Porti e ambiente:

informare senza lasciare parole al vento

15 e 17 Marzo 2021

Il Gas Naturale Liquefatto come combustibile alternativo

Prof. Giovanni Satta

17 marzo 2021

Le strategie green nello shipping: opzioni per la riduzione dell'impatto ambientale

Ship propulsion systems & alternative fuels	Tech. solutions for energy & environ. efficiency	Waste treatment systems	Water treatment systems	Automation & digital technologies
Integrated Electric Prop. (IEP)/Battery	Exhaust Gas Cleaning System (scrubber)	Waste reduction policies	Adv. wastewater purif. systems (AWWPS)	Autonomous shipping
Diesel-Electric engines	Hull air lubrication ("bubble technology")	Unsorted/separated waste compactors	Ballast water Exchange	Digital technologies
Wind assisted propulsion	Fuel saving propeller attach. & ship design	Wet waste compactor (Converter NV)	Onboard treatment	Etc.
VLSFO/ULSFO	New bulbous bow (nose job)	Hazardous chemical waste management	Etc.	
LNG/LPG	Heating, Ventilation and Air Conditioning			
Hydrogen/Fuel Cell (FC) systems	Solar power			
Biofuels	**Cold ironing**			

Tecnologie e soluzioni per la riduzione del emissioni di Gas

Overview of technologies and fuels and their GHG-reduction potential (%)

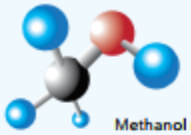
LOGISTICS AND DIGITALIZATION	HYDRODYNAMICS	MACHINERY	FUELS AND ENERGY SOURCES
Speed reduction	Hull coating	Machinery improvements	LNG/LPG
Vessel utilization	Hull-form optimization	Waste heat	Electrification
Vessel size	Air lubrication	Engine de-rating	Biofuel
Alternative routes	Cleaning	Battery hybridization	Hydrogen etc.
>20%	10%–15%	5%–20%	0%–100%

Principali carburanti alternativi

Biofuels

Biofuels are derived from primary biomass or biomass residues that are converted into liquid or gaseous fuels. A large variety of processes exist for the production of conventional (first-generation) and advanced (second and third-generation) biofuels, involving a variety of feedstocks and conversions. The most promising biofuels for ships are biodiesel (e.g. HVO - hydrotreated vegetable oil, BTL - biomass-to-liquids, FAME - fatty acid methyl ester) and LBG (liquid biogas, which primarily consist of methane).

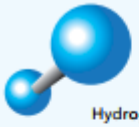
Biodiesel is most suitable for replacing MDO/MGO, LBG for replacing fossil LNG, and SVO (straight vegetable oil) for replacing HFO.



Methanol molecule

Methanol

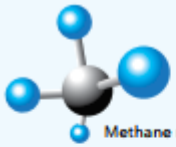
With its chemical structure CH_3OH, methanol is the simplest alcohol with the lowest carbon content and highest hydrogen content of any liquid fuel. Methanol is a basic building block for hundreds of essential chemical commodities and is also used as a fuel for transport. It can be produced from a number of different feedstock resources like natural gas or coal, or from renewable resources such as biomass or CO_2 and hydrogen.



Hydrogen molecule

Hydrogen

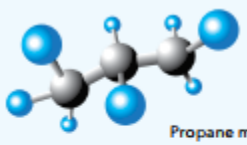
Hydrogen (H_2) can be produced in several different ways, for example by electrolysis of renewable matter or by reforming natural gas. The production of hydrogen through electrolysis could be combined with the growing renewable energy sector which delivers, by its nature, intermittent power only. Conversion to hydrogen could facilitate storage and transport of this renewable energy.



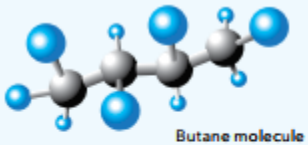
Methane molecule

LNG

Liquefied natural gas (LNG) has more or less the same composition as natural gas used for households and power generation, and in the industry. Its main component is methane (CH_4), the hydrocarbon fuel with the lowest carbon content.



