JOURNAL OF MARITIME RESEARCH

Vol XVII. No. I (2020) pp 86–92

ISSN: 1697-4040, www.jmr.unican.es

Technical structure of the Gas carrier fleet in 2019

C. Gonzalez-Gutierrez[1,*], C. Perez-Labajos [1,2]

ARTICLE INFO

Article history:
Received 30 March 2020;
in revised form 9 April 2020;
accepted 10 April 2020.

Keywords:
Data Processing 1, Maritime 2, Intelligence 3.

ABSTRACT

This work aims to structure the gas carrier fleet in service in December 2019. The structure is made considering as most descriptive parameters the following factors: deadweight, gross tonnage, age, power installed by main engines and flag of registration.
The structure is made separating the LPG ships and the LNG ships due to the differences existing between these two types of gas carrier, going from different dimensions until different trading followed by the LNG and LPG ships.
The structure of the gas carrier fleet made in this work may be used as a starting point for developing other metrics that helps to describe deeper the LNG and the LPG carriers and, the structure can be used in other analysis related to the gas fleet.

1. Introduction.

Gas carriers is a group within the tanker's group within the maritime transport. Gas carriers are specialized tankers that transport liquefied petroleum gases (LPG carrier), and ships that transport liquefied natural gas (LNG carrier).

Liquefied natural gas (LNG) is currently one of the preferred options as an energy source by many industries because produces negligible NO_x and SO_x emissions, besides a reduction in CO_2 emissions of around 20% in comparison with residual fuels (Calderón et al., 2016). These characteristics make natural gas an important alternative in the global energy mix thanks for the flexibility that this type of energy source is providing when it comes to balancing the electrical networks when they are connected or are depending on renewable energies as well as being a cleaner fuel alternative for the transportation sector (Economides et al., 2009; Aguilera, R.F. 2014; Kuang, M., 2018). With these advantages, there are LNG demand forecasts that project an estimated increase of 40% in the next 20 years (International Energy Agency, 2018).

Today, the global LNG trade has seen a steady increase over the past few years (International Gas Union, 2019). This has been largely driven by growing environmental concerns, highly competitive prices for natural gas compared to other fuels, low cost of LNG production (Varahrami et al., 2018), and the emergence of a greater number of emerging markets, with Australia, the United States, Nigeria, Malaysia, Qatar and Trinidad and Tobago being the largest LNG suppliers worldwide (Zhang et al., 2018).

The prediction of growth in the global natural gas trade implies that the fleet of LNG vessels that is part of the natural gas supply chain will grow significantly in the coming decades (Shaton et al., 2019). Most likely this increment of the LNG fleet will place this type of ships as a more significant segment of maritime transport (UNCTAD, 2018). At the end of 2019, the LNG vessel fleet consisted of 522 vessels with a supply of 128 new builds projected as of 1st January 2020 (International Gas Union, 2019; Information Handling Services Markit, 2020).

The other large group in the gas carrier group is the one dedicated to the transport liquefied petroleum gases (LPG). LPG is a set of products resulting from the natural gas and crude extraction processes, and, therefore, it is logical to assume that the available supply of LPG will depend on the production levels of crude oil and natural gas. The LPG market follows the "supply push" strategy instead of the "demand pull" strategy,

[1]University of Cantabria. Germán Gamazo nº 1, 39004 Santander, Cantabria (SPAIN). Coastal and Ocean Planning and Management I+D Group.

[2]Professor of Marine Economics of the Department of Navigation and Naval Construction Science and Techniques. Tel. (+034) 942201362. E-mail Address: clabajos@unican.es.

*Corresponding author: C. Gonzalez-Gutierrez. Tel. (+034) 620595749. E-mail Address: carlos.gonzalezgu@alumnos.unican.es.

that is, production and transportation is regulated based on anticipated customer demand (Adland et al., 2008).

LPG is an option that is being considered to ensure that energy demand is met, and it is also an alternative as a fuel for transportation since it is less polluting than other fossil fuels that are used globally (Baranzini et al., 1996; Johnson, 2003; Raslavičius et al., 2014; Synák et al., 2019).

As mentioned above, the LPG market depends on the natural gas and crude oil market and, considering the forecast that exists for a plausible increase in the natural gas market, it is to be expected that, consequently, the LPG market will increase, being necessary an expansion of the existing fleet of LPG vessels. 109 new LPG vessels are projected as of 1st January 2020 (Information Handling Services Markit, 2020).

This work aims to structure the gas carrier fleet in service in December 2019. The structure is made considering as most descriptive parameters the following factors: deadweight, gross tonnage, age, power installed by main engines and flag of registration.

