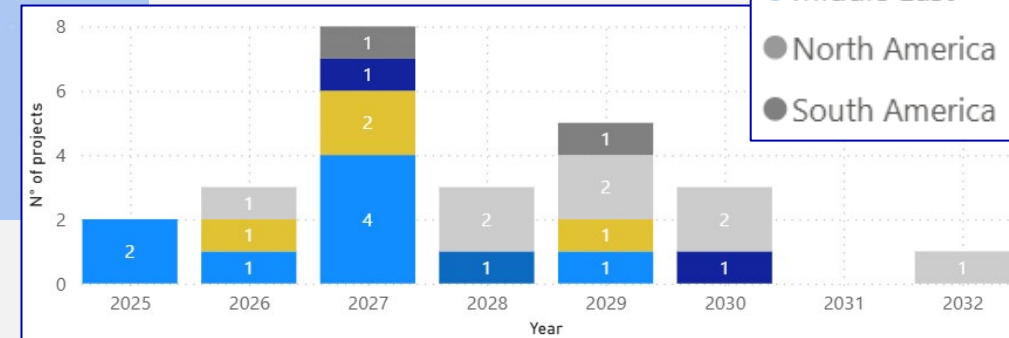
BUREAU
VERITAS

— FLNG

FLNG PROJECTS EXPECTED



Combined data from internal sources, EIC Database



INCREASED VARIETY OF FLNG PROJECTS

| Name | Country | Length (LBP) | Width | LNG storage m ³ | CCS | NB or Conv |
|--|------------|-----------------------|---------------------|----------------------------|-------------------|---------------|
| Golar Hilli Episeyo | Cameroon | 281 m | 41.6 m (+sponsoons) | 125,000 | Type B MOSS | Conversion |
| Tortue-Ahmeyim FLNG (Gimi FLNG) | Senegal | 293 m | 42 m (+sponsoons) | 138,000 | Type B MOSS | Conversion |
| Coral FLNG | Mozambique | 439 m | 66 m | 227,480 | Membrane – Mk.III | New Built |
| PFLNG Dua | Malaysia | 333 m | 64 m | 177,000 | Membrane – Mk.III | New Built |
| PRELUDE | Australia | 473 m | 74 m | 220,000 | Membrane – Mk.III | New Built |
| PFLNG Satu | Malaysia | 300 m | 60 m | 177,000 | Membrane – NO.96 | New Built |
| MARINE XII FLNG | Congo | 144 m / 277 m | 32 m + 43 m | 16,000 + 138,000 | Type C + NO.96 | Redeploy |
| Altamira "FLNG" | Mexico | 3 Jackups + FSU 280 m | FSU 43 m | 160,000 | Membrane – Mk.III | Conv/Redeploy |

Conversions

2/8

New-built

4/8

Redeploy

2/8

INCREASED VARIETY OF FLNG PROJECTS

Arriving New-builts

3

2 Type B-SPB:
-Nguya FLNG
-Kasuri FLNG

1 Membrane:
-ZLNG

| Name | Country | Length (LBP) | Width | LNG storage m ³ | CCS | NB or Conv |
|--|------------|-----------------------|---------------------|----------------------------|-------------------|---------------|
| Golar Hilli Episeyo | Cameroon | 281 m | 41.6 m (+sponsoons) | 125,000 | Type B MOSS | Conversion |
| Tortue-Ahmeyim FLNG (Gimi FLNG) | Senegal | 293 m | 42 m (+sponsoons) | 138,000 | Type B MOSS | Conversion |
| Coral FLNG | Mozambique | 439 m | 66 m | 227,480 | Membrane – Mk.III | New Built |
| PFLNG Dua | Malaysia | 333 m | 64 m | 177,000 | Membrane – Mk.III | New Built |
| PRELUDE | Australia | 473 m | 74 m | 220,000 | Membrane – Mk.III | New Built |
| PFLNG Satu | Malaysia | 300 m | 60 m | 177,000 | Membrane – NO.96 | New Built |
| MARINE XII FLNG | Congo | 144 m / 277 m | 32 m + 43 m | 16,000 + 138,000 | Type C + NO.96 | Redeploy |
| Altamira "FLNG" | Mexico | 3 Jackups + FSU 280 m | FSU 43 m | 160,000 | Membrane – Mk.III | Conv/Redeploy |

Conversions

2/11

New-built

7/11

Redeploy

2/11

INDUSTRY RESOURCEFULNESS



<https://www.eni.com/en-IT/actions/global-activities/republic-congo/lng.html>

MARINE XII FLNG

- Fastest ever deployment of FLNG terminal
- First ever multi-body floating terminal in split-mooring
- Allows Congo to join LNG exporting countries club
- To be joined in by the Nguya FLNG

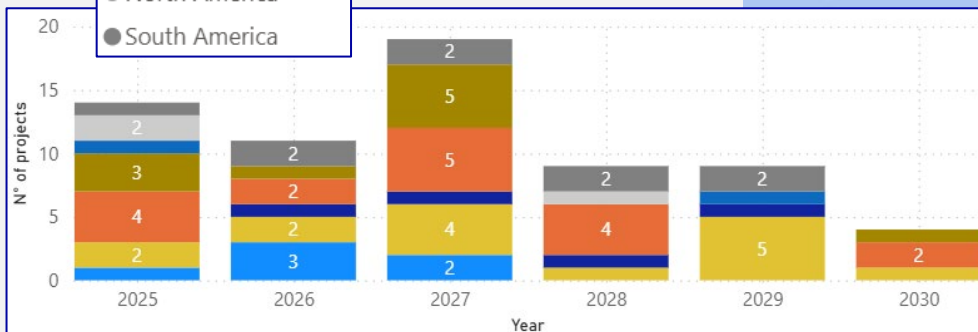
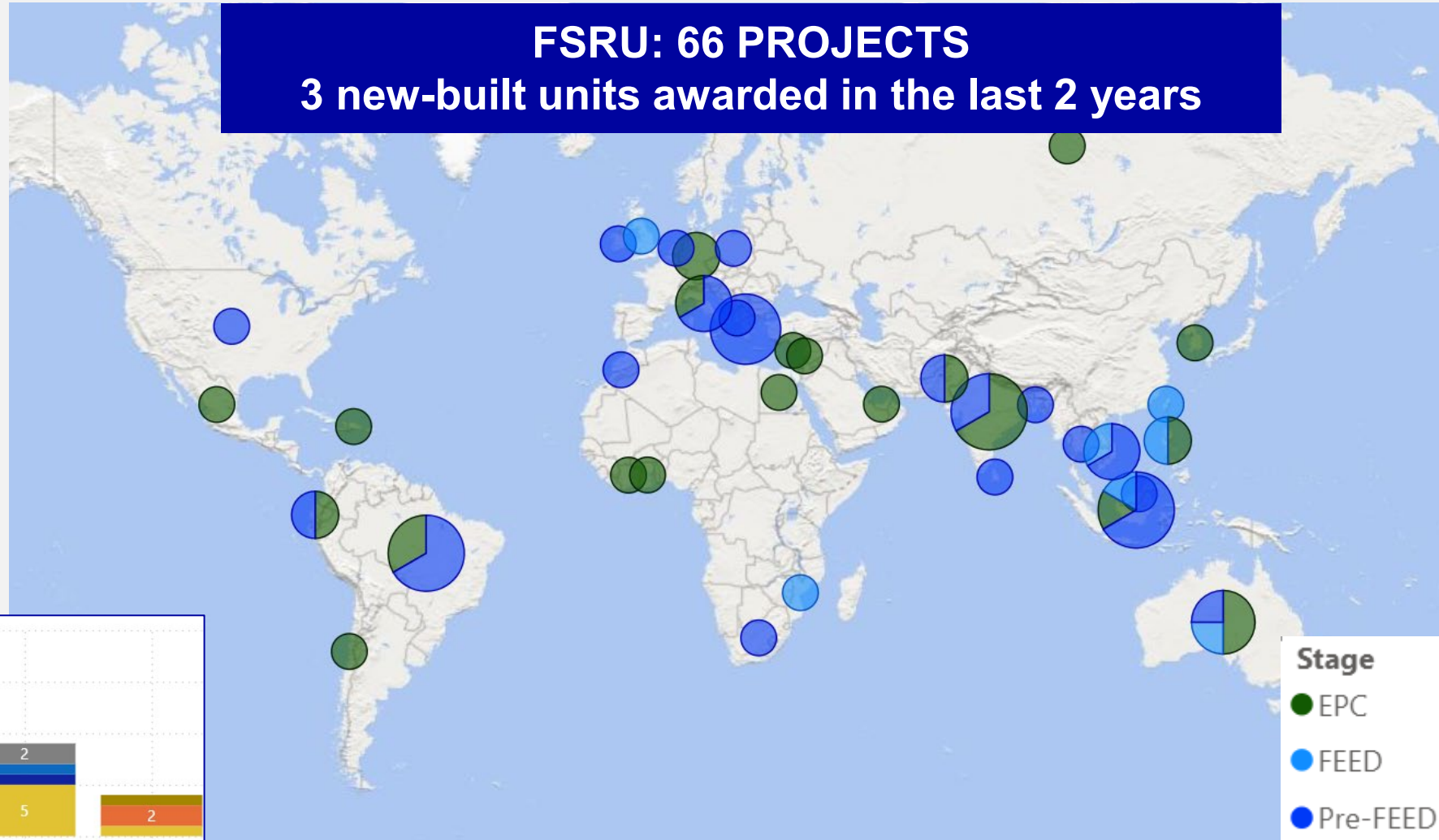


