Chapter One

LNG trade in the Atlantic Basin: Situation and Perspectives

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Object and scope

In 1959, the first Liquefied Natural Gas (LNG) cargo was shipped from Lake Charles, Louisiana (US) to Canvey Island in the UK.[1] This can be considered the beginning of the development of the sector. However, it is not until 1964 when the first commercial cargo of LNG was shipped from Arzew (Algeria) to Canvey Island (UK) (BG Group, 2014). Since then natural gas trade has made enormous progress in terms of volume of transport.

Worldwide the total volume of traded gas has grown from 4.4% of production in 1970 to nearly 30% in 2015. LNG has increased continuously its share in the volume of total traded gas, from 5.9% in 1970 to 21.4% in 1999 and to 31.1% in 2015, as well as its share of total gas production from practically nonexistent in 1970 to 9% currently.

Curiously, as mentioned LNG trade began in the Atlantic Basin, but later this area lost importance in global terms. However nowadays the dramatic increase in shale gas production in the US and the increasing needs of gas imports in Europe have revitalized trade and commerce in the Atlantic Basin, especially in the North.

In this sense, in February 2016, US LNG exports started with the first cargo from Sabine Pass liquefaction plant (Cheniere) to Brazil. Four other liquefaction plants are currently under construction in the US that in 2020 could become the third largest exporter in the world after Australia and Qatar (Cornot-Gandolphe, 2016). Furthermore, the production and LNG exports from Africa (mainly from the Gulf of Guinea) and the Caribbean (Trinidad and Tobago) and the regasification projects with the corresponding gas imports in Latin America (Colombia and Brazil with floating stor-

1. The world's first LNG tanker, The Methane Pioneer, a converted World War II liberty freighter built in 1945, carried 5,000 cubic meters of LNG in five 7,000 bbl aluminum prismatic tanks (BG Group, 2014).

age and regasification units [FSRU] and Argentina) have also made significant contributions to the trade in the Atlantic Basin. All these elements stress the increasing role of the Atlantic Basin.

The following maps show the differences of natural gas and LNG trade flows in 2002 and 2016. Trade has interconnected the Atlantic Basin from coast to coast (principally South America, Europe and Africa) and at the same time "inter-basin" flows (Atlantic Basin vs. Pacific Basin) have appeared thanks to LNG growth, setting the basis of a globalized LNG market, in terms of developments of infrastructures (liquefaction and regasification plants), LNG vessels, as well as of spot traded volumes and prices (different among regions).

Looking to the medium term regarding the infrastructures, it is expected that LNG exports and as a consequence also LNG regasification terminals shall increase their capacity. The LNG fleet is forecasted to increase as well.

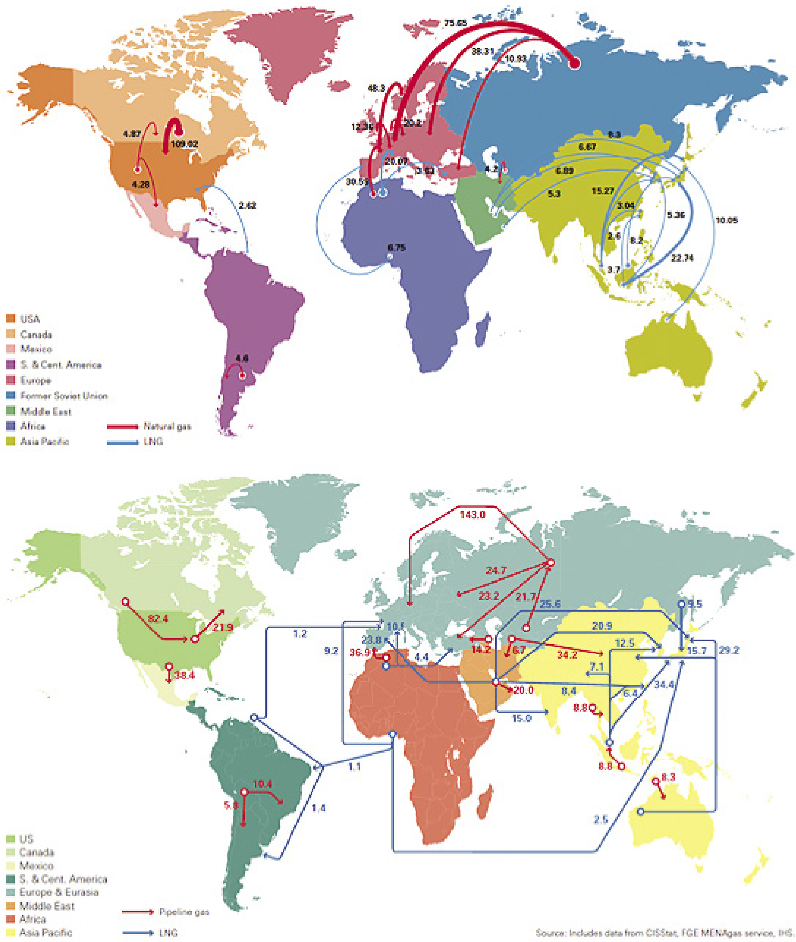
This chapter will deal with LNG trade in the Atlantic Basin. After a description of the main infrastructures of the LNG supply chain, next this chapter will focus on LNG trade continuing with contracts and prices and costs of LNG to finalize with an examination of the perspectives of LNG trade in the future and the relevance of the Atlantic Basin.