The structure of the gas carrier fleet made in this work may be used as a starting point for developing other metrics that helps to describe deeper the LNG and the LPG carrier and, the structure can be used in other analysis related to the gas fleet.

This work consists of four more sections as follows: 2. Methodology and Data, 3. LPG fleet structure, 4. LNG fleet structure and, 5. Concluding remarks.

2. Methodology and Data.

In this section it is explained the methodology used to make the structure of the gas carrier fleet and the data used for such purpose.

The structure of the gas carrier fleet is made for the ships in operation in December 2019, it is analyzed using the data obtained from the IHS Fairplay database.

The gas carrier's fleet, as it has been mentioned, it is divided into two types of ships mainly, the LPG ships and the LNG ships. As of 1st January 2020, 2,004 gas carriers were counted in service according to IHS Fairplay data. With a distribution of 522 LNG vessels and 1,482 LPG vessels sailing and fully operational.

The technical structure of the gas carrier fleet is analyzed separately for LNG ships and LPG ships due to the different nuances existing between them (Gonzalez-Gutierrez et al., 2017), through the evaluation of 5 groups or structures: by deadweight, gross tonnage, age, power installed by main engines and flag of registration.

From the IHS Fairplay database, the total fleet of gas tankers has been obtained, dates from 1939 to 31st December 2019.

In this database, it was obtained, among other data, the status of each ship and the date of decommissioning of the ships. The status reported by IHS Fairplay are:

- Broken Up
- In Service / Commission
- Continue Existence in doubt
- Total Loss
- Converting / Rebuilding
- Hulked
- Cancelled before construction
- In casualty or repair
- Keel Laid
- Laid-up
- Launched
- No Longer meet the IHS criteria
- On Order / Not commenced
- Scuttled
- To be broken up
- Under construction

In this work, only the ships with status "in Service/Commission" are used for the structure of the fleet due to the structure is made for the active fleet in December 2019.

The groups defined for each structure are made using as reference existing structures available for the maritime transport such as the published by UNCTAD and IMO.

3. LPG fleet structure.

LNG ships and LPG ships have differences between them that make both fleets have different characteristics (different lengths, sizes, installed power and types of propulsion installed on board), therefore, the structural analysis will be made for each of the fleets separately. In this section is analyse the technical structure for the LPG carriers.

3.1. LPG fleet structure by deadweight.

For the LPG carriers, 4 groups of deadweight have been made to structure the LPG fleet. The groups correspond to smaller LPG ships that are generally used for coastal transport (ships with less than 5,000 tons of deadweight) to the largest ships for cargo transport over greater distances, which are ships with equal or greater than 50,000 tons of deadweight.

The total deadweight of the LPG fleet in service in December 2019 was 25,840,880 tons.

Table 1: LPG fleet by group of Deadweight for the total values for the variables: number of ships, deadweight gross tonnage and propulsion power.

Group of Deadweight (DWT)	DWT (t)	GT (t)	Prop. Power (kW)
DWT < 5,000	1,541,877	1,481,713	1,284,193
5,000 ≤ DWT < 10.000	1,663,356	1,476,126	1,012,257
10,000 ≤ DWT< 50.000	9,024,239	7,883,927	3,031,401
DWT ≥ 50,000	13,611,408	11,845,142	3,248,369

Source: Authors.

There are 650 LPG ships with less than 5,000 tons of deadweight, 235 ships between 5,000 and 10,000 tons, 348 ships between 10,000 and 50,000 tons and, 249 ships with equal or greater than 50,000 tons of deadweight.

The average deadweight per LPG ship in service in December 2019 is 17,436 tons.

Calculating the mean values per ship for each deadweight group for every variable analysed, being these ones the deadweight, gross tonnage, and propulsion power, it is obtained the values shown in Table 2.

Table 2: Average value per ship for the LPG fleet by group of deadweight for the variable deadweight gross tonnage and propulsion power.

Group of Deadweight (DWT)	DWT (t)	GT (t)	Prop. Power (kW)
DWT < 5.000	2,372	2,280	1,976
5,000 ≤ DWT < 10.000	7,078	6,281	4,307
10,000 ≤ DWT< 50.000	25,932	22,655	8,711
DWT ≥ 50,000	54,664	47,571	13,046

Source: Authors.

3.2. LPG fleet structure by Gross Tonnage.

For the LPG carriers, 4 groups of gross tonnage have been made to structure the LPG fleet. The groups correspond to smaller LPG ships (ships with less than 3,000 gross tonnage) to the largest ships which are ships with equal or greater than 15,000 tons of gross tonnage.

The total gross tonnage of the LPG fleet in service in December 2019 was 22,686,908 tons.