BUREAU
VERITAS

— FSRU

REGASIFICATION UNITS GAINING TRACTION

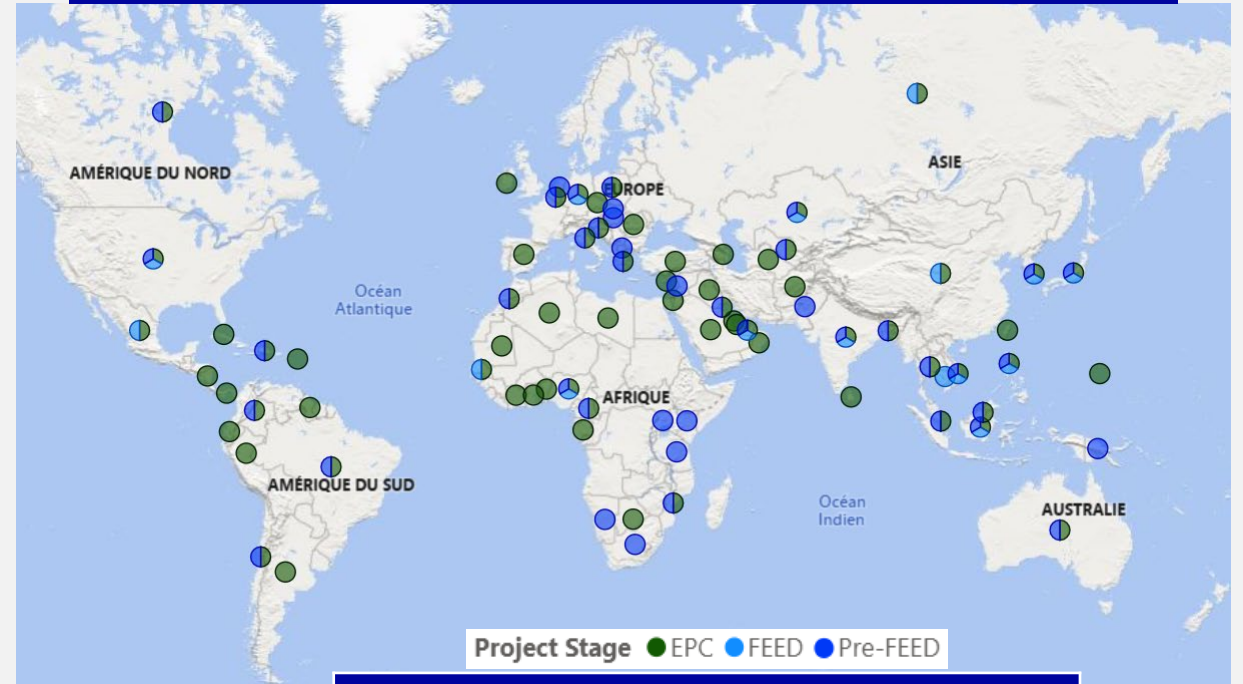
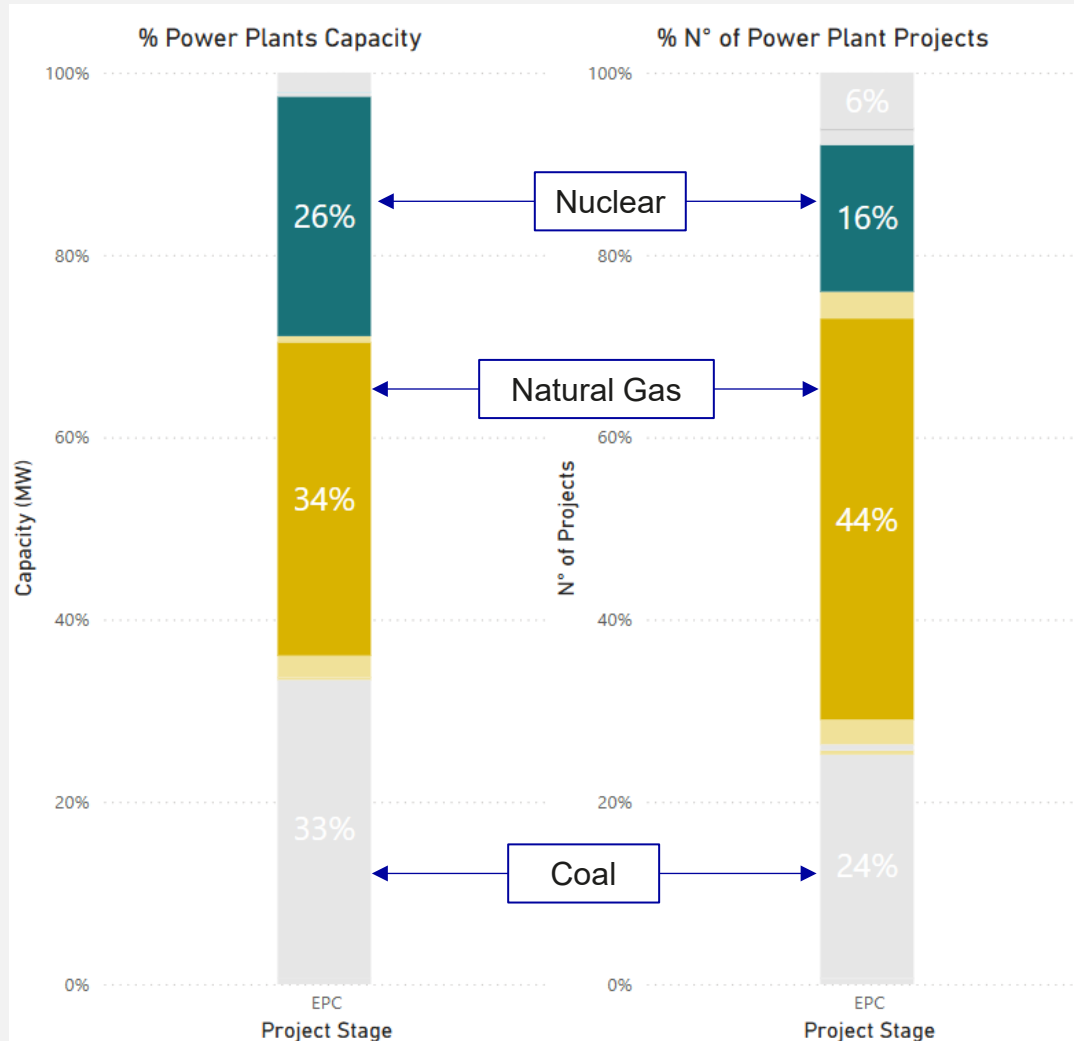
FSRU: 66 PROJECTS
3 new-built units awarded in the last 2 years