Propane molecule



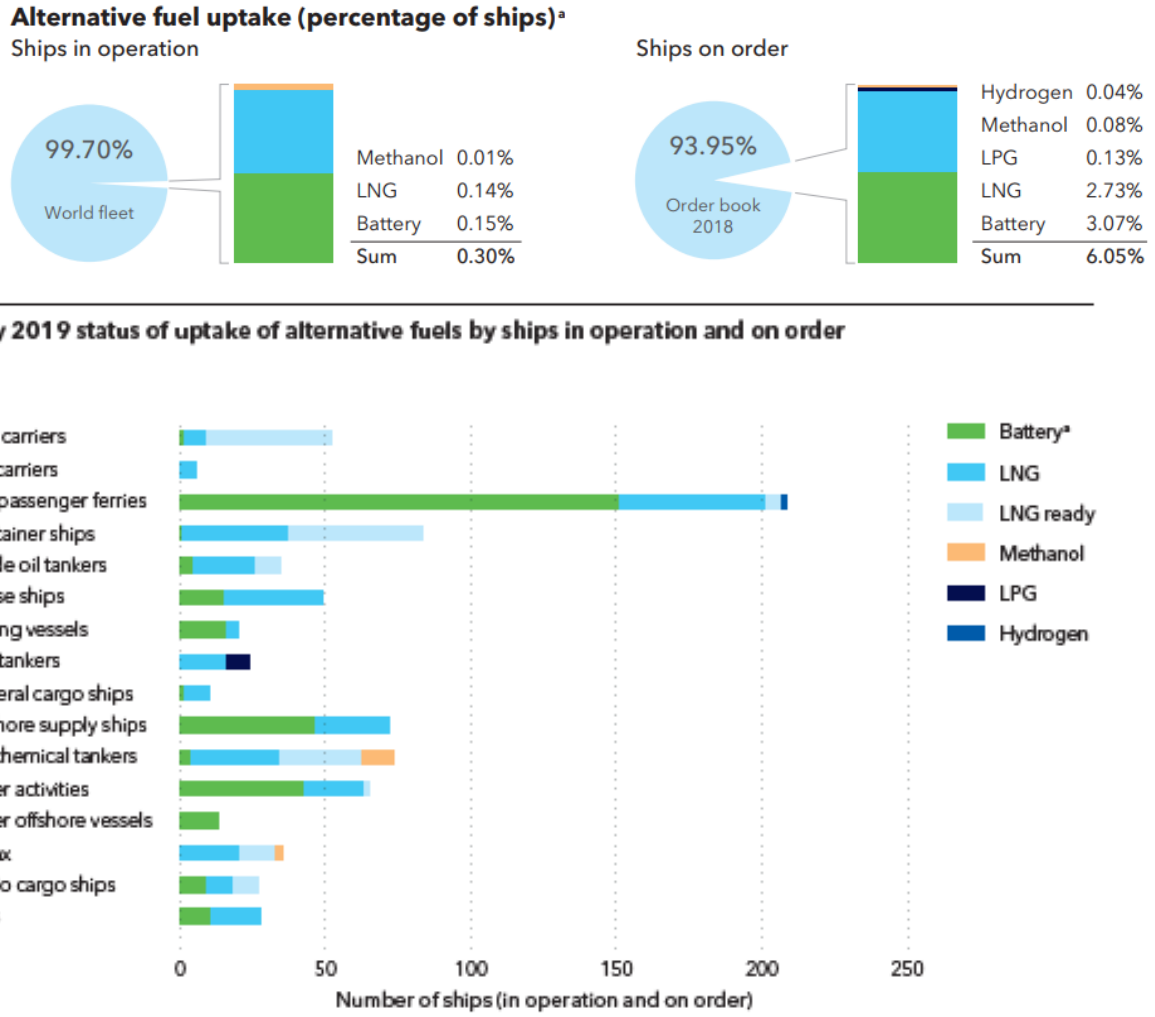
Butane molecule

LPG

Liquefied petroleum gas (LPG) is by definition any mixture of propane and butane in liquid form. For instance, in the USA, the term LPG is generally associated with propane. Mixing butane and propane enables specific saturation pressure and temperature characteristics.

Source: DNV-GL, «Assessment of selected alternative fuels and technologies» - April 2019

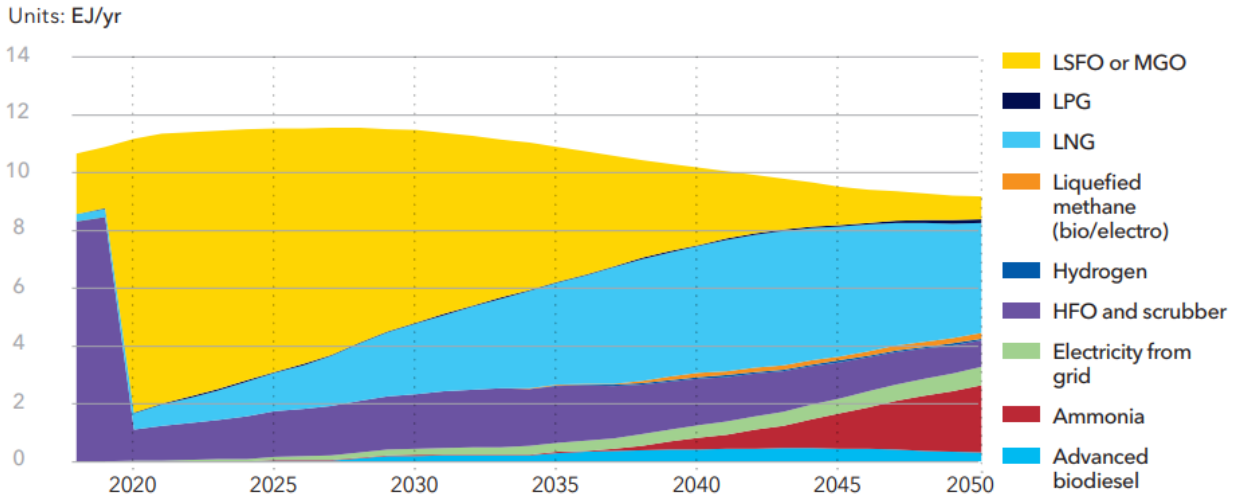
Trend nell'utilizzo dei carburanti alternativi



