Liquefied Natural Gas (LNG) quality database

Gas composition and main properties

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Contact

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ABOUT MARCOGAZ

Founded in 1968, MARCOGAZ represents 29 member organisations from 21 countries. Its mission encompasses monitoring and policy advisory activities related to the European technical regulation, standardisation and certification with respect to safety and integrity of gas systems and equipment, rational use of energy as well as environment, health and safety issues. It is registered in Brussels under number BE0877 785 464.

DISCLAIMER

Content

1. Summary

Due to the lack of a public database on LNG quality, MARCOGAZ decided to collect this information amongst its members and sharing it with the general public.

Seven MARCOGAZ members shared information, although only the data from five of them was suitable to create the database. In total, information on LNG composition from 760 LNG cargos, from 16 origins arriving in Europe in 2022 and 2023, has been procesed.

The data has been arranged to produce the average composition and the main properties of LNG per origin (including maximum, minimum and standard deviation of each one).

In order to avoid, commercial confidentiality issues, the way in which the information is shown in this report does not allow to identify the LNG terminal receiving the cargo, maintaining the confidenciality of the information provided, as it was agreed amongst MARCOGAZ members.

2. Introduction

Nowadays, there is a lack of a public database with recent information on Liquified Natural Gas (LNG) quality/composition by origin:

- Most cited source in different publication, GIIGNL[1], is from a 2012 report (the composition table appeared in later reports but it is always the same) [1].
- Many liquefaction terminals (or expansions of old ones) and new countries have started operation in last decade, so the previous information is no longer complete.

Due to this, MARCOGAZ WG Gas Quality agreed in 2023 to launch a survey amongst its members to collect recent quality data of LNG in order to help decision to natural gas market actors in the present natural gas supply scenario in Europe.

3. Scope of work

The following scope of work was agreed by WG Gas Quality:

- Collect LNG composition data from MARCOGAZ members managing LNG terminals.
    - Data from each individual cargo.
        - Only information of cargos coming from liquefaction terminals, not re-loading operation between LNG regasification terminals, i.e, between European countries.

[1] https://giignl.org/

- The information will be used *to calculate the main gas quality parameters* from the different origins.
    - Average gas composition and standard deviation.
        - Maximum and minimum of each component.
    - Gross calorific value, Wobbe index, relative density, density and Methane number, in ISO reference conditions (15/15[2]).
        - Average of all the cargos
        - Range: maximum and minimum value

Regarding this scope, some consideration can be made.

It is known that the composition of LNG changes during ship transportation and storage in the LNG terminal tanks, so at the end, the information collected will not be exactly the quality of the LNG as it was at its country of origin, after the liquefaction train, but the LNG quality that arrives to Europe, after the journey. It is clear that, due to this, the LNG quality from a country, i.e., Qatar, will be slightly different if it is downloaded in Greece or The Netherlands. Anyway, a lot of new LNG carriers has reliquefication unit installed, so most of the boil-off gas is liquefied again and the composition could remain almost constant.

In any case, the information collected from MARCOGAZ member LNG terminals will show approximately the maximum range of composition, and properties, that can be expected from a specific LNG origin at the arrival in Europe.

It is also worth to mention that the LNG arriving to a terminal could be mixed in the storage tank with LNG from other origins, so the final gas quality sent to the transmission grid will be different from the LNG of a specific origin. It should be clear that, in avoidance of any doubt, the quality of any natural gas injected into the network at the exit of a LNG regasification terminal shall be inside the range defined by the applicable National natural gas quality regulation/specification.

No information about the amount of LNG (either volume or energy) downloaded by cargo has been collected, as this is considered commercial sensitive information. Anyway, for knowing more about the origin of LNG arriving in different European countries, information is included in the mentioned *GIIGNL reports*[3], which is updated yearly.

4. Information collected

Information supplied by MARCOGAZ members, comprissing the years 2022 and 2023, is the following:

- France, Elengy: data of 265 cargos.
- Germany, Open Grid Europe:

[2] ISO reference condition: 15 °C (288.15 K) as a combustion reference temperature and 15 °C (288.15 K) for volume with 1 013,25 mbar (101.325 kPa) as reference pressure.
[3] https://giignl.org/resources2/ (consulted in November 2024)

    - Information of 137 LNG quality data taken from different sources, mostly from open literature.
        - The structure of the data supplied does not allow to use in this study.
- Greece, DESFA: data of 104 cargos.
- Italy, Snam: data of 18 cargos.
- Portugal, REN (no member of MARCOGAZ, supplied information to APEG):
    - Quality properties from 6 origins. No composition data included, so the data has not been used in the study.
- Spain, Enagás: data of 341 cargos
- The Netherland, Gasunie:
    - EET LNG FSRU: data for 39 cargos.