Internal sources, EIC Database

GAS-TO-POWER

GAS POWER PLANTS PROJECTS: 404



LNG-TO-POWER with FSRUs gaining interest

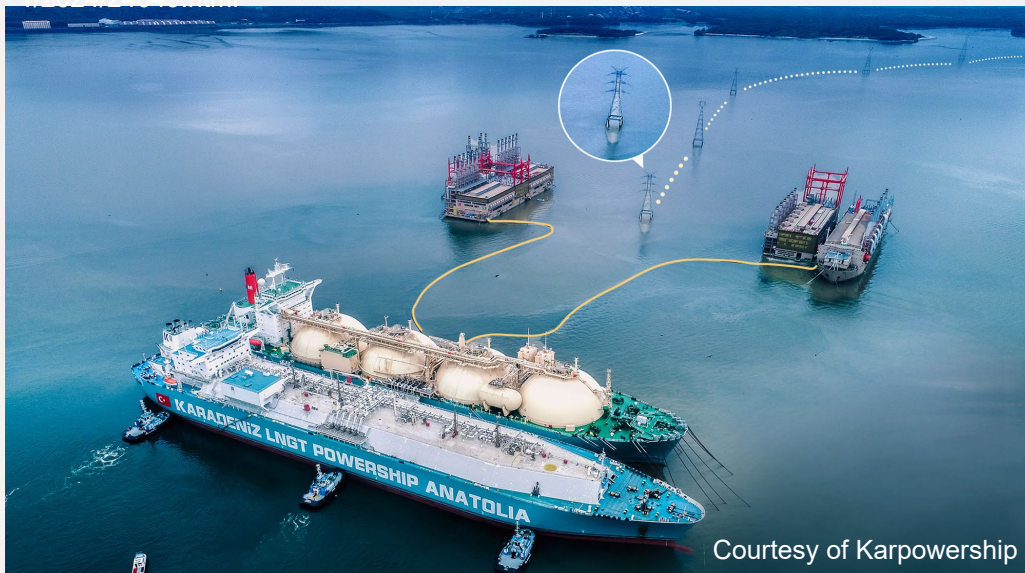
- Vietnam
- Indonesia
- Puerto Rico
- Bahamas
- South Africa
- Philippines
- Sri-Lanka
- Honduras

LNG-TO-POWER



JAWA SATU FSRU

Asia's 1st Gas-to-Power Project Using an FSRU
Connected to 1.76 GW power plant project
300 MMscfd and locally sourced LNG (Tangguh)
170,000 m³ – Membrane Mk.III



Port of Itaguaí FSRU + Powerships deployment

Direct Gas-to-power offshore multi-vessel deployment
Total nominal power by 4 Powerships: 576 MW
300 MMscfd - 127,000 m³ – MOSS FSRU



**BUREAU
VERITAS**

LNG CARRIERS

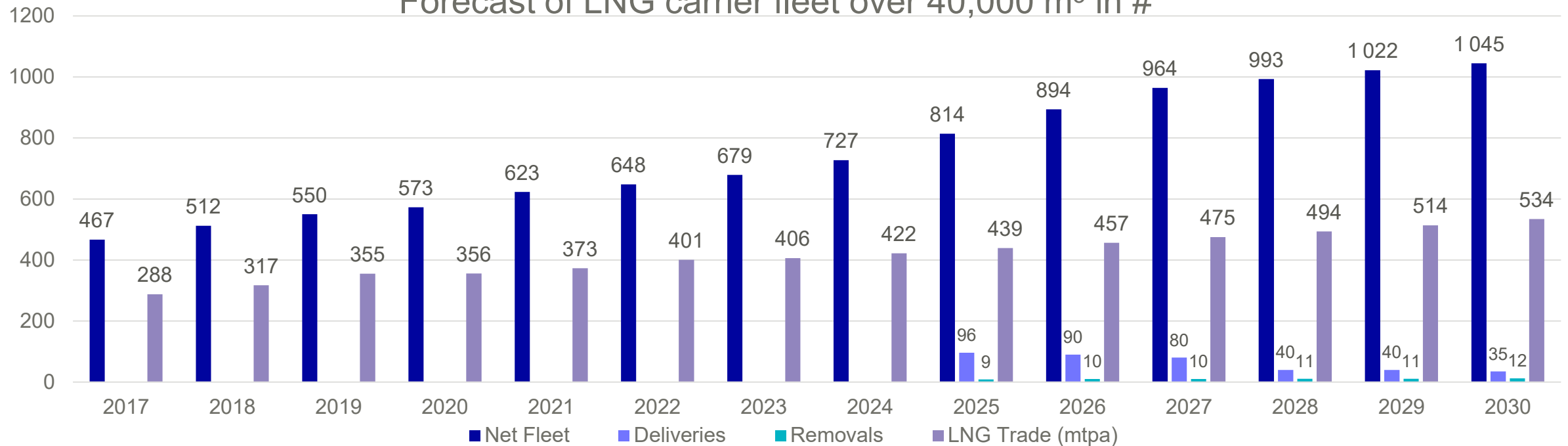
SHIPPING & TRADE

LNG trade expected to increase in short and mid term (will we see a plateau from 2035?)

Newbuilding activity slowing down (current fleet on order ≈50% of in-service fleet)

Increased removals expected (environmental regulations and OPEX as drivers)

Forecast of LNG carrier fleet over 40,000 m³ in #



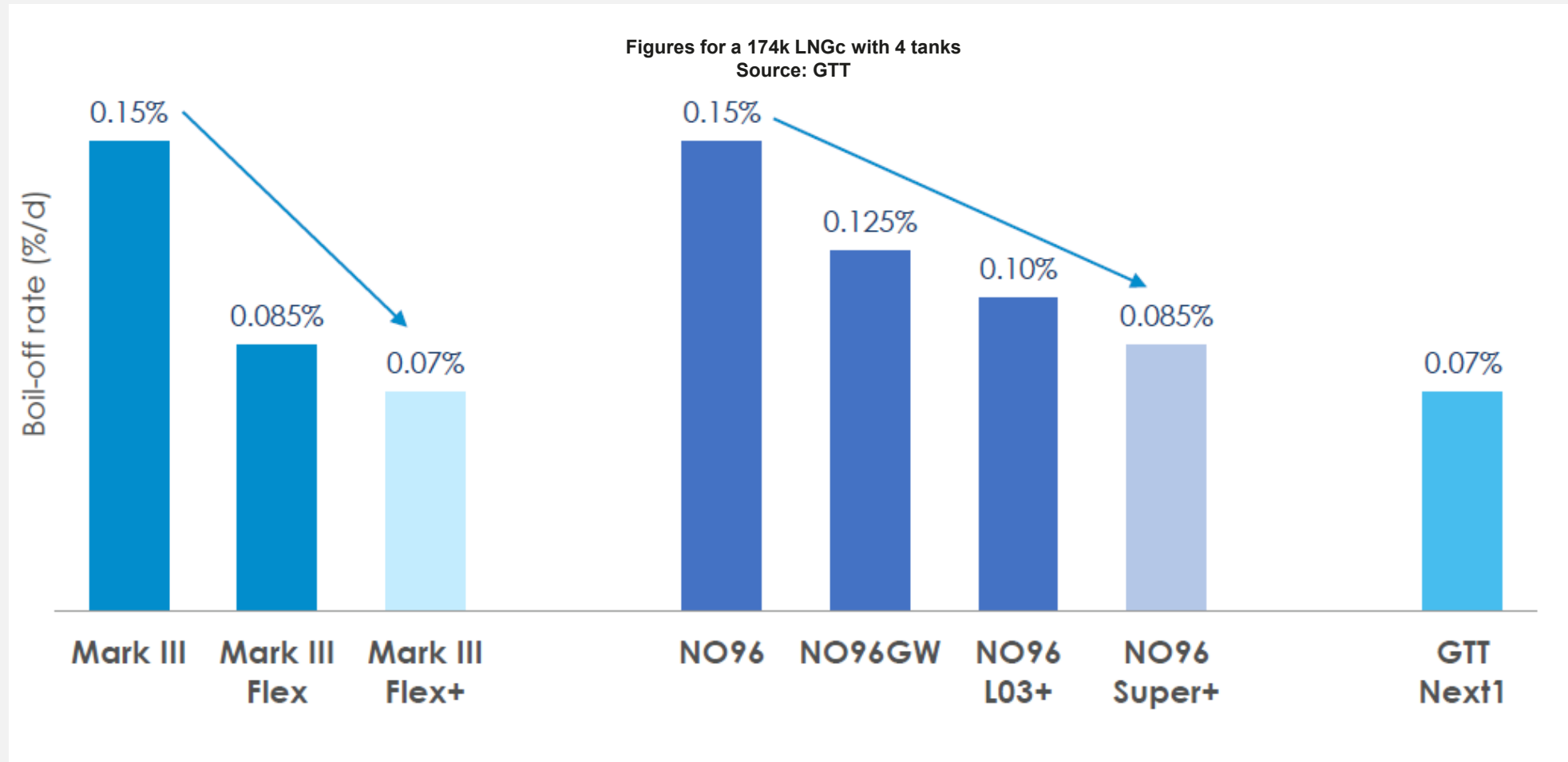
PRESENT AND FUTURE OF LNGC DESIGN

| DESIGN ITEM | DESIGN BASELINE IN CURRENT DESIGNS | AVAILABLE ENHANCEMENTS |
|-------------------|---|---|
| Capacity: | 174000 – 180000 m ³ | Economy of scale: 200,000-271,000 m ³ |
| Hull shape/speed: | Optimized twin screw hull form max speed 19.0 – 19.5 knots | Further hull optimization, reduced service speed and ALS |
| Dimensions: | Approx. 290 x 46 x 26 m Draught 12.0 – 12.5m | For 200K: 300 x 48.9 x 26.9 m Keep acceptable terminal compatibility |
| Cargo tanks/ BOR: | 4 x GTT membrane BOR 0.07 – 0.10 % V/day laden | Latest GTT CCS (Mark III Flex+, NO96 Super+ and NEXT1) 4 tanks but new designs with only 3 (even 200k) |
| Main engines: | 2 x WIN GD X-DF(1.0 or 2.1) MAN ME-GI or ME-GA | Latest versions of DF engines |
| Generators: | 2 x 8 cylinder DF + 2 x 6 cylinder DF | Improved combustion technologies and combination with PTO |
| Boilers: | 2 x oil fired boilers (DF as an option) | |
| Cargo pumps: | 8 x cargo pumps approx. 1,900 m ³ /h – 12-14 h discharge time | |
| BOG management | GCU for 100% BOG Partial reliquefaction or subcooling (1.5 t/h) | Full reliquefaction capacity (match BOR and consumers on board) |