Source: DNV-GL, «Maritime Forecast to 2050: Energy Transition Outlook», 2019

Trend nell'utilizzo dei carburanti alternativi

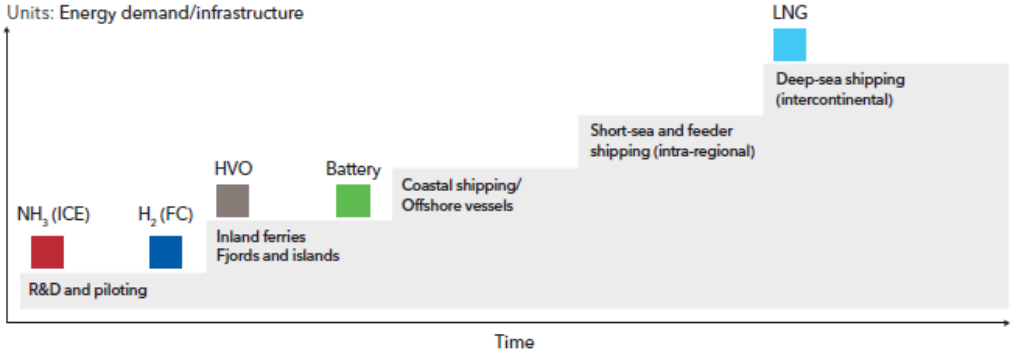
Energy use and projected fuel mix 2018-2050 for the simulated IMO ambitions pathway with main focus on design requirements



LSFO, low-sulphur fuel oil; MGO, marine gas oil; LPG, liquefied petroleum gas; LNG, liquefied natural gas; HFO, heavy fuel oil;
Advanced biodiesel, produced by advanced processes from non-food feedstocks