Table 3: LPG fleet by group of Gross tonnage for the total values for the variables: number of ships, deadweight gross tonnage and propulsion power.

Group of Gross tonnage (GT)	DWT (t)	GT (t)	Prop. Power (kW)
GT < 3,000	609,100	566,483	628,086
3,000 ≤ GT < 5,000	1,145,440	1,072,036	777,651
5,000 ≤ GT < 15,000	2,516,381	2,199,728	1,401,619
GT ≥15,000	21,569,959	18,848,661	5,768,864

Source: Authors.

There are 411 LPG ships with less than 3,000 gross tonnage, 277 ships between 3,000 and 5,000 tons, 273 ships between 5,000 and 15,000 tons and, 521 ships with equal or greater than 15,000 tons of gross tonnage.

The average gross tonnage per LPG ship in service in December 2019 is 15,308 tons.

Calculating the mean values per ship for each Gross tonnage group for every variable analysed, being these ones the deadweight, gross tonnage, and propulsion power, it is obtained the values shown in Table 4.

Table 4: Average value per ship for the LPG fleet by group of Gross tonnage for the variable deadweight gross tonnage and propulsion power.

Group of Gross tonnage (GT)	DWT (t)	GT (t)	Prop. Power (kW)
GT < 3,000	1,482	1,378	1,528
3,000 ≤ GT < 5,000	4,135	3,870	2,807
5,000 ≤ GT < 15,000	9,218	8,058	5,134
GT ≥15,000	41,401	36,178	11,073

Source: Authors.

3.3. LPG fleet structure by age.

For the LPG carriers, 5 groups of age have been made to structure the LPG fleet. The groups correspond to smaller most recent built ships (with 5 or less years old) to the oldest ships with more than 20 years.

Table 5: LPG fleet by group of age for the total values for the variables: number of ships, deadweight gross tonnage and propulsion power.

Group of Ages (A)	DWT (t)	GT (t)	Prop. Power (kW)
A ≤ 5	10,245,343	9,205,200	2,782,877
5< A ≤10	2,278,557	2,026,386	807,943
10< A ≤15	6,110,588	5,259,836	2,163,763
15< A ≤20	3,003,728	2,594,046	1,044,252
A>20	4,202,664	3,601,440	1,777,385

Source: Authors.

There are 335 LPG ships with 5 or less years, 147 ships between 6 and 10 years, 327 ships between 11 and 15 years,

159 ships between 16 and 20 years and 514 LPG ships with 21 years or more.

The average age of the active LPG fleet in December 2019 is 15.2 years.

In the Table 6 is shown that the newest ships are, as average bigger in size (deadweight and gross tonnage) and in consequence, with more propulsion power required.

Table 6: Average value per ship for the LPG fleet by group of age for the variable deadweight gross tonnage and propulsion power.

Group of Ages (A)	DWT (t)	GT (t)	Prop. Power (kW)
A ≤ 5	30,583	27,478	8,307
5< A ≤10	15,500	13,785	5,496
10< A ≤15	18,687	16,085	6,617
15< A ≤20	18,891	16,315	6,568
A>20	8,176	7,007	3,458

Source: Authors.

3.4. LPG fleet structure by propulsion power.

For the LPG carriers, 4 groups of age have been made to structure the LPG fleet. The groups correspond to the ship with lower propulsive power installed on board (less than 2,000 kW), normally the smaller ships in the fleet and the ones with the larger propulsive engines installed on board (equal or greater than 10,000 kW).

The total propulsion power installed on the LPG fleet in service in December 2019 was 10,353,605 kW.

Table 7: LPG fleet by group of Propulsion Power for the total values for the variables: number of ships, deadweight gross tonnage and propulsion power.

Group of propulsive power (P)	DWT (t)	GT (t)	Prop. Power (kW)
P < 2.000	398,793	365,755	437,543
2.000 ≤ P < 5.000	2,341,864	2,173,816	1,546,929
5.000 ≤ P < 10.000	6,850,314	5,995,130	2,545,667
P ≥ 10.000	16,249,909	14,152,207	4,046,081

Source: Authors.

There are 338 LPG ships with less than 2,000 kW of propulsion power, 493 ships between 2,000 and 5,000 kW, 337 ships between 5,000 and 10,000 kW and 314 LPG ships with equal or more than 10,000 kW of propulsion power.

The average power per LPG ship in service in December 2019 is 6,986 kW per ship.

The ships with more propulsion power correspond with the greater average values for deadweight and gross tonnage as shown in Table 8.

Table 8: Average value per ship for the LPG fleet by group of propulsion power for the variable deadweight gross tonnage and propulsion power.