Future options

- › New propulsion concepts
- › Wind assisted propulsion
- › Onboard carbon capture (post or precombustion)
- › Alternative Fuels / Bio-fuels / H₂ as fuel / Fuel Cell or other technologies

CCS LOW BOR



PRESENT CASE STUDY 1

Maran Gas Maritime at SHI

Fully flexible LNGc design

- › 3 units in service
- › 174,000 m³ cargo capacity
- › Full flexibility with LNG terminals
- › Good overall efficiency
 - › ALS & PTO (shaft generator)
- › Four membrane cargo tanks
 - › Low BOR thanks to Mark III Flex CCS
- › Twin screw with low pressure 2-stroke DF engines



COURTESY: MARAN GAS MARITIME

PRESENT CASE STUDY 2

Dynagas at HHI

Well optimized and efficient LNGc design

- › 14 units ordered with approx. half of the fleet currently in service
- › 200,000 m³ cargo capacity
- › Panama canal compatible
- › Suitable flexibility with LNG terminals
- › Good overall efficiency
- › Four membrane cargo tanks
- › Very low BOR thanks to
 - › Mark III Flex+ CCS, and
 - › Volume of tanks
- › Specific study for sloshing due to nonstandard tanks
- › Twin screw with low pressure 2-stroke DF engines



AN ACHIEVABLE FUTURE

BVS design optimization prior to class involvement

AIP by BV in September 2024

200k cargo capacity with suitable ship dimensions

- › Original concept with 4 tanks and finally, only 3 tanks
- › Design optimized for reduced operational speed

Advantages

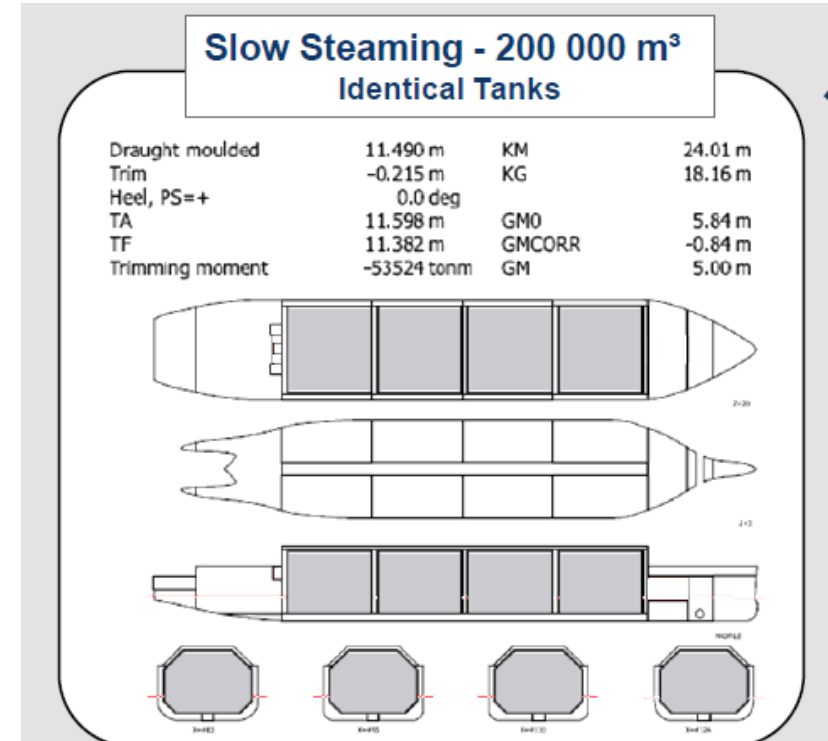
- › Reduced transportation cost and GHG emissions
- › Reduced CAPEX and OPEX
- › Reduced BOR (0.06-0.075%Vol/day)

Main challenges

- › Damage stability
- › Sloshing



Source: GTT



Source: GTT

POLL TIME



**BUREAU
VERITAS**



**BUREAU
VERITAS**

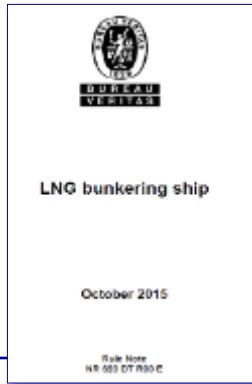
LNG BVS

BV TRACK RECORD

BV leading class in the field

Specific regulation NR620 – LNG bunkering ship (2015/2024)

Deep involvement in bunkering guidelines and LNG as fuel



First multipurpose gas carrier (LNG/LPG/LEG)

2009

First LNG Bunkering Ship Class Rules

Transfer systems, BOG, Piping, Safety

2015

First purpose-built LNG Bunkering Vessels

2017

Participation in Singapore LNG bunkering *standard* development

2017-2020

First Membrane (GTT) sea-going LNG bunkering vessel and the largest

2020

First LNG Bunkering vessel built in Spain

2022

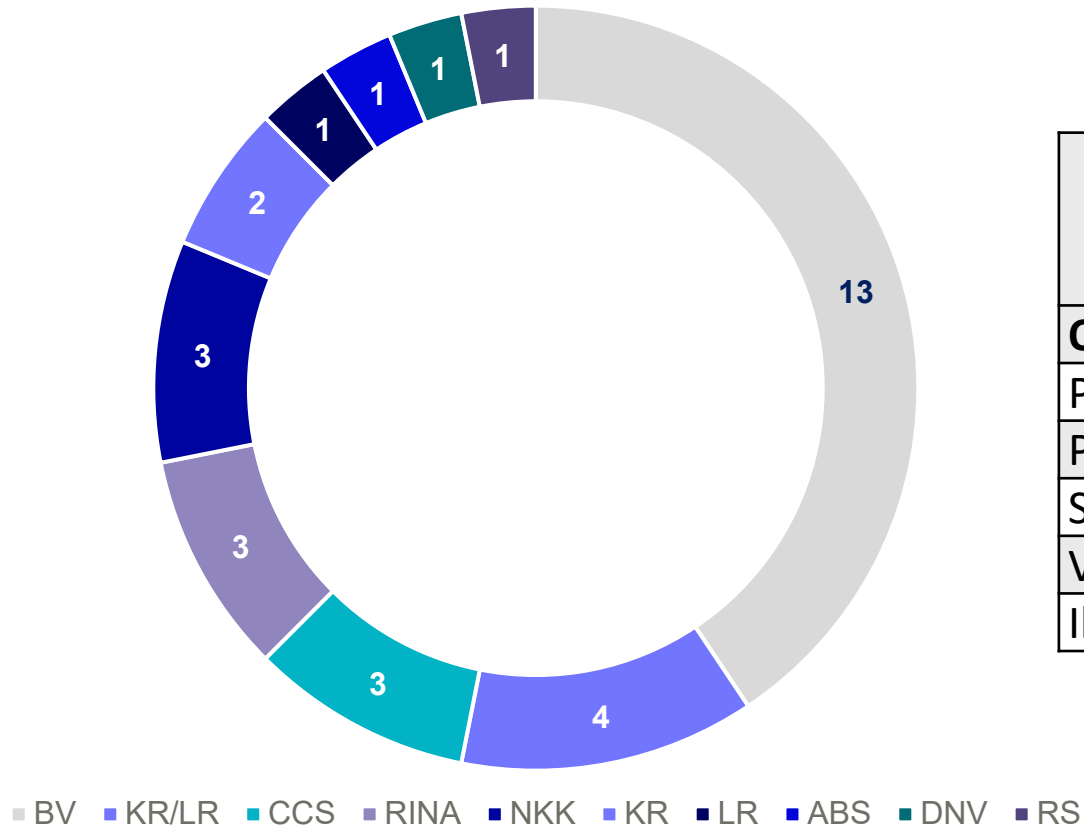
First membrane (GTT) LNG bunkering vessel built in Singapore