Source: DNV-GL, «Maritime Forecast to 2050: Energy Transition Outlook», 2019

Current development stage for selected alternative fuels

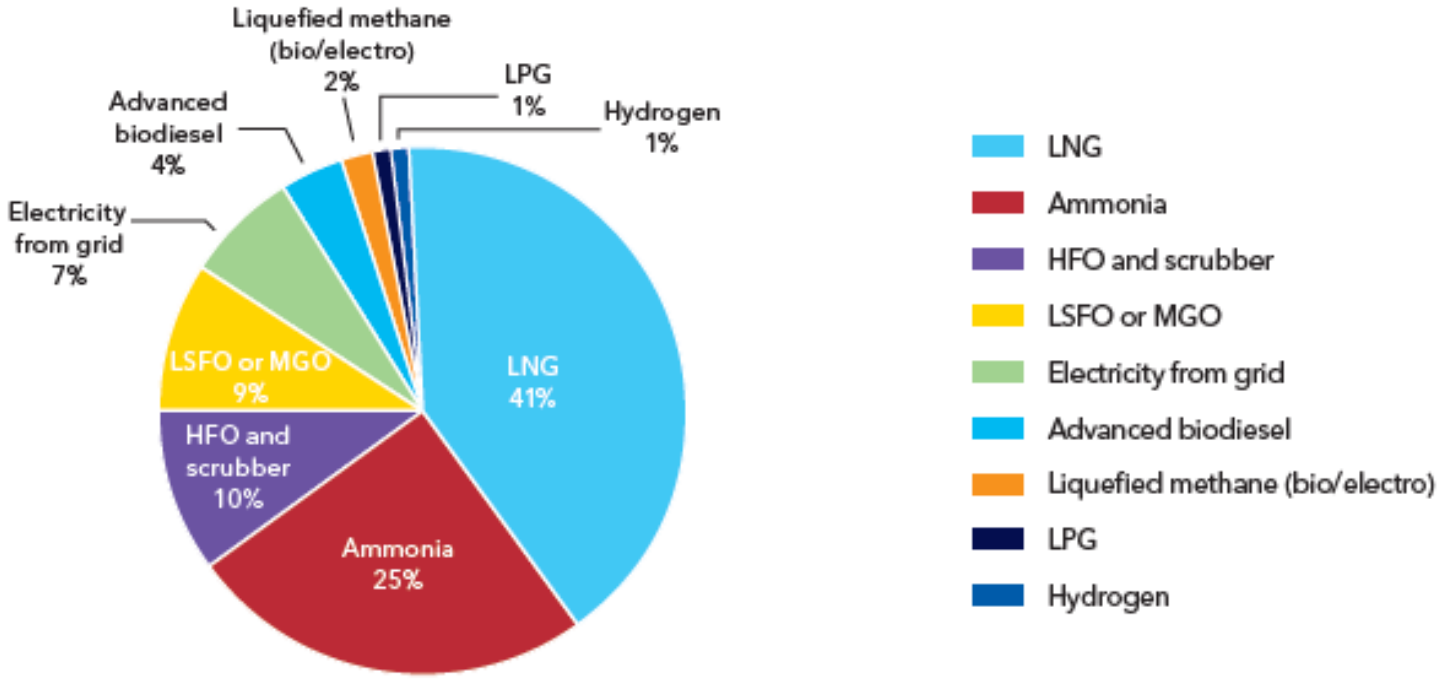


NH_3 (ICE), ammonia burned in internal combustion engines; H_2 (FC), hydrogen in fuel cells; HVO, hydrotreated vegetable oil; Battery, full electric with batteries; LNG, liquefied natural gas

** HVO: Hydrogenated Vegetable Oil*
NH_3 (ICE): Ammonia (Internal Combustion Engines)
H_2 (FC): Hydrogen (Fuel Cell)

Trend nell'utilizzo dei carburanti alternativi

Energy use in 2050 by fuel type for the simulated IMO ambitions DR pathway with main focus on design requirements



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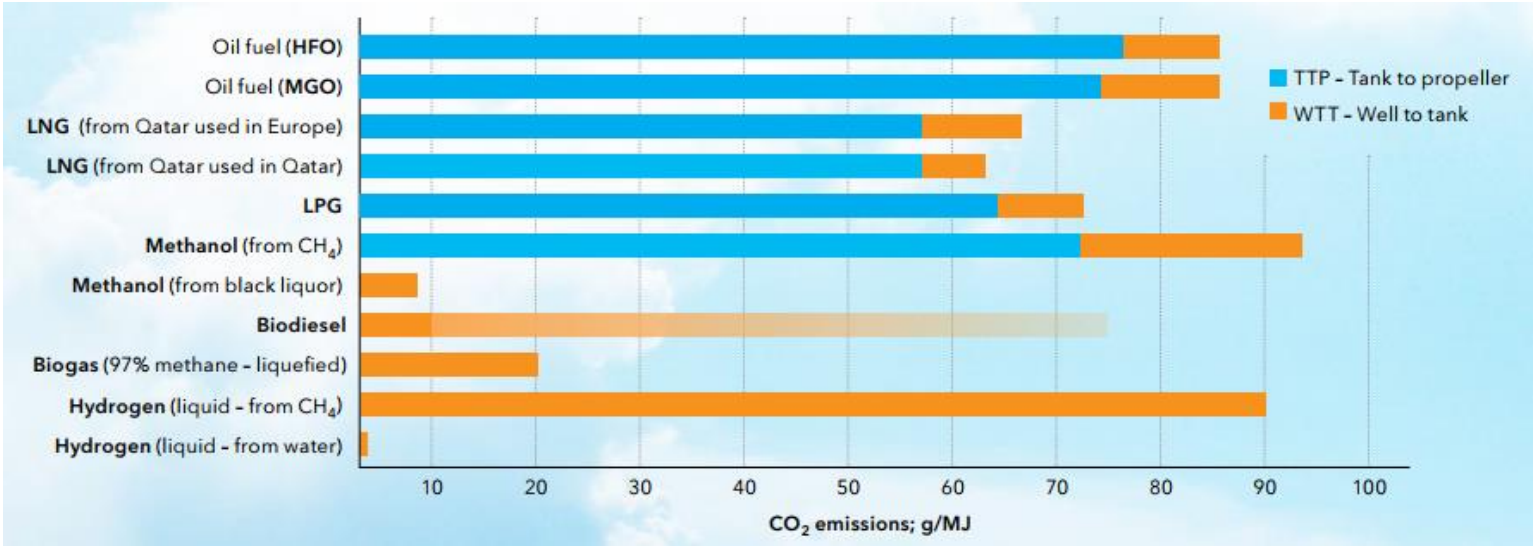
LNG, liquefied natural gas; HFO, heavy fuel oil
Advanced biodiesel, produced by advanced processes from non-food feedstocks