Group of propulsive power (P)	DWT (t)	GT (t)	Prop. Power (kW)
P < 2.000	1,180	1,082	1,295
2.000 ≤ P < 5.000	4,750	4,409	3,138
5.000 ≤ P < 10.000	20,327	17,790	7,554
P ≥ 10.000	51,751	45,071	12,886

Source: Authors.

3.5. LPG fleet structure by groups of registration flags.

It is considered 4 groups of registration flags, both for LPG and LNG carriers. The results for LPG carriers can be seen in the Table 9.

The registration flags are as below:

- EU15: belonging to the Europe of the 15 countries until 2004
- RA: open register flags
- RM: rest of flags that are not in any of the previous groupings
- ROECD: OECD countries that are not within the EU15 group

Table 9: LPG fleet by group of groups of registration flags for the total values for the variables: number of ships, deadweight gross tonnage and propulsion power.

Group Registration flags	DWT (t)	GT (t)	Prop. Power (kW)
EU15	1,793,454	1,575,880	679,476
RA	13,538,983	11,880,099	4,210,735
RM	10,028,371	8,806,921	3,312,925
ROCDE	480,072	424,008	373,084

Source: Authors.

In the EU15 group, there are 119 LPG ships registered, 563 ships are in the RA group, 602 ships are in RM group and 198 ships in the ROCDE group.

The ships registered under RA flags are, as average, the bigger ships (greater deadweight and gross tonnage) and the most powerful ships in regards propulsive power Table 10.

Table 10: Average value per ship for the LPG fleet by group registration flags for the variable deadweight gross tonnage and propulsion power.

Group Registration flags	DWT (t)	GT (t)	Prop. Power (kW)
EU15	15,071	13,243	5,710
RA	24,048	21,101	7,479
RM	16,658	14,629	5,503
ROCDE	2,425	2,141	1,884

Source: Authors.

4. LNG fleet structure.

As it has been mentioned, the LNG ships and the LPG ships have differences between them that make both fleets have different characteristics (different lengths, sizes, installed power and types of propulsion installed on board), therefore, the structural analysis will be made for each of the fleets separately. In this section is analyse the technical structure for the LNG carriers.

4.1. LNG fleet structure by deadweight.

For the LNG carriers, 4 groups of deadweight have been made to structure the LNG fleet. The groups correspond to smaller LNG ships (ships with less than 75,000 tons of deadweight) to the largest ships which are ships with equal or greater than 100,000 tons of deadweight.

The total deadweight of the LNG fleet in service in December 2019 was 44,161,203 tons.

Table 11: LNG fleet by group of Deadweight for the total values for the variables: number of ships, deadweight gross tonnage and propulsion power.

Group of Deadweight (thousands-DWT)	DWT (t)	GT (t)	Prop. Power (kW)
DWT < 75	4,564,731	6,735,283	1,659,742
75 ≤ DWT < 85	15,422,175	19,858,426	5,754,334
85 ≤ DWT < 100	18,715,285	23,397,344	7,069,816
DWT ≥ 100	5,459,012	6,542,158	1,651,703

Source: Authors.

There are 83 LNG ships with less than 75,000 tons of deadweight, 191 ships between 75,000 and 85,000 tons, 203 ships between 85,000 and 100,000 tons and, 45 ships with equal or greater than 100,000 tons of deadweight.

The average deadweight per LNG ship in service in December 2019 is 84,600 tons.

Calculating the mean values per LNG ship for each deadweight group for every variable analysed, being these ones the deadweight, gross tonnage, and propulsion power, it is obtained the values shown in Table 12.

Table 12: Average value per ship for the LNG fleet by group of deadweight for the variable deadweight gross tonnage and propulsion power.

Group of Deadweight (DWT)	DWT (t)	GT (t)	Prop. Power (kW)
DWT < 75,000	54,997	81,148	19,997
75,000 ≤ DWT < 85,000	80,744	103,971	30,127
85,000 ≤ DWT < 100,000	92,194	115,258	34,827
DWT ≥ 100,000	121,311	145,381	36,705

Source: Authors.

4.2. LNG fleet structure by Gross Tonnage.

For the LNG carriers, 4 groups of gross tonnage have been made to structure the LNG fleet. The groups correspond to smaller LNG ships (ships with less than 60,000 gross tonnage) to the largest ships which are ships with equal or greater than 120,000 tons of gross tonnage.

The total gross tonnage of the LNG fleet in service in December 2019 was 56,533,211 tons.

Table 13: LNG fleet by group of Gross tonnage for the total values for the variables: number of ships, deadweight gross tonnage and propulsion power.