Largest LNG bunkering vessel for West Med

2023

BV INVOLVEMENT

NUMBER OF LNG BVs IN SERVICE



ON ORDER BV CLASS LNG BV's

| Owner | Builder | Capacity (CBM) | Built in |
|-----------|-----------------|----------------|----------|
| Peninsula | Hyundai Mipo | 18,000 | 2027 |
| Peninsula | Hyundai Mipo | 18,000 | 2027 |
| Scale Gas | CMIC SOE | 12,500 | 2026 |
| Vitol | CMIC SOE | 12,500 | 2026 |
| Ibaizabal | Hudong Zhonghua | 18,600 | 2026 |

NOTE: FROM CLARKSONS WORLD FLEET REGISTER

MARKET DEVELOPMENTS

Some small scale LNG carriers have also been used for bunkering

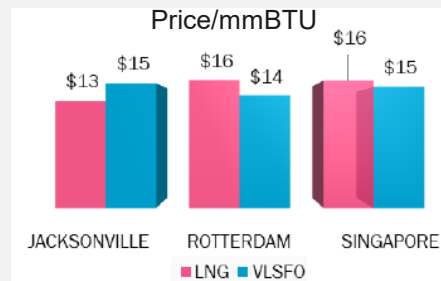
- › So far 32 pure LNG BV seagoing units deployed
- › In addition, ≈20 more small scale LNG carriers and inland/non-propelled units

Growing demand for LNG bunkering vessels

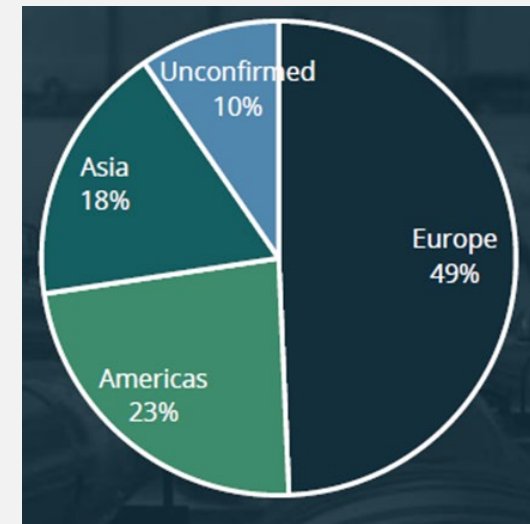
- › Europe is pioneer in Ship-to-Ship bunkering and still leading
- › China, Japan, Korea, Southeast Asia and USA developing
- › Last announcement is Middle East with an existing LNG BV

LNG fuel is affordable and the most realistic option now

- › Price is still convenient compared to other alternative fuels
- › Relevant bunkering hubs are covered
- › Chicken and egg is over
 - › Technology and regulations in place

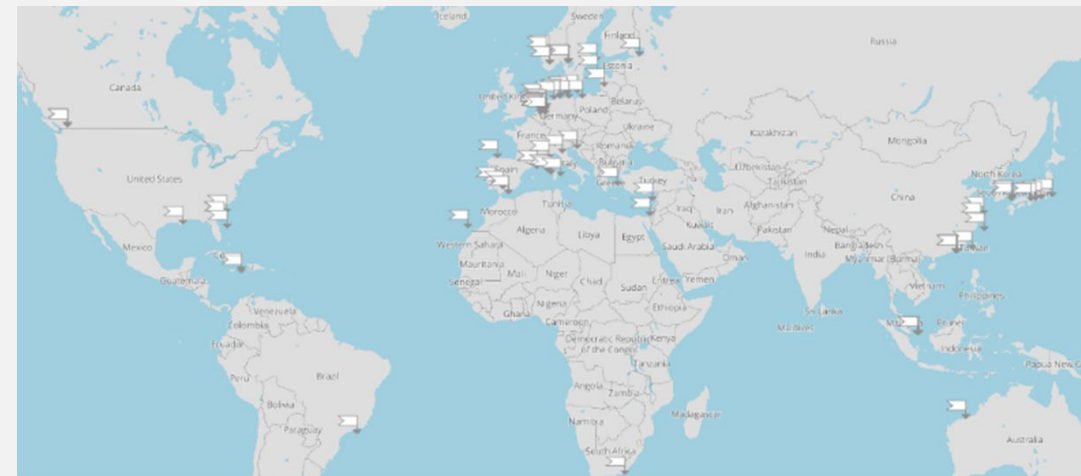


Source: SSY Dec 2024



Regional deployment of LNG Bunkering vessels in operation & orderbook

Source: Fearnleys Oct 2024



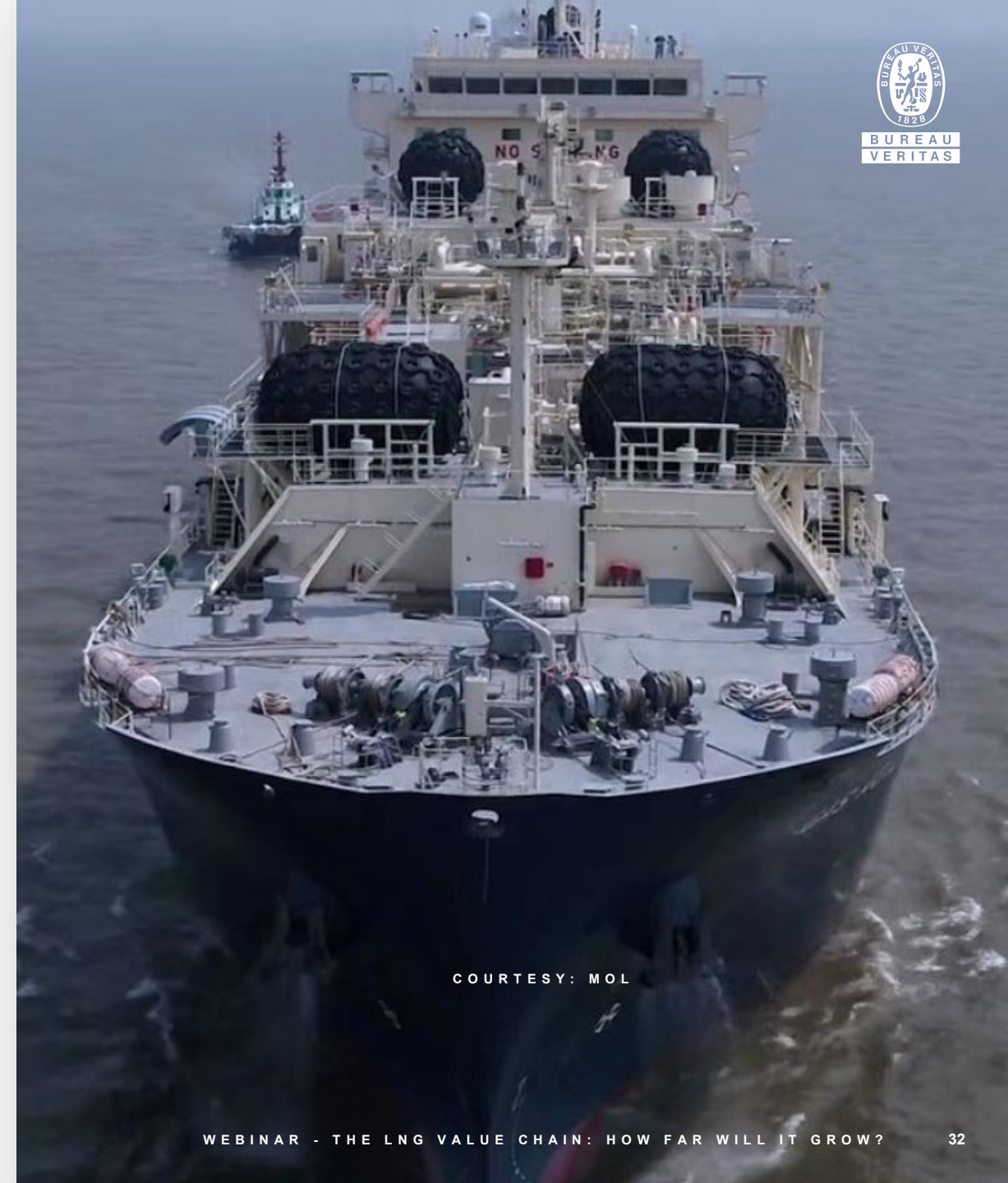
LNG bunker vessel locations (white flags)
Source: SEA-LNG