Source: DNV-GL, «Maritime Forecast to 2050: Energy Transition Outlook», 2019

Carburanti alternativi: confronto emissioni

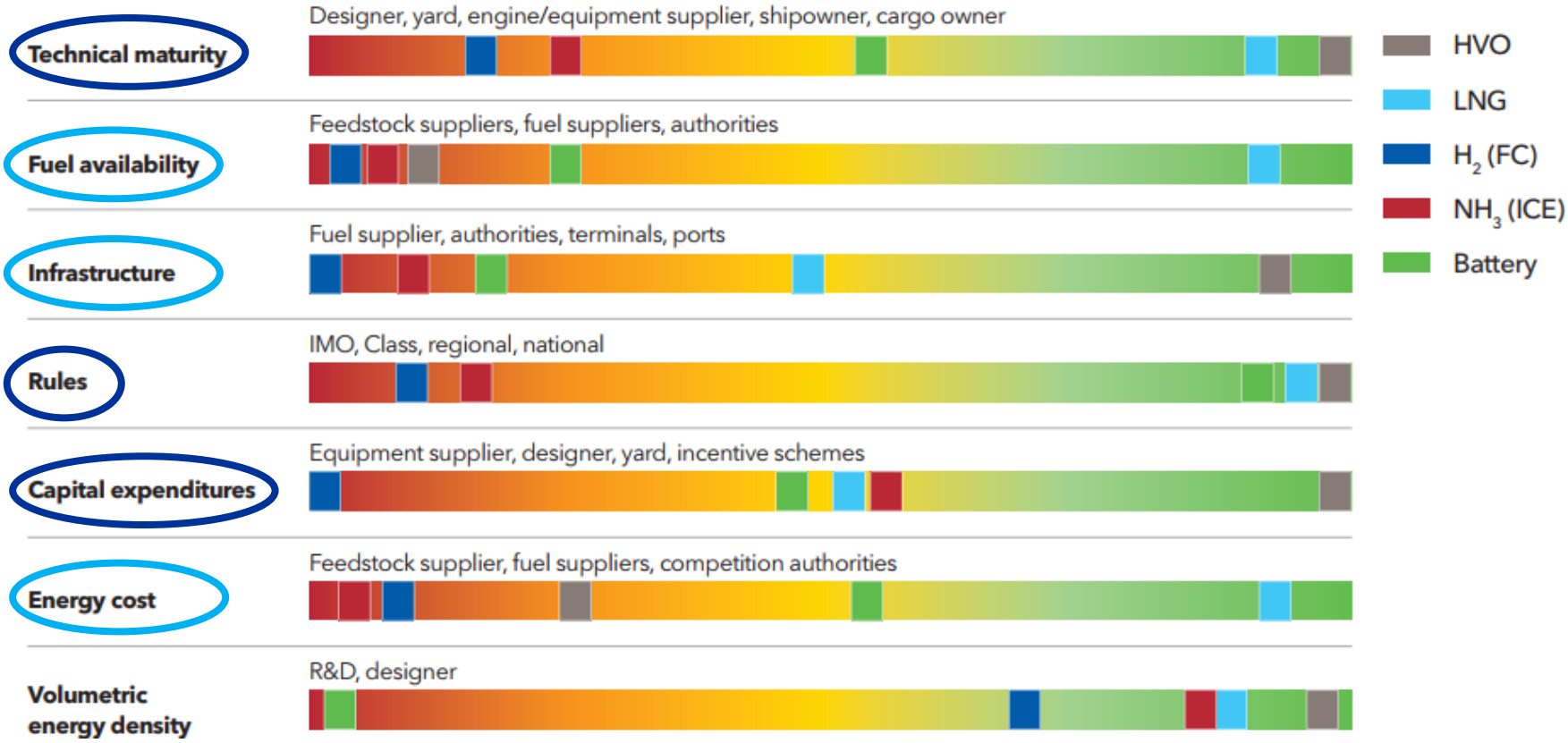
Fuel	Net calorific value	SFC	Operational fuel emission factor (g/kWh)					
	MJ/kg	g/kWh	CO_2	CH_4	N_2O	SO_x	NO_x	PM
LSHFO	40.5	179	541	0.010	0.027	3.23	15.8	0.72
MDO	42.6	170	524	0.010	0.026	0.32	14.8	0.16
LNG	48.6	150	412	3.0	0.016	0.003	1.17	0.027
LH_2	120.0	57	0	0	0	0	0	0
Methanol	20.0	381	522	0	0	0	3.05	0
SVO Soy	37.5	195	–	0.0064	0.013	0.37	17.1	0.19
SVO Rape	37.4	195	–	0.0064	0.013	0.37	17.1	0.19
Biodiesel Soy	37.8	187	–	0.0061	0.013	0.36	17.9	0.18
Biodiesel Rape	37.9	187	–	0.0061	0.013	0.36	17.9	0.18

Data on bio-derived fuels are taken from Baquero et al. (2011) and ANL (2008). Data on sfc are taken or adapted from Smith et al. (2014), whilst emission per unit of fuel are based on USEPA (2015). Data on fuel carbon content are taken from USEIA (2016). Data on the energy content of hydrogen and methanol are taken from Satyapal et al. (2007) and Stone (2012) respectively. The sfc for refined bio-derived fuels increases relative to MDO due to a lower net calorific value, following Xue et al. (2011).