Some members of MARCOGAZ informed that they were not able to provide the information due to the clauses included in the contract signed between the LNG terminal operator and the LNG shipper company.

In total, useful data about 767 from 5 countries was collected. After rejecting information of re-loading operations, a total of 760 cargos from 16 origins has been used in the analysis.

5. Analysis of data

The analysis of the data made is as follows:

- Mean average composition, and maximum and minimum composition of each component, collected per origin.
    - Standard deviation of the average is included.
- Main properties: WI, GCV, MN and relative density.
    - Average, maximum and minimum value per origin.

From some origins only few data are available but for many supply origins to Europe, the number of cargos collected gives to the information a quite sound statistic value.

5.1. Composition

The analysis of composition data is given in Table 1 and shows the following information in the different rows:

- *Country of origin and number of cargos* collected
- *Average value of each LNG component*, mol/mol. The sum of all of them is not shown but should be 1.
- *Maximum value of each LNG component*, mol/mol. The sum of all of them is not shown and should not be necessarily 1.

- *Minimum value of each LNG component*, mol/mol. The sum of all of them is not shown and should not be necessarily 1.
- *Standard deviation value of each LNG component*, mol/mol.

Regarding the composition shown in Table 1 there is the following remarks:

- Carbon dioxide (CO2) is not considered because is not a component present on LNG in a measurable amount. CO2 is eliminated from natural gas in the treatment previous to liquefaction.
- Neo-pentane (Neo-C5) is not considered because its presence is almost negligible in LNG, besides most of gas chromatograph cannot detect it.
- Oxygen (O2) is not a normal component of LNG. Although in recent years the presence of O2 has been reported in some cargo manifestos arriving to Europe, the amount is very small and is not analysed/detected by the gas chromatograph installed in LNG terminals.

Table 1.- LNG composition (mol/mol) by origin and numbers of cargos considered.

Country (nº cargos)		Nitrogen	Methane	Ethane	Propane	Iso-Butane	N-Butane	Iso-Pentane	N-Pentane	Hexane+ (*)
UAE (1)	Avg	**0.00430**	**0.87810**	**0.09640**	**0.01800**	**0.00180**	**0.00140**	**0.00000**	**0.00000**	**0.00000**
	Max									
	Min									
	StD									
Algeria (122)	Avg	**0.00558**	**0.89850**	**0.08373**	**0.01036**	**0.00052**	**0.00051**	**0.00056**	**0.00024**	**0.00000**
	Max	0.00734	0.92494	0.09041	0.01828	0.00249	0.00346	0.00101	0.00061	0.00004
	Min	0.00231	0.88048	0.06700	0.00011	0.00000	0.00000	0.00000	0.00000	0.00000
	StD	0.00231	0.00737	0.00377	0.00341	0.00040	0.00055	0.00036	0.00018	0.00001
Angola (12)	Avg	**0.00016**	**0.91113**	**0.08178**	**0.00638**	**0.00026**	**0.00027**	**0.00001**	**0.00001**	**0.00000**
	Max	0.00040	0.92030	0.08738	0.00820	0.00044	0.00052	0.00004	0.00002	0.00001
	Min	0.00002	0.90727	0.07550	0.00360	0.00007	0.00003	0.00000	0.00000	0.00000
	StD	0.00011	0.00367	0.00382	0.00136	0.00013	0.00017	0.00002	0.00001	0.00000
Cameroun (2)	Avg	**0.00154**	**0.93665**	**0.03684**	**0.01923**	**0.00220**	**0.00278**	**0.00039**	**0.00027**	**0.00010**
	Max	0.00190	0.93732	0.03730	0.01969	0.00223	0.00281	0.00040	0.00027	0.00010
	Min	0.00117	0.93604	0.03637	0.01876	0.00216	0.00275	0.00038	0.00026	0.00009
	StD	0.00052	0.00091	0.00066	0.00066	0.00005	0.00004	0.00001	0.00001	0.00001
Egypt (41)	Avg	**0.00023**	**0.96943**	**0.02065**	**0.00596**	**0.00194**	**0.00133**	**0.00026**	**0.00009**	**0.00011**
	Max	0.00171	0.99198	0.07321	0.01946	0.00628	0.00424	0.00080	0.00028	0.00029
	Min	0.00000	0.89575	0.00522	0.00084	0.00076	0.00025	0.00006	0.00000	0.00000
	StD	0.00029	0.02512	0.01718	0.00571	0.00138	0.00120	0.00015	0.00007	0.00011
Equatorial Guinea (4)	Avg	**0.00013**	**0.93551**	**0.06187**	**0.00211**	**0.00019**	**0.00017**	**0.00000**	**0.00001**	**0.00001**
	Max	0.00020	0.93957	0.06494	0.00326	0.00037	0.00032	0.00000	0.00003	0.00002
	Min	0.00000	0.93108	0.05829	0.00140	0.00000	0.00000	0.00000	0.00000	0.00000
	StD	0.00009	0.00352	0.00273	0.00082	0.00016	0.00014	0.00000	0.00002	0.00001