PRESENT CASE STUDY 1

Series of largest units with membrane tanks

3 x 18,600 m³ unrestricted navigation

- › 2 units in service, 1 unit ordered in 2024
- › Owned by MOL (2) and Ibaizabal (1)
- › Built by Hudong-Zhonghua
- › Cargo handling & bunkering
 - › 2 Membrane GTT Mark III Flex tanks
 - › Extensive sloshing assessment
 - › Sub-cooling system
 - › Two level main manifold and forward manifold
- › Propulsion
 - › Dual Fuel Diesel Electric
 - › 2 Azimuth propellers
- › Area of operation
 - › ARA and Marseille for the 2 units in service



COURTESY: MOL

PRESENT CASE STUDY 2

Tailor made solution for Cruise ships

5.000 m3 LNG BV coastal navigation

- › Single unit in service
- › Owned by Knutsen & Scale Gas
- › Built by Armon
- › Cargo handling & bunkering
 - › 2 Type C bi-lobe tanks
 - › Sub-cooling system
 - › Mid-ship and aft manifolds
- › Propulsion
 - › Gas Fuel Diesel Electric
 - › 2 Azimuth propellers
- › Very low air draft and accommodation forward
- › Area of operation
 - › Barcelona (Spain)

COURTESY: KNUTSEN



PRESENT CASE STUDY 3

Suitable solution for inland navigation and harbours

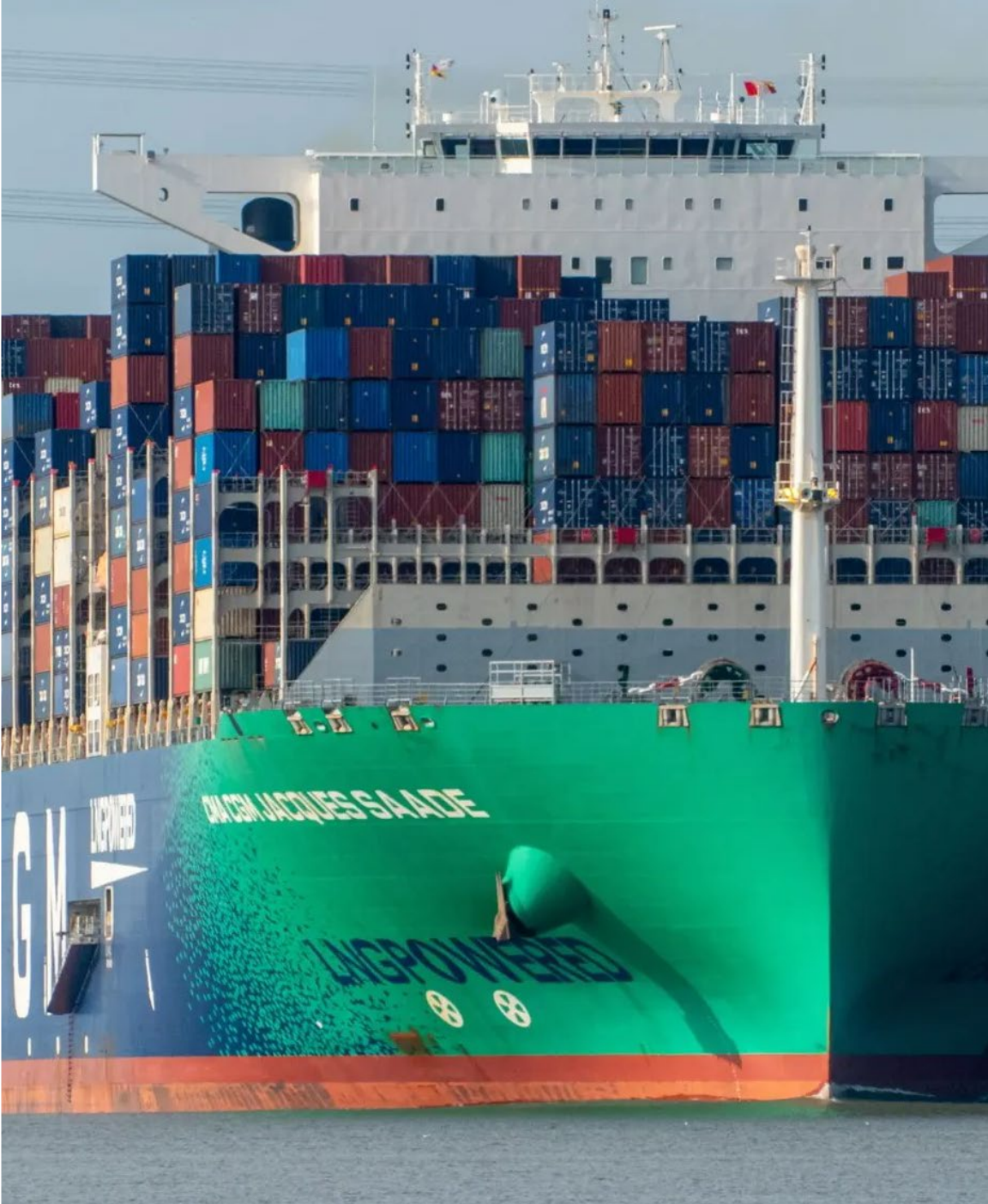
8.000 m³ LNG BV

- › Single unit in service
- › Owned by Sogestran & Victrol
- › Built by LNG Shipping S.A.
- › Cargo handling & bunkering
 - › 8 Type C cylindrical tanks
 - › Sub-cooling system
 - › Mid-ship manifolds
- › Propulsion
 - › Gas Fuel Diesel Electric
 - › 2 Azimuth propellers
- › Very low air draft
- › Area of operation
 - › ARA