Principali barriere alla diffusione di carburanti alternativi

The Alternative Fuel Barrier Dashboard: Indicative status of key barriers for selected alternative fuels



** HVO: Hydrogenated Vegetable Oil*
NH_3 (ICE): Ammonia (Internal Combustion Engines)

GNL nella propulsione navale: benefici ambientali

- Forte **impegno** a livello **nazionale** e **regionale** nell'introduzione allo **sviluppo del GNL** nei porti di interesse (con il supporto del AdSP del Mari Ligure Occidentale)
- Partecipazione degli enti istituzionali regionali ai **4 progetti Interreg Marittimo ITA-FRA 14-20** relativi al cluster del GNL

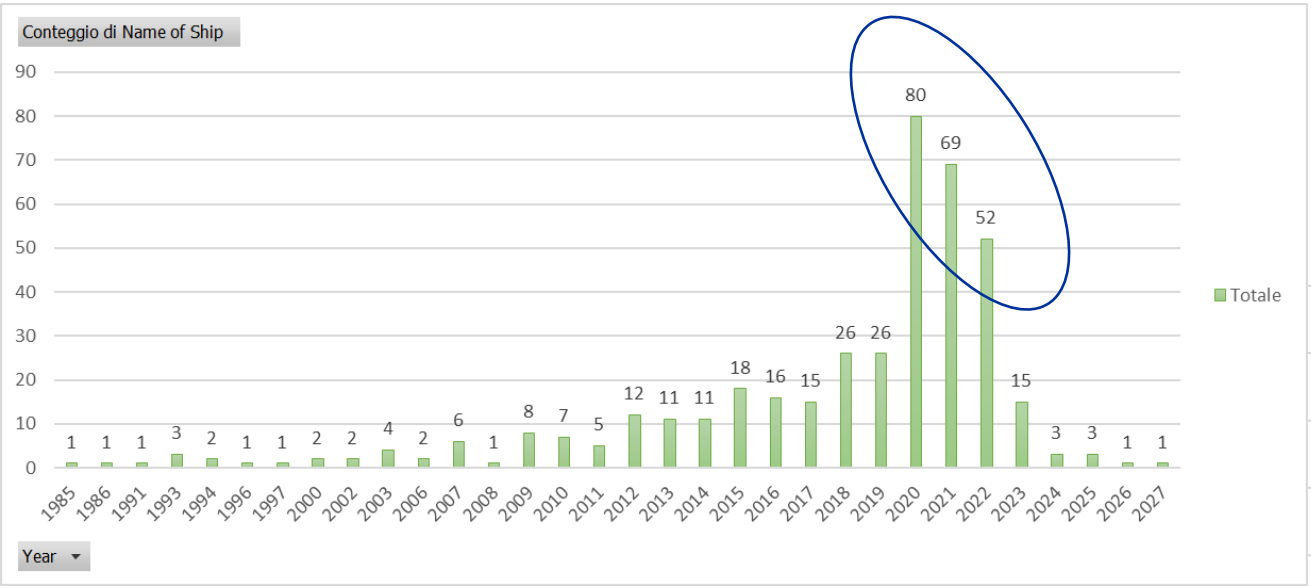
ENVIRONMENTAL REGULATIONS		
Emission component	**Emission reduction with LNG as fuel**	**Comments**
SO_x	100%	Complies with ECA and global sulphur cap
NOx, low-pressure engines (Otto cycle)	85%	Complies ECA 2016 Tier III regulations
NOx, high-pressure engines (Diesel cycle)	40%	Need EGR/SCR to comply with ECA 2016 Tier III regulations
CO_2	25–30%	Benefit for the EEDI requirement, no other regulations (yet)
Particulate matter	95–100%	No regulations (yet)