Group of Gross tonnage (Thousands-GT)	DWT (t)	GT (t)	Prop. Power (kW)
GT < 60	363,344	505,211	188,073
60 ≤ GT < 100	9,445,900	11,299,505	3,433,008
100 ≤ GT < 120	22,675,994	29,053,488	8,367,708
GT ≥ 120	11,675,965	15,675,007	4,146,806

Source: Authors.

There are 24 LNG ships with less than 60,000 gross tonnage, 119 ships between 60,000 and 100,000 tons, 264 ships between 100,000 and 120,000 tons and, 115 ships with equal or greater than 120,000 tons of gross tonnage.

The average gross tonnage per LNG ship in service in December 2019 is 108,301 tons.

Calculating the mean values per ship for each Gross tonnage group for every variable analysed, being these ones the deadweight, gross tonnage, and propulsion power, it is obtained the values shown in Table 14.

Table 14: Average value per ship for the LNG fleet by group of Gross tonnage for the variable deadweight gross tonnage and propulsion power.

Group of Gross tonnage (GT)	DWT (t)	GT (t)	Prop. Power (kW)
GT < 60,000	15,139	21,050	7,836
60,000 ≤ GT < 100,000	79,377	94,954	28,849
100,000 ≤ GT < 120,000	85,894	110,051	31,696
GT ≥ 120,000	101,530	136,304	36,059

Source: Authors.

4.3. LNG fleet structure by age.

For the LNG carriers, 5 groups of age have been made to structure the LNG fleet. The groups correspond to smaller most recent built ships (with 5 or less years old) to the oldest ships with more than 20 years.

Table 15: LNG fleet by group of age for the total values for the variables: number of ships, deadweight gross tonnage and propulsion power.

Group of Ages (A)	DWT (t)	GT (t)	Prop. Power (kW)
A ≤ 5	15,351,081	19,801,559	5,793,552
5< A ≤10	3,949,807	4,899,693	1,650,629
10< A ≤15	14,120,360	17,397,813	4,985,020
15< A ≤20	6,718,490	8,698,656	2,271,416
A>20	4,021,465	5,735,490	1,434,978

Source: Authors.

There are 171 LNG ships with 5 or less years, 48 ships between 6 and 10 years, 153 ships between 11 and 15 years, 89 ships between 16 and 20 years and 61 LPG ships with 21 years or more.

The average age of the active LNG fleet in December 2019 is 9.4 years.

In the Table 16 is shown that the oldest ships are, as average smaller in size (deadweight and gross tonnage) and in consequence, with less propulsion power required.

Table 16: Average value per ship for the LNG fleet by group of age for the variable deadweight gross tonnage and propulsion power.

Group of Ages (A)	DWT (t)	GT (t)	Prop. Power (kW)
A ≤ 5	89,772	115,799	33,880
5< A ≤10	82,288	102,077	34,388
10< A ≤15	92,290	113,711	32,582
15< A ≤20	75,489	97,738	25,522
A>20	65,926	94,024	23,524

Source: Authors.

4.4. LNG fleet structure by propulsion power.

For the LNG carriers, 4 groups of age have been made to structure the LNG fleet. The groups correspond to the ship with lower propulsive power installed on board (less than 20,000 kW), normally the smaller ships in the fleet and the ones with the larger propulsive engines installed on board (equal or greater than 40,000 kW).

The total propulsion power installed on the LNG fleet in service in December 2019 was 17,570,573 kW.

Table 17: LPG fleet by group of Propulsion Power for the total values for the variables: number of ships, deadweight gross tonnage and propulsion power.

Group of propulsive power (P)	DWT (t)	GT (t)	Prop. Power (kW)
P ≤ 20.000	1,289,328	1,869,882	411,882
20.000 ≤ P < 30.000	20,550,350	27,021,427	6,623,229
30.000 ≤ P < 40.000	18,873,784	23,251,843	7,319,725
P ≥ 40.000	3,447,741	4,390,059	1,780,759

Source: Authors.

There are 37 LNG ships with less than 20,000 kW of propulsion power, 251 ships between 20,000 and 30,000 kW, 199 ships between 30,000 and 40,000 kW and 35 LNG ships with equal or more than 40,000 kW of propulsion power.

The average propulsion power installed per LNG ship in service in December 2019 is 33,600 kW.

The ships with more propulsion power correspond with the greater average values for deadweight and gross tonnage as shown in Table 18.

Table 18: Average value per ship for the LPG fleet by group of propulsion power for the variable deadweight gross tonnage and propulsion power.