POLL TIME



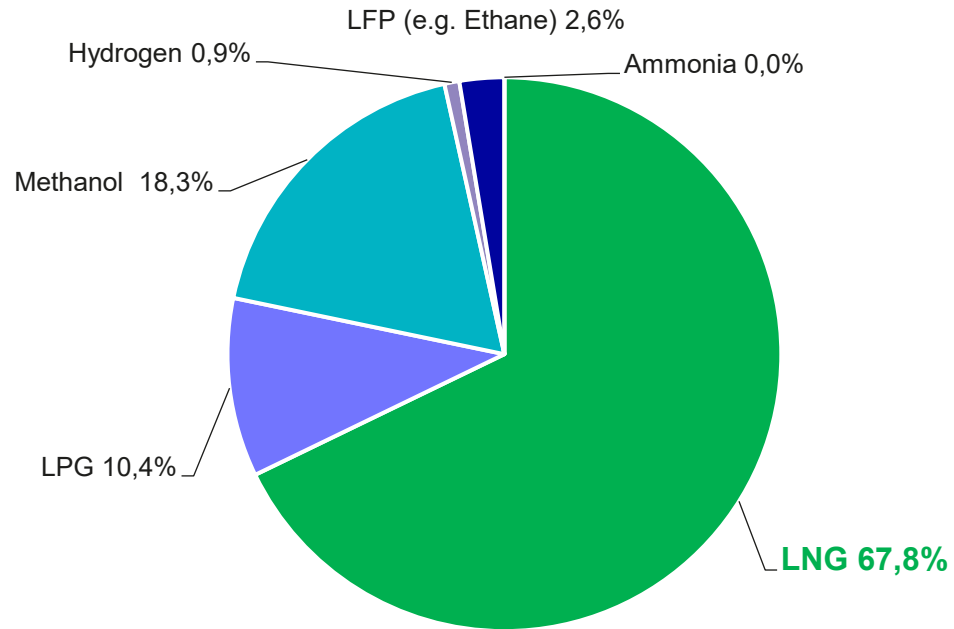


BUREAU
VERITAS

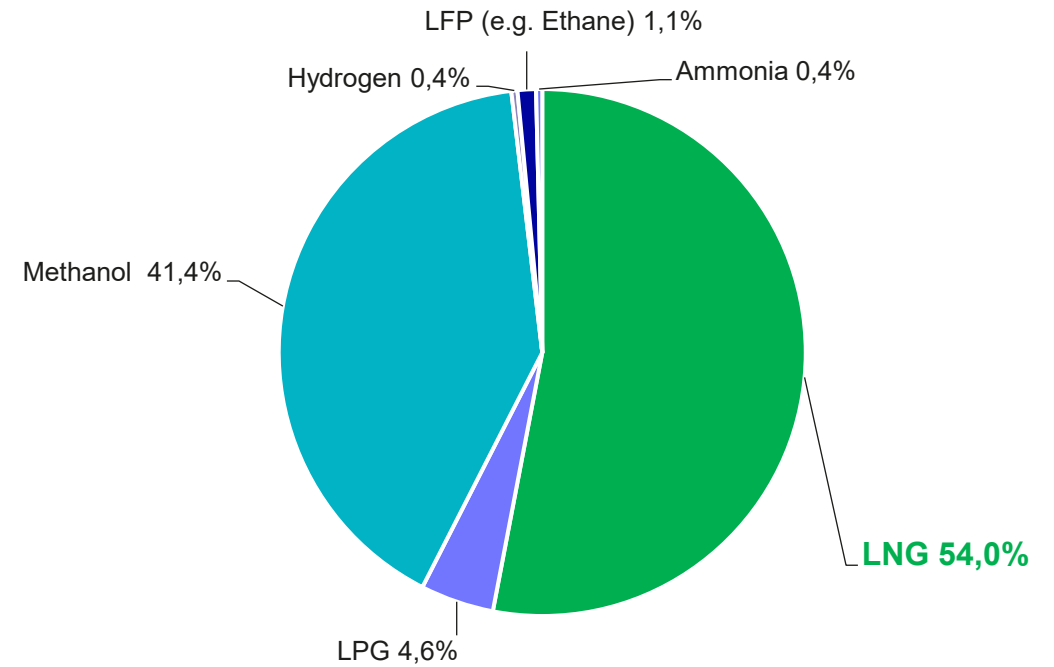
LNG AS FUEL

BV 2024 ORDER BOOK

Alternative Fuel Distribution



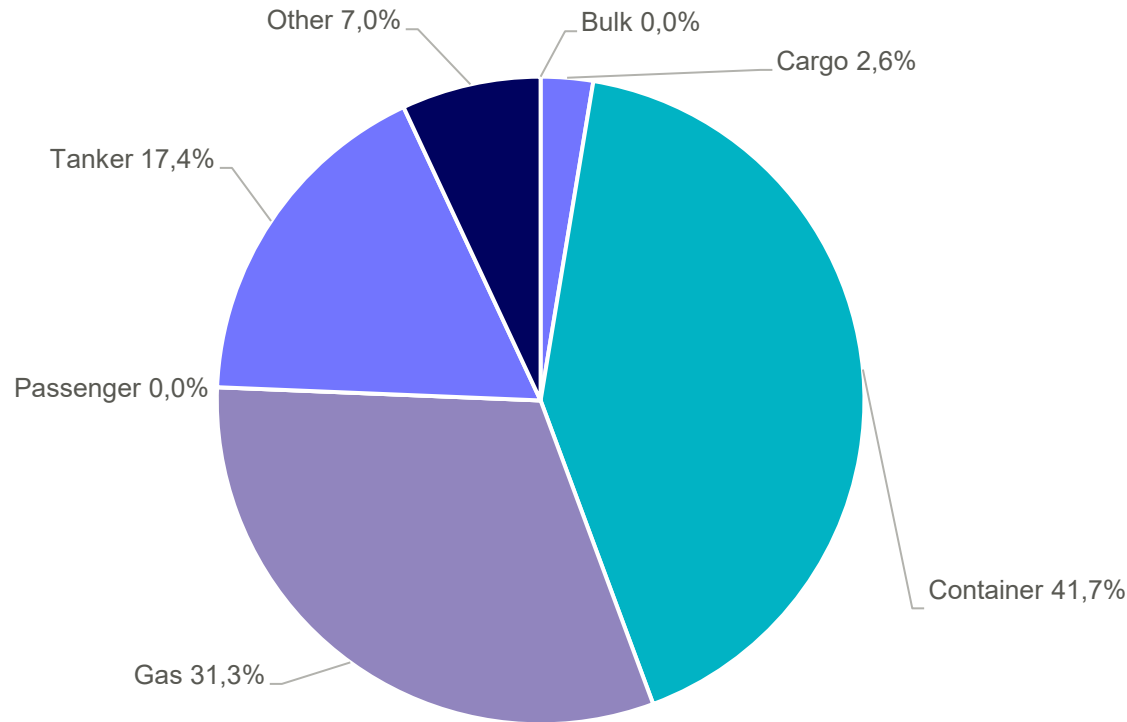
Alternative Fuel Distribution *(incl. Prepared Notations)*



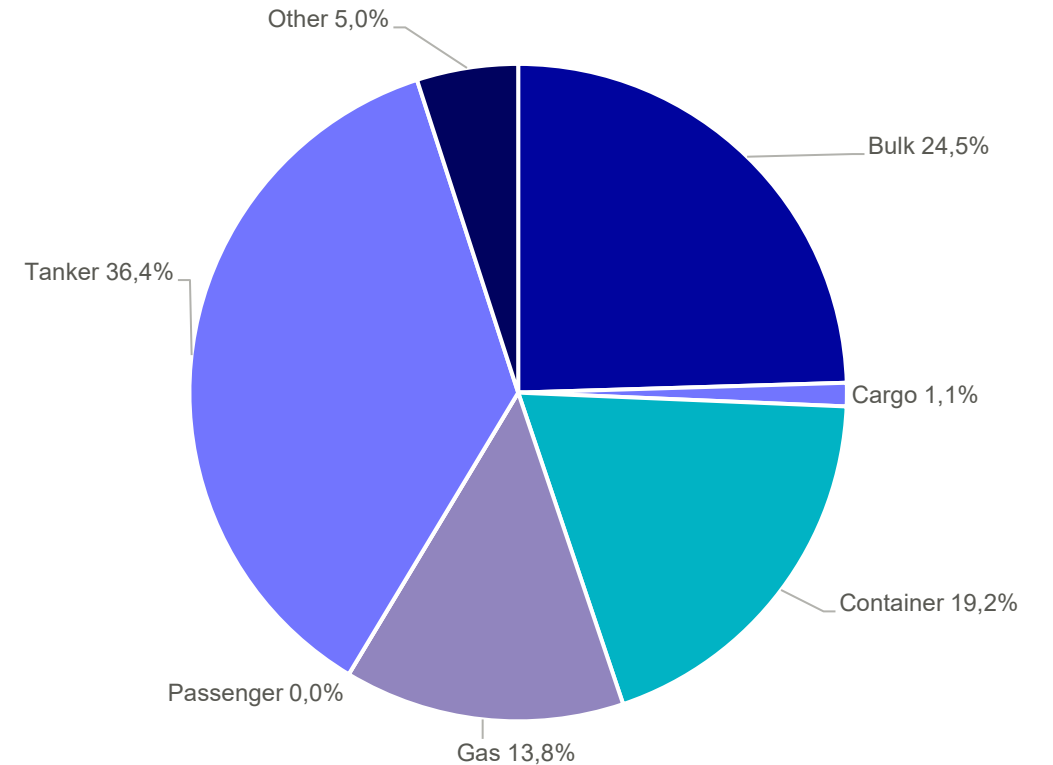
Only contracts signed in 2024

BV 2024 ORDER BOOK

SHIP TYPE



SHIP TYPE (incl. Prepared Notation)



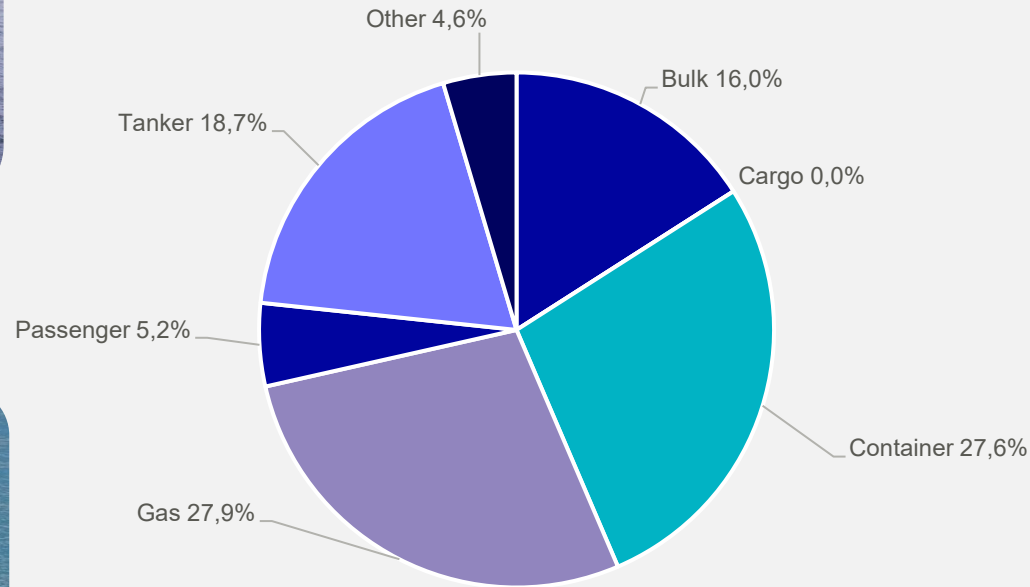
Only contracts signed in 2024

BV INVOLVEMENT

>300 vessels delivered with LNG as fuel notation / Delivered or in construction phase (BV Class)