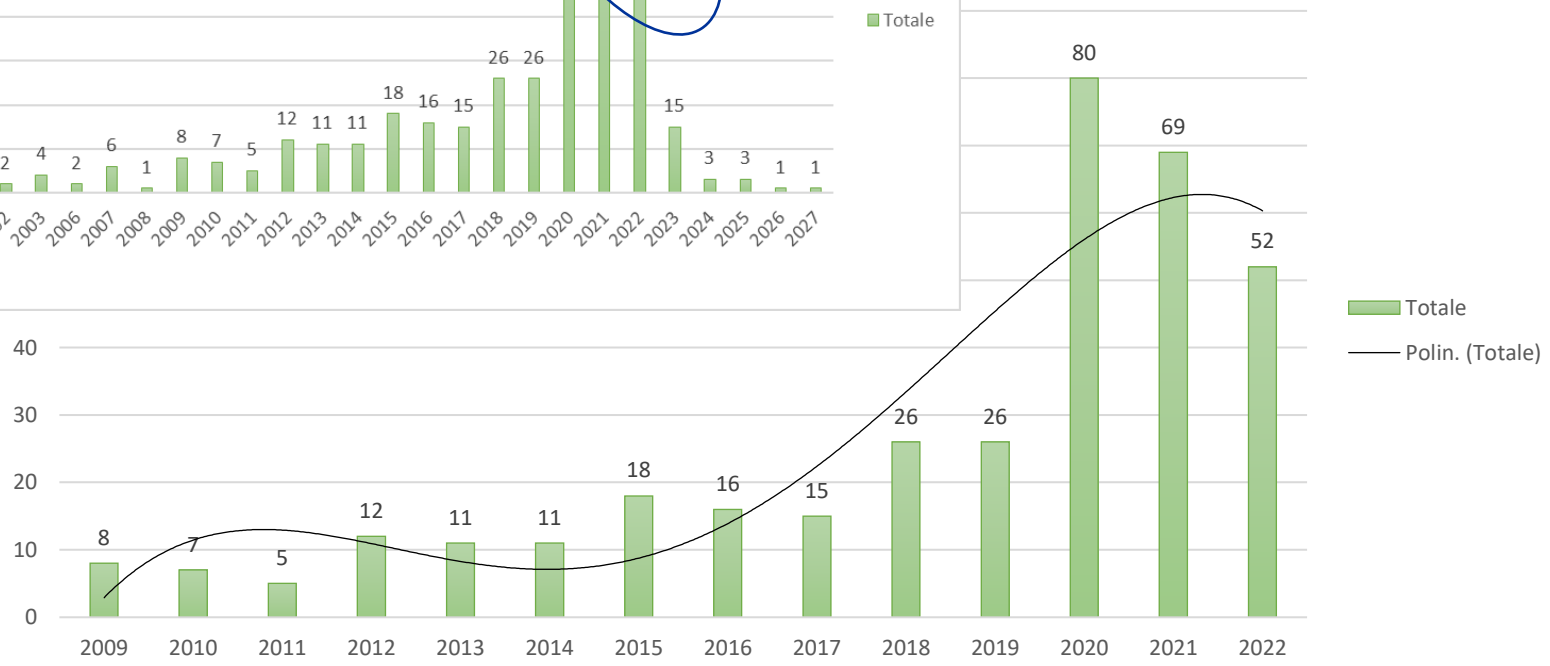
COMPARISON OF EMISSIONS FROM DIFFERENT FUELS					
	CO_2 equivalent [g/MJ] (Tab 3, DNV-2012-0719)			% CO_2 (HFO = 100%)	
Data from DNV No. 2011-1449, Rev. 1 (Tab 16 mainly); DNV NO 2012-0719	**Well-to-tank CO_2 emissions (WTT)**	**Tank To Propeller CO_2 emissions (TTP)**	**Total CO_2 emissions**	**% total**	**% Tank To Propeller**
Oil fuel (HFO)	9.80	77.70	87.50	100.00	100.00
Oil fuel (MGO)	12.70	74.40	87.10	99.54	95.75
LNG (from Qatar used in Europe)	10.70	69.50	80.20	91.66	89.45
LNG (from Qatar used in Qatar)	7.70	69.50	77.20	88.23	89.45

Source: DNV-GL, «Assessment of selected alternative fuels and technologies» - April 2019

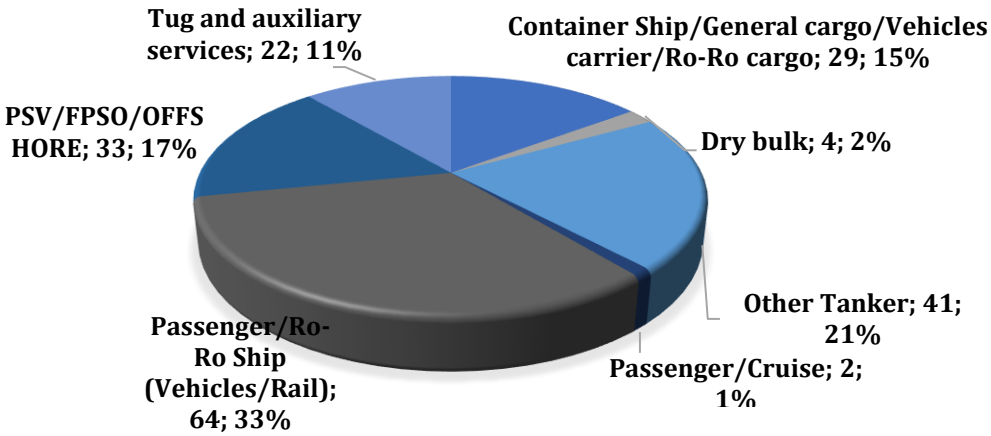
Market analysis:
Flotta mondiale LNG-propelled (evoluzione temporale)