Country (nº cargos)		Nitrogen	Methane	Ethane	Propane	Iso-Butane	N-Butane	Iso-Pentane	N-Pentane	Hexane+ (*)
Indonesia (2)	Avg	**0.00005**	**0.94993**	**0.02656**	**0.01739**	**0.00294**	**0.00291**	**0.00018**	**0.00001**	**0.00003**
	Max	0.00010	0.94996	0.02884	0.01855	0.00325	0.00362	0.00033	0.00002	0.00005
	Min	0.00000	0.94995	0.02427	0.01623	0.00262	0.00219	0.00002	0.00000	0.00000
	StD	0.00007	0.00001	0.00323	0.00164	0.00045	0.00101	0.00022	0.00001	0.00004
Mozambique (1)	Avg	**0.00331**	**0.92921**	**0.06650**	**0.00096**	**0.00001**	**0.00001**	**0.00000**	**0.00000**	**0.00000**
	Max									
	Min									
	StD									
Nigeria (98)	Avg	**0.00015**	**0.90941**	**0.05990**	**0.02345**	**0.00382**	**0.00322**	**0.00004**	**0.00001**	**0.00000**
	Max	0.00043	0.91808	0.07460	0.02763	0.00461	0.00418	0.00024	0.00010	0.00004
	Min	0.00000	0.89251	0.05423	0.01974	0.00261	0.00156	0.00000	0.00000	0.00000
	StD	0.00009	0.00414	0.00336	0.00139	0.00035	0.00053	0.00004	0.00001	0.00001
Norway (14)	Avg	**0.00453**	**0.92382**	**0.05327**	**0.01372**	**0.00129**	**0.00319**	**0.00015**	**0.00003**	**0.00000**
	Max	0.00572	0.93172	0.06062	0.01771	0.00182	0.00423	0.00020	0.00008	0.00001
	Min	0.00158	0.91703	0.04807	0.01168	0.00105	0.00265	0.00004	0.00000	0.00000
	StD	0.00105	0.00393	0.00290	0.00161	0.00021	0.00043	0.00006	0.00002	0.00000
Oman (6)	Avg	**0.00145**	**0.90370**	**0.05870**	**0.02225**	**0.00684**	**0.00667**	**0.00032**	**0.00007**	**0.00000**
	Max	0.00280	0.90551	0.06101	0.02338	0.00705	0.00710	0.00044	0.00020	0.00000
	Min	0.00085	0.90003	0.05770	0.02165	0.00658	0.00636	0.00000	0.00004	0.00000
	StD	0.00068	0.00211	0.00119	0.00073	0.00017	0.00025	0.00016	0.00006	0.00000
Peru (4)	Avg	**0.00292**	**0.90306**	**0.09294**	**0.00105**	**0.00002**	**0.00001**	**0.00000**	**0.00000**	**0.00000**
	Max	0.00381	0.90556	0.09852	0.00127	0.00006	0.00002	0.00000	0.00000	0.00001
	Min	0.00097	0.89931	0.08962	0.00079	0.00000	0.00000	0.00000	0.00000	0.00000
	StD	0.00134	0.00266	0.00392	0.00021	0.00003	0.00001	0.00000	0.00000	0.00001
Qatar (47)	Avg	**0.00281**	**0.93018**	**0.06342**	**0.00260**	**0.00040**	**0.00059**	**0.00000**	**0.00000**	**0.00000**
	Max	0.00481	0.93497	0.08125	0.02078	0.00388	0.00586	0.00002	0.00003	0.00001
	Min	0.00000	0.90818	0.05813	0.00014	0.00000	0.00000	0.00000	0.00000	0.00000
	StD	0.00102	0.00746	0.00315	0.00597	0.00113	0.00171	0.00000	0.00001	0.00000
Russia (80)	Avg	**0.00183**	**0.95840**	**0.03084**	**0.00532**	**0.00204**	**0.00150**	**0.00005**	**0.00001**	**0.00001**
	Max	0.00320	0.96827	0.05102	0.01822	0.00270	0.00261	0.00026	0.00019	0.00006
	Min	0.00012	0.92538	0.02564	0.00064	0.00021	0.00008	0.00000	0.00000	0.00000
	StD	0.00040	0.00502	0.00286	0.00195	0.00043	0.00041	0.00003	0.00002	0.00001
Trinidad & Tobago (17)	Avg	**0.00017**	**0.98479**	**0.01174**	**0.00258**	**0.00033**	**0.00032**	**0.00004**	**0.00002**	**0.00001**
	Max	0.00160	0.98741	0.01792	0.00318	0.00077	0.00103	0.00009	0.00005	0.00003
	Min	0.00000	0.97819	0.00948	0.00140	0.00016	0.00020	0.00000	0.00000	0.00000
	StD	0.00038	0.00250	0.00232	0.00036	0.00012	0.00021	0.00002	0.00001	0.00001
USA (299)	Avg	**0.00108**	**0.96495**	**0.03156**	**0.00178**	**0.00025**	**0.00028**	**0.00004**	**0.00002**	**0.00004**
	Max	0.00812	0.97942	0.06395	0.00513	0.00202	0.00210	0.00012	0.00010	0.00040
	Min	0.00002	0.93218	0.01469	0.00056	0.00004	0.00002	0.00000	0.00000	0.00000
	StD	0.00114	0.00916	0.00916	0.00071	0.00018	0.00031	0.00004	0.00002	0.00005