The Atlantic Basin. A brief review of concepts

It is worth referring to the Atlantic Basin concept. It can be considered from two main perspectives (Isbell, 2013).

The first could be called the 'broad Atlantic Basin'. This more political conception of the Atlantic Basin incorporates all four coastal continents of the Atlantic Ocean in their entirety, including those countries with no Atlantic coastline (ie, Peru and Chile, Tanzania and Kenya, etc.) along with those countries of the Mediterranean Basin (i.e. Algeria and Egypt). The second, more geographically 'narrow' conception could be called the 'geo-economic' Atlantic Basin or 'narrow Atlantic Basin'. This more specific regional scaling would embrace only those countries with an Atlantic coastline and those landlocked countries directly linked to (or integrated with) the Atlantic Basin, such as Paraguay. Most of the references made to the Atlantic Basin in this chapter will be from the point of view of the 'broad Atlantic Basin'.

Map 1. Major trade movements of natural gas and LNG (2002 and 2016)



Source: (BP, 2003; BP, 2017).

One of the main challenges that the Atlantic Basin must face is the fact that relations are still established principally within each of its constituent regions instead of between them (Ayuso, A., & Viilup, E., 2013). In this regard, Africa is the place where intra-regional exports and cooperation

are less developed. In contrast, in Europe, most trade is taking place inside the territory. However, Central and South America are more dependent on Atlantic exports than any other Atlantic territory.

LNG in the Atlantic Basin: Reserves and main infrastructures

Natural gas is the Earth´s cleanest burning hydrocarbon, whose combustion does not produce ash residues or sulphur oxides but only nitrogen oxides. Natural gas is found throughout the world alone or together with crude oil, under dry land or beneath the ocean floor. Methane is the primary component of natural gas, and prior to entering the market it undergoes processing (IGU, 2017b).

Natural gas can be transported in two main ways: as gas by pipeline and as liquid shipped in LNG cargoes. In the first case, an extensive network of high- and low-pressure pipelines lets transportation of natural gas from production places to demand points (IGU, 2017b).

In the second case, natural gas is shipped over long distances as a liquid, known as liquefied natural gas or LNG. In order to transform gas into liquid, it has to be cooled. This will lead the reduction of the gas volume by 600 times, and makes it possible to transport very large energy content in specially-designed ocean tankers and trucks[2]. Once the LNG tanker reaches its destination at the receiving terminal, it will be re-heated and converted back to a gas via a process known as regasification. Then it will be sent through pipelines to be delivered to end-users (IGU, 2017b).

Reserves are relevant in LNG trade situation and perspectives, together with liquefaction, transport and regasification, therefore next we will deal with these elements of the natural gas value chain.

Reserves

In 1990, the Atlantic Basin held around 22-23% of world total reserves of natural gas. In 2015, even if there were more reserves than in 1990, the Atlantic Basin lost weight to 18-19% according to estimations. In spite of the increase in reserves in OECD Americas (US) in the period 1990-2015, the Atlantic Basin decreased its percentage of worldwide reserves as although, the Atlantic Basin increased 24-39% its reserves, the world increased them by 50-65% according both to Cedigaz and *Oil & Gas Journal*.