Group of propulsive power (P)	DWT (t)	GT (t)	Prop. Power (kW)
P ≤ 20.000	34,847	50,537	11,132
20.000 ≤ P < 30.000	81,874	107,655	26,387
30.000 ≤ P < 40.000	94,843	116,843	36,783
P ≥ 40.000	98,507	125,430	50,879

Source: Authors.

4.5. LNG fleet structure by groups of registration flags.

As mentioned before, there are considered 4 groups of registration flags, both for LPG and LNG carriers. The results for LNG carriers can be seen in the Table 19. The groups of flag registrations are identical as the ones used for the LPG fleet.

Table 19: LPG fleet by group of groups of registration flags for the total values for the variables: number of ships, deadweight gross tonnage and propulsion power.

Group Registration flags	DWT (t)	GT (t)	Prop. Power (kW)
EU15	5,054,557	6,012,399	1,879,216
RA	27,576,687	35,364,815	10,100,426
RM	8,348,796	10,438,295	3,030,177
ROCDE	3,181,163	4,717,702	1,125,776

Source: Authors.

In the EU15 group, there are 59 LNG ships registered, 311 ships are in the RA group, 103 ships are in RM group and 49 ships in the ROCDE group.

The LNG ships registered under RA flags are, as average, the bigger ships (greater deadweight and gross tonnage) and the most powerful ships in regards propulsive power, while the smaller ships and less powerful LNG ships are found in ROCDE group, as shown in Table 20.

Table 20: Average value per ship for the LPG fleet by group registration flags for the variable deadweight gross tonnage and propulsion power.

Group Registration flags	DWT (t)	GT (t)	Prop. Power (kW)
EU15	85,670	101,905	31,851
RA	88,671	113,713	32,477
RM	81,056	101,343	29,419
ROCDE	64,922	96,280	22,975

Source: Authors.

5. Concluding remarks.

By doing the structure by separating between LPG and LNG ships, it is visible the differences between these two types of gas carrier. The average LPG ship in service in December 2019 has 17,436 tons of deadweight, 15,308 gross tonnage and 6,986 kW of propulsion power installed. On other hand, the average LNG ships has 84,600 tons of deadweight, 108,301 gross tonnage and 33,600 kW of propulsion power installed. This is indicating that, as average, the LNG ships are 4.8 times bigger in deadweight and propulsion power than the LPG ships, and they are 7.1 times bigger than the LPG ships in regards the gross tonnage. Moreover, aggregating both fleets with the goal of getting a unique metrics for the gas fleet, the results might be biased due to the disproportionate number of LPG ships versus the number of LNG ships forming the gas fleet (74% ships are LPG and 26% are LNG ships).

This big difference between the two types of ships makes necessary to separate them when are carried out deeper analyses of the Gas carrier fleet, highlighting the need to split the gas carrier fleet in LNG and LPG carriers for making more accurate analyses, especially those analyses based on the bottom-up approach where the trading patterns (ship operations) and design factors of each ship, plays an essential role in the calculation processes.

For both fleets, it is also seen that the newer ships (with 5 or less years old) are, in average, bigger in size than older ships for both, LNG and LPG ships. There is an exception in the LNG ships where the biggest average deadweight is found on LNG ships built between 10 and 15 years ago, corresponding with the time where the biggest LNG ships were built, the ones known as Q-Flex and Q-Max ships, in operation as part of the mega project of Qatar Gas.

Regarding the propulsion power installed on board, it has been going increasing a bit over the years as well, as it is shown in the Figure 2.

References.

Adland, R., Jia, H. and Lu, J. (2008) 'Price dynamics in the market for Liquid Petroleum Gas transport', Energy Economics, 30(3), pp. 818–828. doi: 10.1016/j.eneco.2007.02.008.

Aguilera, R. F. (2014) 'The role of natural gas in a low carbon Asia Pacific', Applied Energy. Elsevier Ltd, 113, pp. 1795–1800. doi: 10.1016/j.apenergy.2013.07.048.

Baranzini, A. and Goldemberg, J. (1996) 'Desertification, energy consumption and liquified petroleum gas use, with an emphasis on Africa', Energy for Sustainable Development, 2(5), pp. 32–37. doi: 10.1016/S0973-0826(9)60001-6.

Calderón, M., Illing, D. and Veiga, J. (2016) 'Facilities for Bunkering of Liquefied Natural Gas in Ports', Transportation Research Procedia. Elsevier B.V., 14(0), pp. 2431–2440. doi: 10.1016/j.trpro.2016.05.288.

Economides, M. J. and Wood, D. A. (2009) 'The state of natural gas', Journal of Natural Gas Science and Engineering. Elsevier Ltd, 1(1–2), pp. 1–13. doi: 10.1016/j.jngse.2009.03.005.