(*) Hexane+: Hexane and/or heavier

Avg: Average
Max: Maximum
Min: Minimum
StD: Standard deviation

5.2. Properties of LNG

The calculated properties of LNG are shown in tabular and graphical way. For combustion properties, ISO 6976:2016 [2] has been used. For Methane number, Annex A of EN 16726:2015 [3].

Table 2 & Table 3 show the following information in the different rows:

- *Country of origin and number of cargos* collected
- *Maximum, minimum and average gross calorific value (GCV)*, in ISO 15/15 condition.
- *Maximum, minimum and average Wobbe index value (WI)*, in ISO 15/15 condition.
- *Maximum, minimum and average relative density value (dr)*, in ISO 15/15 condition.
- *Maximum, minimum and average density value (d)*, in ISO 15/15 condition.
- *Maximum, minimum and average Methane number value (MN)*.

The figures show the same information in the following way:

- X axis: *Country of origin and number of cargos collected*
- Y axis: *Property*:
    - Dots: average value
    - Bar: range between minimum and maximum value

Table 2.-Gross calorific value, Wobbe index and relative density by country of origin and numbers of cargos considered. Included the average (Avg), maximum (Max) and minimum (Min) calculated values. ISO 15/15 reference condition.

Country (nº cargo)	GCV, MJ/m³ (15/15)			WI, MJ/m³ (15/15)			Relative Density (15/15)		
	Max	Min	*Avg*	Max	Min	*Avg*	Max	Min	*Avg*
UAE (1)	-	-	*41.67*	-	-	*52.67*	-	-	*0.63*
Algeria (122)	41.73	39.79	*40.73*	52.66	51.59	*52.10*	0.63	0.59	*0.61*
Angola (12)	40.65	40.14	*40.52*	52.31	52.02	*52.24*	0.60	0.60	*0.60*
Cameroun (2)	40.43	40.31	*40.37*	52.13	52.03	*52.08*	0.60	0.60	*0.60*
Egypt (41)	41.99	38.12	*39.05*	53.03	50.89	*51.42*	0.63	0.56	*0.58*
Equatorial Guinea (4)	39.88	39.56	*39.69*	51.89	51.71	*51.79*	0.59	0.59	*0.59*
Indonesia (2)	40.14	39.94	*40.04*	52.03	51.91	*51.97*	0.60	0.59	*0.59*
Mozambique (1)	-	-	*39.61*	-	-	*51.59*	-	-	*0.59*
Nigeria (98)	41.91	41.07	*41.42*	52.99	52.52	*52.72*	0.63	0.61	*0.62*
Norway (14)	40.77	40.06	*40.31*	52.30	51.77	*51.91*	0.61	0.60	*0.60*
Oman (6)	42.02	41.77	*41.85*	52.99	52.78	*52.89*	0.63	0.62	*0.63*
Peru (4)	40.63	40.26	*40.39*	52.26	51.93	*52.04*	0.60	0.60	*0.60*
Qatar (47)	41.47	39.44	*39.72*	52.70	51.43	*51.68*	0.62	0.59	*0.59*
Russia (80)	40.72	38.67	*39.20*	52.34	51.16	*51.43*	0.61	0.57	*0.58*
Trinidad & Tobago (17)	38.50	38.24	*38.32*	51.11	50.98	*51.02*	0.57	0.56	*0.56*
USA (299)	39.79	38.11	*38.80*	51.83	50.52	*51.24*	0.59	0.57	*0.57*

Table 3.-Density and Methane number by country of origin and numbers of cargos considered. Included the average (Avg), maximum (Max) and minimum (Min) calculated values. ISO 15/15 reference condition.

Country (nº cargo)	Density, kg/m^3 (15/15)			Methane number		
	Max	Min	*Avg*	Max	Min	*Avg*
UAE (1)	-	-	*0.77*	-	-	*72*
Algeria (122)	0.77	0.73	*0.75*	82	71	*75*
Angola (12)	0.74	0.73	*0.74*	79	77	*77*
Cameroun (2)	0.74	0.74	*0.74*	78	77	*78*
Egypt (41)	0.77	0.69	*0.71*	95	70	*87*
Equatorial Guinea (4)	0.72	0.72	*0.72*	85	81	*83*
Indonesia (2)	0.73	0.73	*0.73*	81	80	*80*
Mozambique (1)	-	-	*0.72*	-	-	*82*
Nigeria (98)	0.77	0.75	*0.76*	75	71	*73*
Norway (14)	0.75	0.73	*0.74*	79	76	*78*
Oman (6)	0.77	0.77	*0.77*	71	70	*71*
Peru (4)	0.74	0.74	*0.74*	81	77	*78*
Qatar (47)	0.76	0.72	*0.72*	86	73	*83*
Russia (80)	0.74	0.70	*0.71*	89	76	*85*
Trinidad & Tobago (17)	0.70	0.69	*0.69*	94	91	*93*
USA (299)	0.72	0.69	*0.70*	93	81	*88*