2. In this chapter we will deal especially with LNG transported in ships.

Table 1. World reserves of natural gas (billion cubic meters, bcm)

	Cedigaz			*Oil & Gas Journal*		
	End 1990	End 2015	Variation	End 1990	End 2015	Variation
Atlantic Basin	28,091	34,836	24%	26,846	37,402	39%
Total World	130,361	196,228	51%	118,807	196,363	65%
Total OECD	16,705	18,696	12%	15,302	17,244	13%
Non-OECD Europe/ Eurasia	55,150	66,212	20%	45,413	61,823	36%
Middle East	37,833	78,986	109%	37,478	79,530	112%
Africa	8,413	12,619	50%	8,070	17,129	112%
Asia	7,497	12,092	61%	7,864	12,969	65%
Non-OECD Americas	4,763	7,622	60%	4,680	7,668	64%

Note: The International Energy Agency defines Reserves as the portion of energy resources that can be recovered economically by using current technologies and for which a project has been defined.

Source: own elaboration from (IEA, 2017c).

In 2017, worldwide proved natural gas reserves grew according to the *Oil & Gas Journal*'s annual survey of reserves. In this regard, the latest estimates of natural gas reserves establishes them in 196,802 bcm. The newest estimates of non-OPEC countries show an increase of gas reserves. The main changes can be observed in the following table.

In the Atlantic Basin, only Venezuela and Argentina have shown a positive variation of reserves in 2017. The US, Canada, Mexico, Western Europe, Norway, UK and Brazil showed a decrease of their reserves.

Liquefaction capacity

Around 43% of the capacity of the first liquefaction projects of the period from 1964 to 1979 was installed in the broad Atlantic Basin (mainly the Mediterranean, 90.7%). However in the 1990s only 17.8% of total new liquefaction projects were developed in this Basin (Trinidad and Tobago and Nigeria). The new century brought a new and big wave of liquefaction projects (159.5 million tons compared to 55 million tons in 1991-2000 and 32.6 million tons in 1964-1979) (BG Group, 2014). In this period, the

Table 2. Geographical area and natural gas reserves variation from 2016 to 2017

Geographical area	Variation	Geographical area	Variation	Geographical area	Variation
Asia-Pacific	+3%	OPEC	0.033 tcf	Western Europe	-3,6%
India	+2 tcf	Venezuela	+1.34 tcf	Norway	-4%
Indonesia	+3%	US	-61 tcf	UK	-1,1 tcf
Thailand	-6,5%	Canada	-6%	Argentina	+6.4%
China	+4%	Mexico	-18%	Brazil	-12.2%

Note: shaded squares represent the areas of the broad Atlantic Basin.

Source: own elaboration from (Xu & Bell, 2017).

weight of the broad Atlantic Basin grew to 37.6% (60 million tons). Nevertheless, the Atlantic Basin had already lost its initial market share.

By the end of 2016, global LNG export capacity reached 451.8 bcm, increasing 7.4% relative to the previous year, when 30 billion cubic metres (bcm) of LNG liquefaction capacity were added and only two new final investment decisions (FIDs) were taken to expand existing or build new LNG facilities. In 2017, 159 bcm equivalent to 32.6% of total liquefaction capacity was located in the broad Atlantic Basin. Considering the "narrow" Atlantic Basin this figure would decrease to 17%. Average utilization of global liquefaction capacity was around 86.73%. The United States, Nigeria and Norway utilization were above this average (Stadnicka & Janiszewska-Kiewra, 2018).

As the above table shows, global natural gas markets are in the midst of a second big wave of expansion in the supply of LNG. It is expected that global capacity will grow from 487 bcm in 2017 to 650 bcm in 2022. In this period, from 2017 to 2022, 73.3% of the LNG projects under construction (139.4 bcm/y) are in the broad Atlantic Basin (102.3 bcm/y), more than half in the US (78.2 bcm/y)[3].

In August 2017, total US gas liquefaction capacity in the Lower 48 states increased following the completion of the fourth train unit at the Sabine Pass LNG terminal in Louisiana. A fifth train at Sabine Pass and five new projects (Cove Point, Cameron, Elba Island, Freeport and Corpus

3. For information about LNG projects under construction see annex 1.

Table 3. LNG liquefaction capacity operating and under construction as of June 2017 (bcm/year)

Region	Operation	Construction
Broad Atlantic Basin	159	102
Total	487	139
OECD Asia Oceania (Australia)	89	29
Non-OECD Asia	104	8
OECD Europe (Norway)	6	-
FS/non-OECD Europe (Russia)	15	22
Middle East	136	-
Africa (Algeria, Angola, Cameroon, Egypt, Equatorial Guinea, Nigeria)	97	2
OECD Americas (United States)	14	78
Latin America (Peru and Trinidad and Tobago)	27	-

Note: shaded squares represent the areas of the broad Atlantic Basin.