Gonzalez-Gutierrez, C.; Perez-Labajos, C. (2017) 'Typology of the Gas Carriers fleet', Journal of Maritime Research, Vol.14 No(14).Information Handling Services Markit (2020) IHS Maritime World Register of Ships, Maritime & Trade: Shipping Intelligence. Available at: https://ihsmarkit.com/products/-maritime-world-ship-register.html (Accessed: 9 March 2020).

International Energy Agency (2018) 'Security', IEA - Global Gas Security 2018, p. 102.International Gas Union (2019) 2019 World LNG Report. Barcelona.

Johnson, E. (2003) 'LPG: A secure, cleaner transport fuel? A policy recommendation for Europe', Energy Policy, 31(15), pp. 1573–1577. doi: 10.1016/S0301-4215(02)00223-9.

Kuang, M. (2018) The Future of LNG, Bloombergnef. [online] BloombergNEF. Available at: https://about.bnef.com/blog/-the-future-of-lng/.

Raslavičius, L. et al. (2014) 'Liquefied petroleum gas (LPG) as a medium-term option in the transition to sustainable fuels and transport', Renewable and Sustainable Energy Reviews, 32, pp. 513–525. doi: 10.1016/j.rser.2014.01.052.

Shaton, K., Hervik, A. and Hjelle, H. M. (2019) 'The Environmental Footprint of Natural Gas Transportation: LNG vs. Pipeline', Economics of Energy & Environmental Policy, 8(2), pp. 1–22. doi: 10.5547/2160-5890.8.2.ksha.

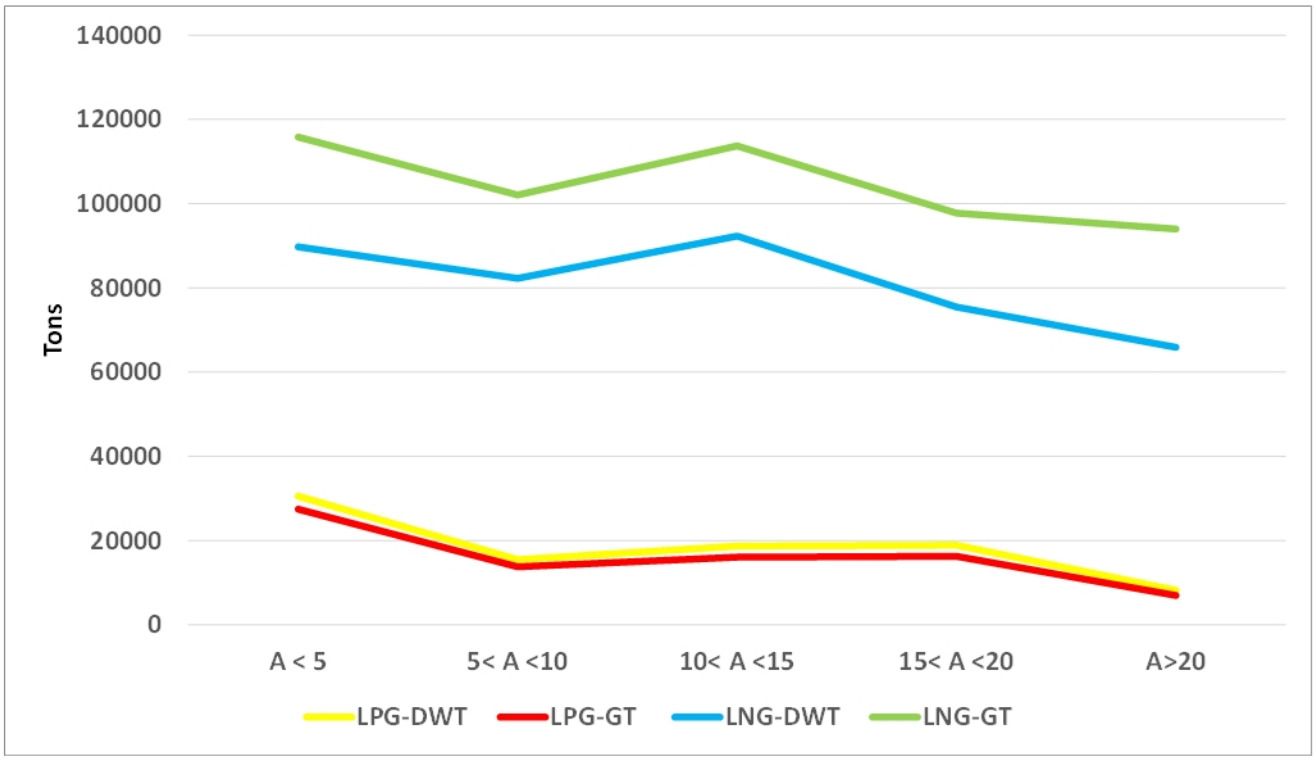
Synák, F. et al. (2019) 'Liquefied petroleum gas as an alternative fuel', Transportation Research Procedia. Elsevier B.V., 40, pp. 527–534. doi: 10.1016/j.trpro.2019.07.076.