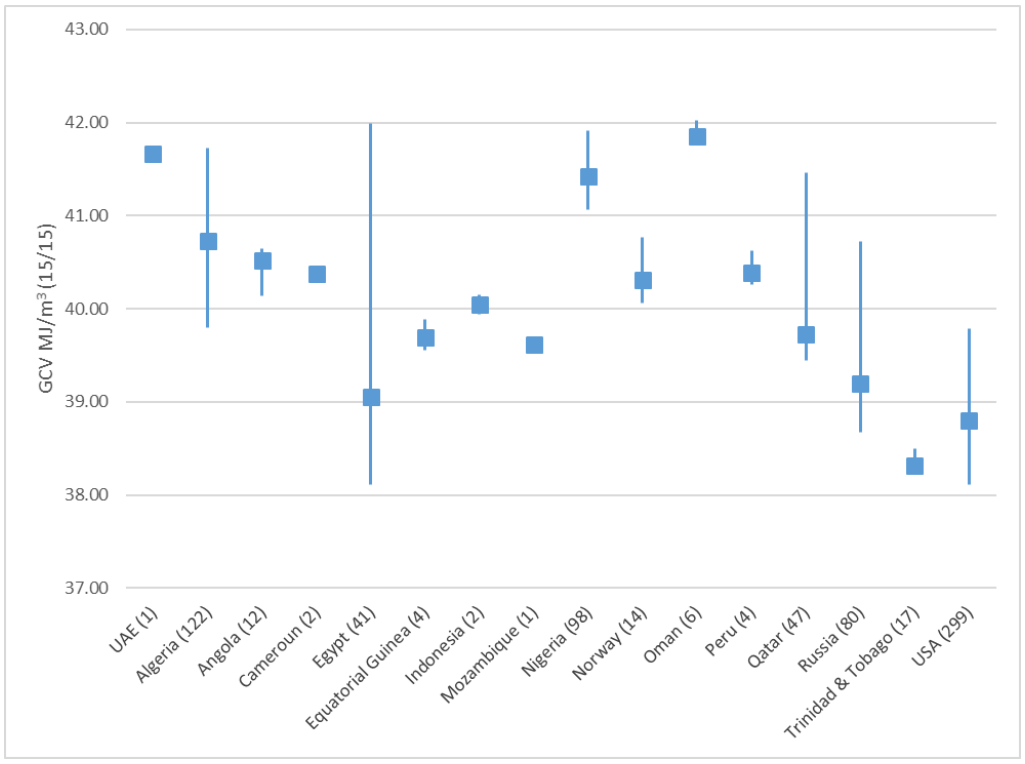

Figure 1.- Average gross calorific value, in MJ/m3 (15/15), and range by origin. Number of cargos used in the calculation included.

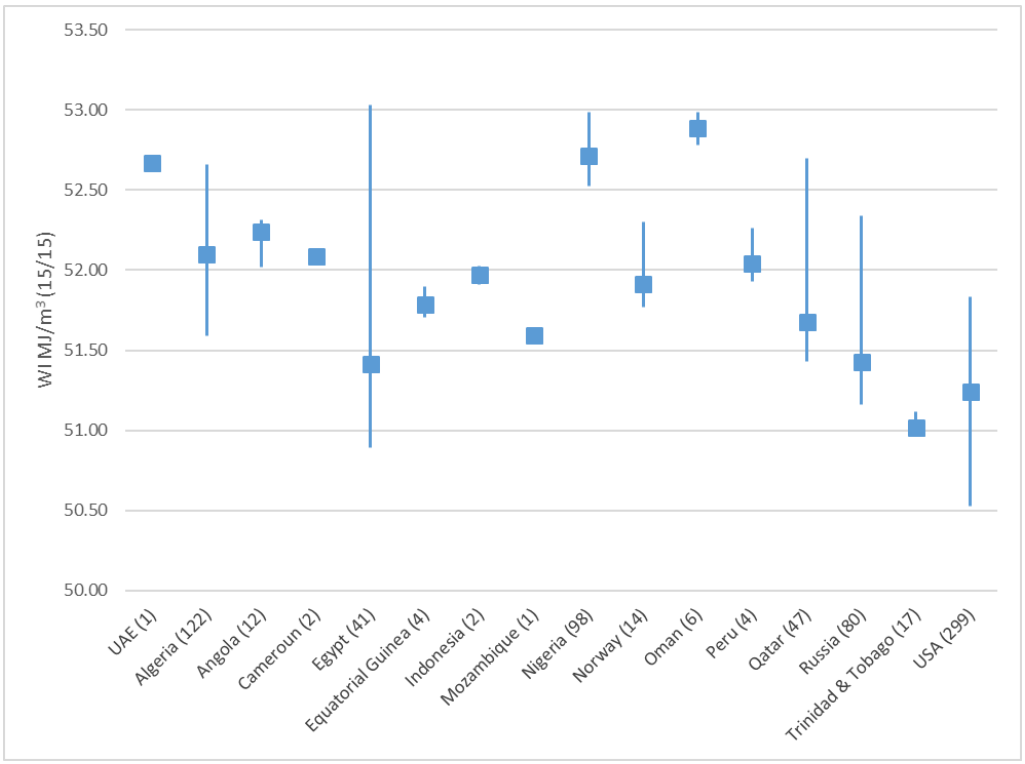

Figure 2.- Average Wobbe index, in MJ/m3 (15/15), and range by origin. Number of cargos used in the calculation included.