Source: Own elaboration from (IEA, 2017a).

Christi) will increase total US liquefaction capacity by the end of 2019 (Xu & Bell, 2018).

According to the International Energy Agency (IEA), Sabine Pass Train 6 and Corpus Christi Train 3 in United States, Fortuna FLNG[4] project in Equatorial Guinea, and Sakhalin II Train 3 in Russia, might take FID in time for a production start-up within the period till 2022. Three of these projects will be expansions of existing facilities with relatively low costs, and one will be FLNG.

There is a trend towards incorporating floating liquefaction projects and smaller LNG capacities. As a consequence, new independent players apart from national and multinational oil companies will be participating in LNG liquefaction projects.

It is expected that by the end of 2022 Australia will have the largest LNG export nameplate capacity, 117.8 bcm per year, and the United States will become the second largest exporter with 106.7 bcm per year (located

4. Floating liquefied natural gas (FLNG) refers to water-based LNG operations, employing technologies designed to enable the development of offshore natural gas resources. Floating above an offshore natural gas field, the FLNG facility produces, liquefies, stores and transfers LNG at sea before carriers ship it directly to markets.

in the Atlantic Basin), slightly above Qatar (104.9 bcm per year). These three big LNG export countries will make up half of the global total LNG export capacity by the end of 2022. The relevance of the LNG export capacity expected in the USA will lead to destination flexibility (IEA, 2017a) and will contribute to the role of the Atlantic Basin in LNG export.

Globally this expansion in supply will exceed expected growth in LNG demand (IEA, 2017b). Well-supplied markets will keep downward pressure on prices and discourage new investments in LNG liquefaction facilities. As a consequence of low LNG prices, only one final investment decision for new liquefaction facilities was taken in 2017, and demand, while growing robustly, is not keeping pace with the addition of supply. LNG capacity increase will slow from 2020 onwards.

Regasification capacity

Regasification facilities increased their capacity in 2016 by 34.2 bcm including expansions (IEA, 2017a), among them Escobar floating and storage regasification unit (FSRU) in Argentina (1 bcm), the Cartagena FRSU in Colombia (5.1 bcm) and the small scale Possi LNG in Finland (0.16 bcm).

In 2017 there were 1,116 bcm of regasification capacity operating and 118 bcm under construction. 42% of the total regasification capacity was located in the broad Atlantic Basin. After OECD Asia, Europe has the highest regasification capacity. In America, the regasification capacity is also significant and diversified.

In the Atlantic Basin there are 23.1 bcm/year under development, thus the great developments will not take place in this Basin, but mainly in China, India and Middle East. Finland-Manga LNG (0.5 bcm) and Uruguay with a significant regasification capacity of 5.5 bcm in LNG FSRU, are important to note, particularly as Uruguay is joining the list of LNG importing countries.[5]

Similar to the case of liquefaction capacity, there is a slight trend that instead of LNG having to be delivered into large import terminals before distribution to final consumers, it can now be delivered to individual plants and customers. Nearly every country that does not currently import LNG seems to have plans to build LNG receiving terminals (BG Group, 2014).

5. For information about regasification, projects under construction see annex 2.

Table 4. LNG regasification capacity operating and under construction as of June 2017 (bcm/year)

Region	Operation	Construction	Region	Operation	Construction
Broad Atlantic Basin	471	23.1			
Total	1.116	118			
OECD Asia Oceania (Japan and Korea)	438	3	FSU/non-OECD Europe	5	-
Non-OECD Asia (excluding China)	97	67	Lithuania	4	-
China	76	12	Malta	1	-
OECD Europe	228	3	Middle East and Africa	39	19
Belgium	9	-	Bahrain	-	8
Finland	0,1	1	Jordan	5	-
France	34	-	Kuwait	8	-
Greece	5	2	United Arab Emirates	13	-
Israel	3	-	Egypt	13	-
Italy	15	-	Ghana	-	5
Netherlands	12	-	Namibia	-	6
Poland	5	-	OECD Americas	197	-
Portugal	8	-	Canada	12	-
Spain	67	-	Chile	8	-
Sweden	1	1	Mexico	23	-
Turkey	20	-	United States	153	-
United Kingdom	49	-	Latin America	37	14

Note: shaded squares represent LNG regasification projects in the countries/ regions of the broad Atlantic Basin.