406 LNG-propelled ships worldwide al **2027**
(excluding LNG tanker che usano il BOG)



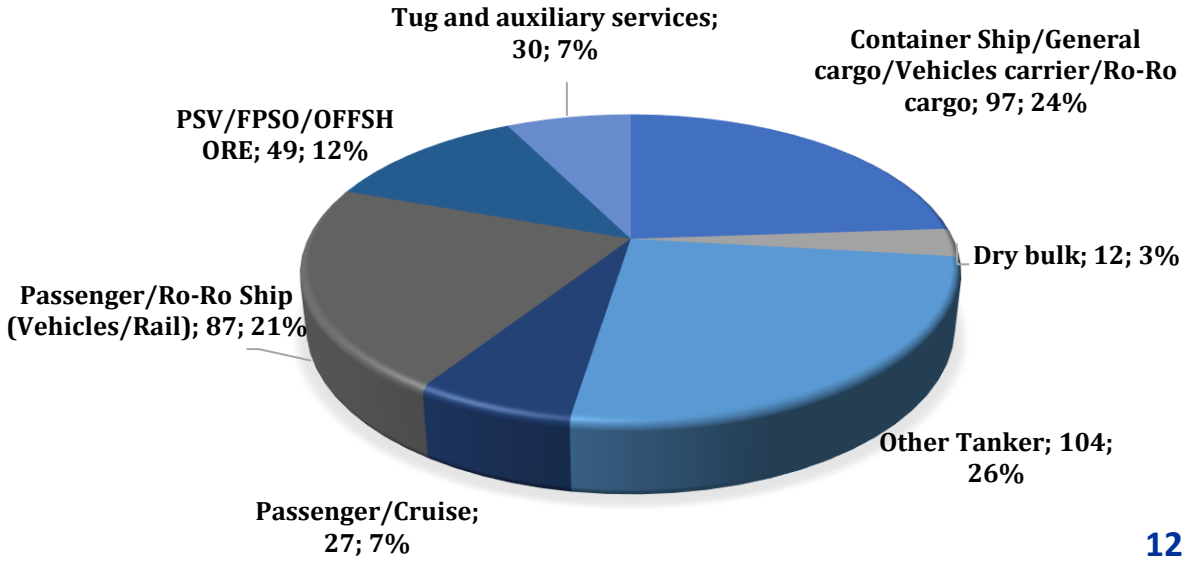


Market analysis:
Segmenti di mercato della flotta internazionale LNG-propelled



195 LNG-propelled ships worldwide al **2020** (excluding LNG tanker che usano il BOG)

406 LNG-propelled ships worldwide in **2027** (excluding LNG tanker che usano il BOG)



Market analysis:
Segmenti di mercato della flotta europea LNG-propelled al 2027

Categoria	No. navi
Container Ship/General cargo/Vehicles carrier/Ro-Ro cargo	**44**
Dry bulk	3
Other Tanker	69
Cruise ships	**9**
Passenger/Ro-Ro Ship (Vehicles/Rail)	**69**
PSV/FPSO/OFFSHORE	30
Tug and auxiliary services	21
Totale complessivo	**245**

Il progetto TDI RETE-GNL

TDI RETE-GNL

Tecnologie e Dimensionamento di Impianti per la RETE di distribuzione primaria di GNL nei porti dell'area transfrontaliera

TDI RETE-GNL

- Il progetto
- I partner
- Che cosa realizza?
- Eventi
- Notizie
- Contatti

Il progetto

TDI RETE-GNL (Capofila UNIGE-CIELI, Responsabile Scientifico Prof. Giovanni Satta) si pone l'obiettivo di individuare **soluzioni tecnologico-produttive per la distribuzione e il bunkering di GNL nei porti dell'area transfrontaliera** basate su standard e procedure operative condivise: il progetto identifica la possibile localizzazione degli impianti e dei depositi della rete di distribuzione primaria, verificandone le potenziali esternalità e la sostenibilità economico-finanziaria.

La recente diffusione del gas naturale liquefatto (GNL) nei porti richiede infatti l'implementazione di un sistema infrastrutturale che privilegi logiche di corridoio e la costituzione di una rete di distribuzione affidabile, sicura e integrata. La realizzazione di tale infrastruttura implica **decisioni strategiche** circa la **localizzazione** degli **impianti** per il **bunkering**, lo **stoccaggio** e l'**approvvigionamento del GNL** e in merito al loro dimensionamento, secondo logiche sistemiche.

http://interreg-maritime.eu/web/tdiretegnl

Grazie per l'attenzione

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Schede di sintesi relative ai prodotti tecnico-scientifici scaricabili presso l'url:

http://interreg-maritime.eu/web/tdiretegnl/checosarealizza