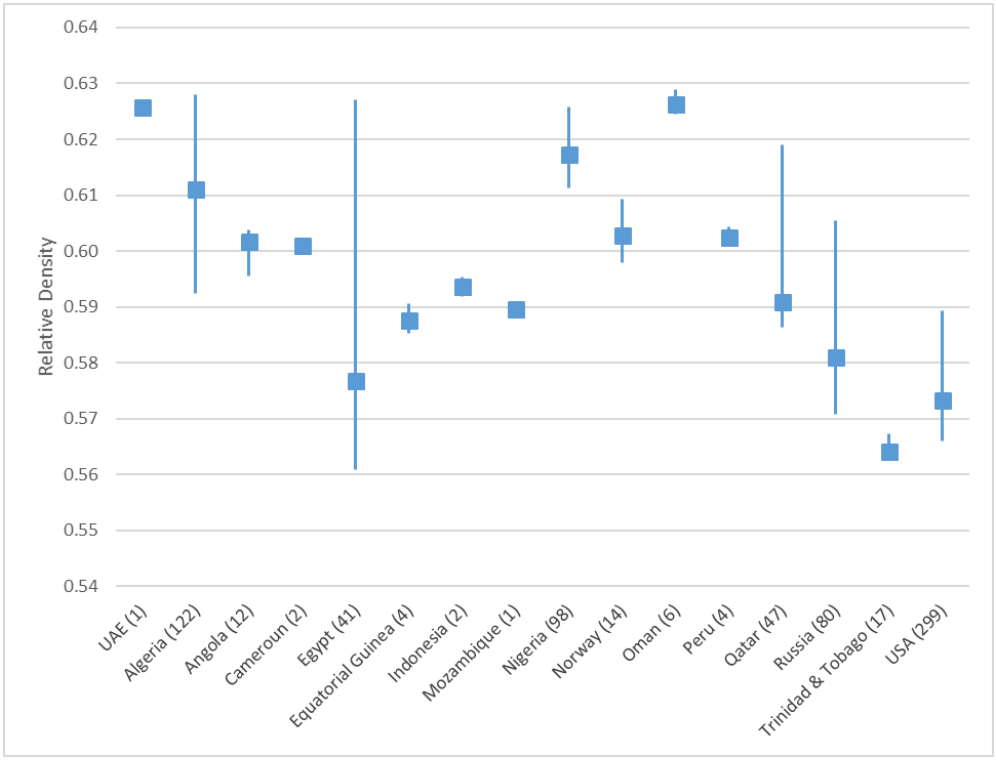

Figure 3.- Average relative density and range by origin. Number of cargos used in the calculation included.