UNCTAD (2018) Review of Maritime Transport 2018. Geneva.

Varahrami, V. and Haghighat, M. S. (2018) 'The assessment of liquefied natural gas (LNG) demand reversibility in selected OECD countries', Energy Reports. Elsevier Ltd, 4, pp. 370–375. doi: 10.1016/j.egyr.2018.05.006.

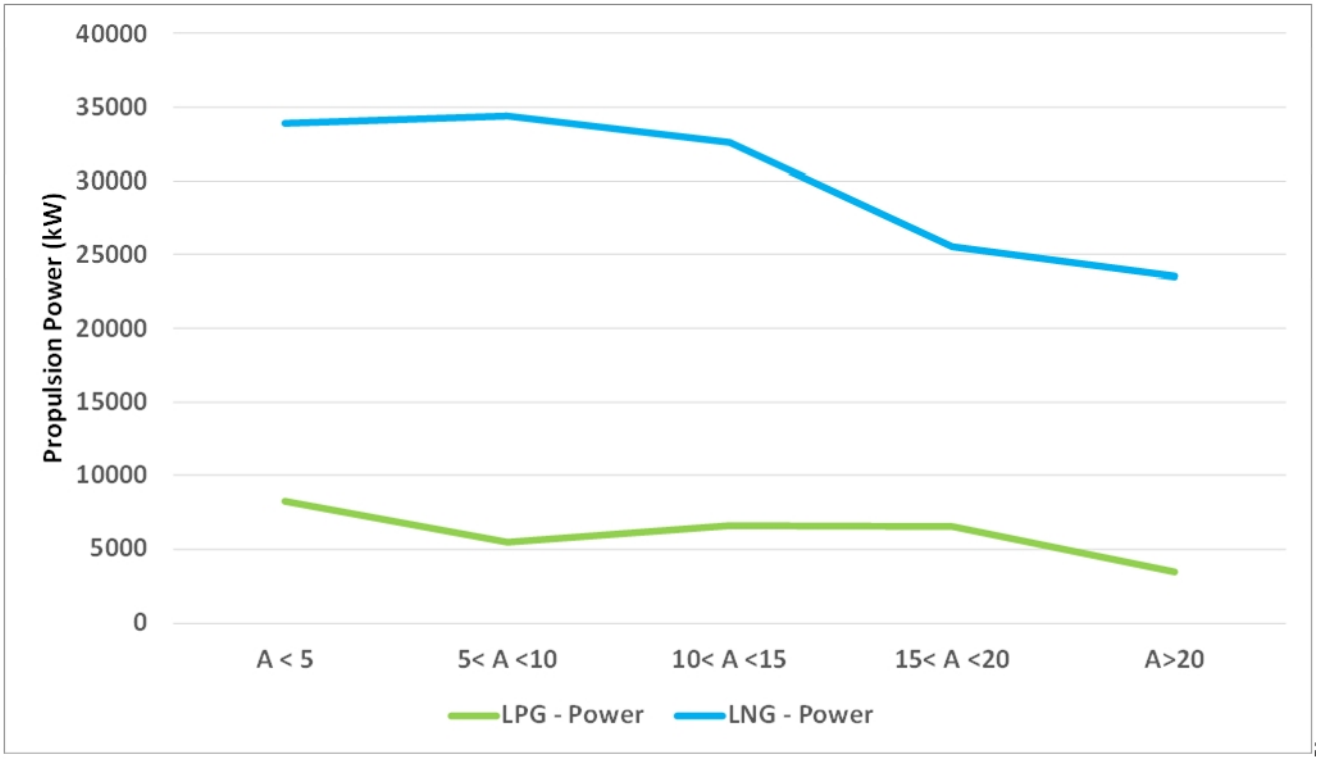
Zhang, H. Y. et al. (2018) 'Exploring the driving factors of global LNG trade flows using gravity modelling', Journal of Cleaner Production. Elsevier Ltd, 172, pp. 508–515. doi: 10.1016/j.jclepro.2017.10.244.

Figure 1: Deadweight and Gross tonnage for LNG and LPG ships by groups of age.



Source: Authors.

Figure 2: Propulsion power installed for LNG and LPG ships by groups of age.



Source: Authors.