Ship Types



EEDI & CII

$$\frac{\left(\prod_{j=1}^n f_j \right) \left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)} \right) + (P_{AE} \cdot C_{FAE} \cdot SFC_{AE} *) + \left(\left(\prod_{j=1}^n f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AE_{eff(i)}} \right) C_{FAE} \cdot SFC_{AE} \right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME} ** \right)}{f_i \cdot f_c \cdot f_l \cdot Capacity \cdot f_w \cdot V_{ref} \cdot f_m}$$

Using a Main Engine WinGD X92 as an example, (Diesel or Dual-Fuel):

Diesel mode: SFC @ 75% : 150 g/KWh to be used with Conversion Factor (Cf) HFO : 3,114

Gas Mode: SFC @ 75% : 145 g/KWh to be used with Conversion Factor (Cf) LNG: 2,75



> 15% reduction when using LNG

Similar impact is expected on CII calculation

$$CII = \frac{\sum(FC_i \times CF_i)}{Capacity \times Distance}$$

To be noted that on FuelEU, methane emission are taken into account:

-1.5g/KWh for low-pressure two-stroke

-18,5 Well-to-Tank gCO2equ per MJ (that currently not allowed to be reevaluated through measurement)

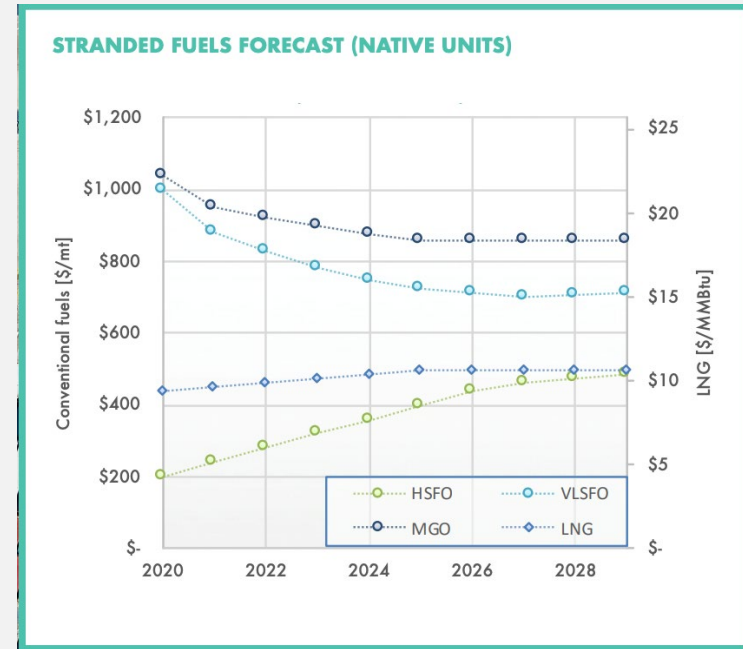
ECONOMICS

New Building Impact

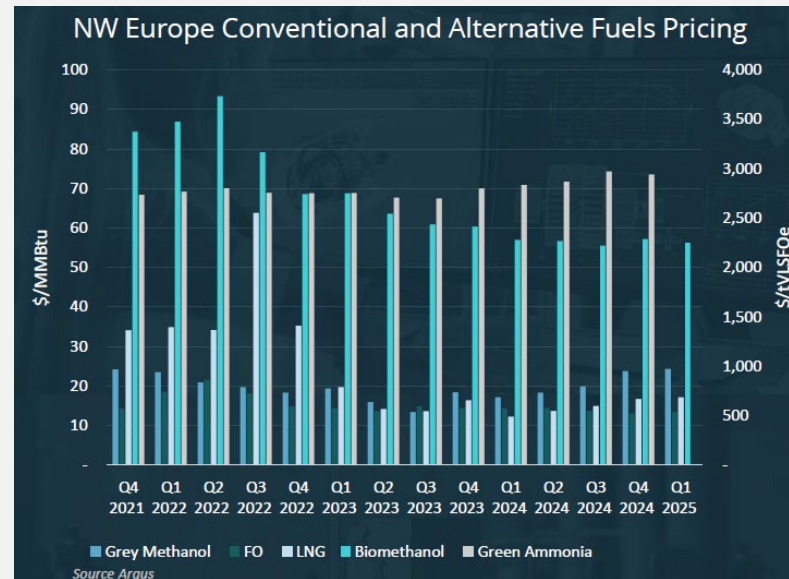
- › Storage (space LNG volumetric density vs HFO)
- › Main Engine more complex
- › Gas treatment (Bunkering, pumps and compressors, etc...)

Ship in Service

- › Additional items for maintenance
- › Cleaner Fuel
- › Innovative designs
- › Fuel cost
- › Boil Off management



Courtesy: Sea-LNG



GHG - Methane slip, fugitive emissions and controlled venting

Engines: Low Pressure / Otto cycle (vs High Pressure / Diesel Cycle)

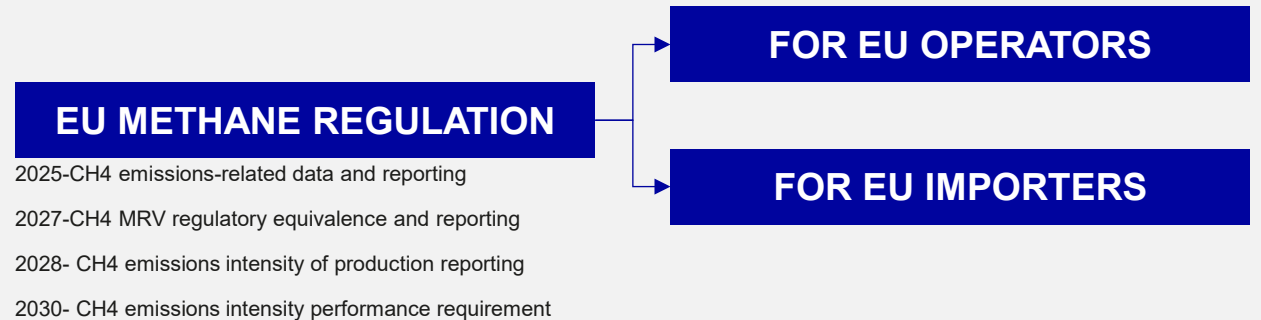
- › Combustion optimisation
- › Exhaust Gas recirculation
- › Up to 90% reduction in the last 30 years?

Abatement technologies

- › Catalyst
- › Plasma
- › Usage of Shaft Generators

Other emissions

- › Fugitives (glands, compressors, valves, ...)
- › Controlled venting (change over, start/stop)



PRESENT CASE STUDY 1

Containeur ships / Large membrane tanks

Only 1 LNG Tank

2 Stroke Main Engine

Generators with Dual Fuel Capability

Enclosed Tank Connection Spaces

Separated Fuel Preparation Room

**Double Wall Fuel piping system between
TCS/FPR/GVU and Engines**

Bunkering station on main deck



PRESENT CASE STUDY 2

Chemical tankers

Vacuum insulated tank

4 Strokes Main Engine

Generators without Dual Fuel Capability

Integrated Tank Connection Space (including LNG supply pump, LNG vaporizer and heater, BOG heater, process valves)

Limited routing of fuel piping with double wall and dedicated ventilation (in Engine Room)

Vents on main deck



PRESENT CASE STUDY 3

Passenger Ship

Duplicated Type C LNG tanks

Dual Fuel Diesel Generator (Electric propulsion)

Dual Fuel Boiler

Gas Combustion Unit

Enclosed Tank Connection Spaces

Separated Fuel Preparation Room

Fuel piping in enclosed spaces with ventilation and segregation philosophy, including vent piping

Double Wall Fuel piping system between TCS/FPR/GVU and Engines

Enclosed bunkering stations



POLL TIME



**BUREAU
VERITAS**



**BUREAU
VERITAS**

Shaping a World of Trust

WWW.BUREAUVERITAS.COM