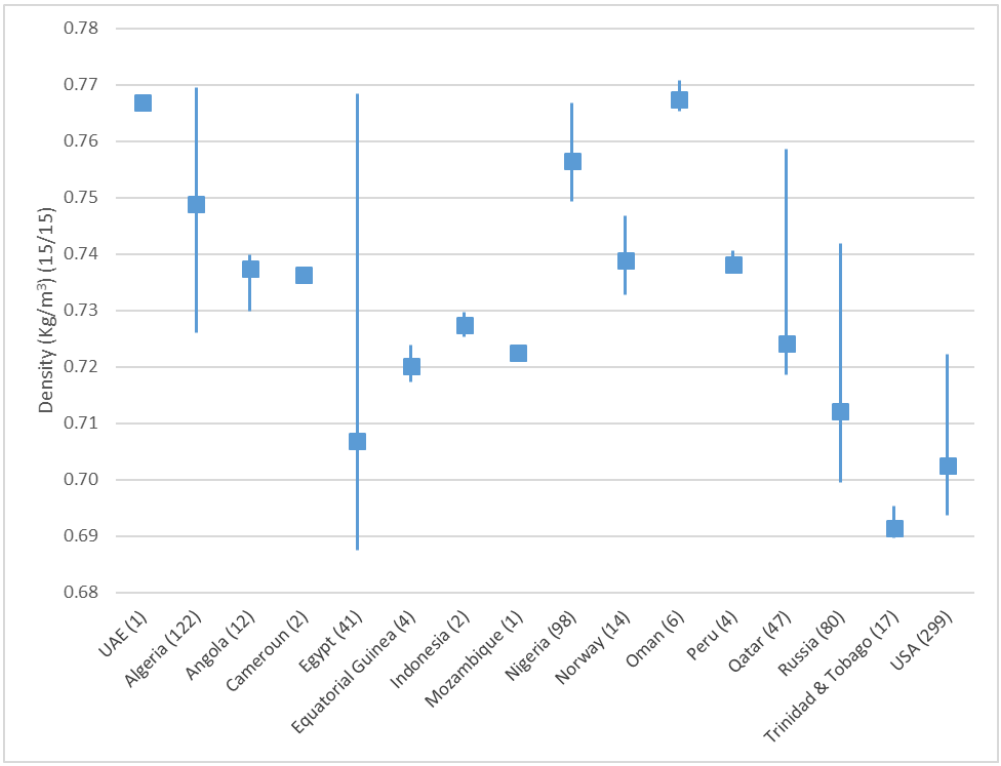

Figure 4.- Average density, in MJ/m3 (15/15), and range by origin. Number of cargos used in the calculation included.

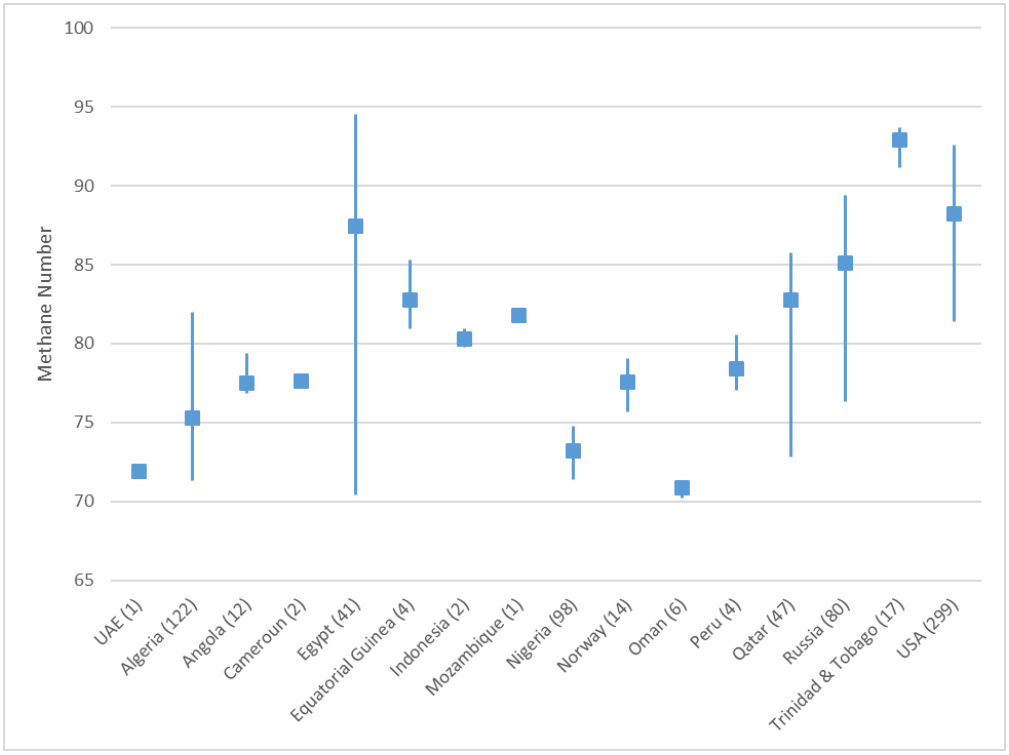

Figure 5.- Average Methane number and range by origin. Number of cargos used in the calculation included.

6. References

[1]. *The LNG Industry 2012*, GIIGNL, France, 2012 (https://giignl.org/wp-content/uploads/2021/07/giignl_the_lng_industry_2012.pdf, consulted on 27th may 2024).

[2]. *ISO 6976:2016, Natural gas - Calculation of calorific values, density, relative density and Wobbe indices from composition*.

[3]. *EN 16726:2015+A1:2016: Gas infrastructure - Quality of gas - Group H*.

7. Glossary

dr: Relative density

FRSU: Floating, Regasification and Storage Unit

GCV: Gross Calorific Value

GIIGNL: Groupe International des Importateurs de Gaz Naturel Liquéfié

ISO: Internation Standardisation Organisation

MJ: Mega Joule

MN: Methane Number

UAE: United Arab Emirates

WI: Wobbe index