Source: own elaboration from (IEA, 2017a).

In this regard, FSRUs have opened the door to LNG for a range of additional markets recently, which import LNG to meet short-term gas demand when the LNG price is competitive with other fuels. FSRUs have been attractive for these markets because of lower initial investment cost, shorter installation period (around 18 months for FSRU versus more than 5 years

for onshore conventional regasification terminals) and more flexibility in length of commitment than onshore regasification facilities. The most recent countries to invest in FSRU are Lithuania in 2014, Egypt and Jordan in 2015, and the United Arab Emirates in 2016 (IEA, 2017b).

Since the world's first FSRU starting operation in the United States in 2005, 24 FSRUs are now in operation. Globally, FSRUs account for 18.5% of the total number of regasification terminals and 10% of regasification capacity.

LNG trade in the Atlantic Basin

At a global level, around 30% of gas produced is traded internationally via pipeline and LNG, and around 70% is consumed in the country where it was produced. In 2000, 23% of all internationally traded gas volumes consisted of LNG. In 2016 this figure was around 33%, and by 2022, LNG share in the international trade is supposed to increase to approximately 38% according to the IEA.

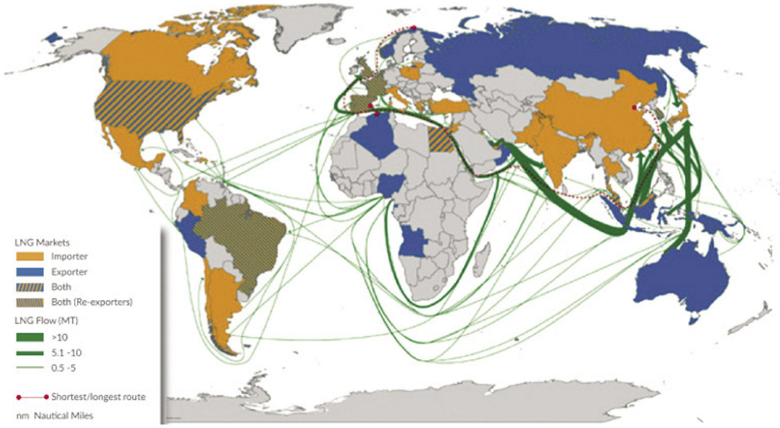
Due to the flexibility of LNG cargoes to be diverted in response to price signals, gas markets are becoming increasingly integrated, with movements in global gas prices becoming more synchronized (BP energy economics, 2018). Moreover, in the last years there has been an increase in the number of nations involved in LNG trade. However, cross-border pipelines will remain the fixed arteries of natural gas international trade (IEA, 2017a).

In 2016, the shortest voyage length was in the Broad Atlantic Basin: Algeria to Spain (130 nautical miles, nm), and the longest one was from Norway to China (12,280 nm) (IGU, 2017b).

In the Atlantic Basin, in terms of gas production, the US play a relevant role, with clear implications on LNG exports and on the increase of LNG trade. European production decrease has also an impact on global LNG trade, and therefore this territory will probably need to increase LNG imports.

Even if it is not dealt with in this chapter, it is important not to forget that trade agreements can play a relevant role in this market. For instance, changes in the North America Free Trade Agreement (NAFTA) could complicate trade between the USA and Mexico (Wood A., Viscidi, & Fargo, 2018).

Map 2. Major LNG Shipping Routes (2016)



Source: (IGU, 2017b).

Global gas production

Global gas production is expected to increase by 1.6% per annum in the period from 2016 to 2022, continuing the growth trend of the prior six years.

The US will be the largest gas producer, representing around one-fifth of total gas production by 2022. Gas production in Mexico is declining, however the country expects to increase its gas use for power generation by

Table 5. Global gas supply growth by region, 2004-2010; 2010-2016 and 2016-2022 (bcm)

	OECD Americas	Latin America	OECD Europe	Middle East	FSU/ non-OECD Europe	Africa	China	Non-OECD Asia	OECD Asia Oceania	Global growth
2004-2010	63	25	-19	189	46	53	54	64	20	496
2010-2016	142	18	-54	120	23	-8	41	4	45	332
2016-2022	141	3	-36	67	83	35	64	-24	37	371

Note: shaded squares represent the areas of the broad Atlantic Basin.

Source: own elaboration from (IEA, 2017a).

Table 6. Global demand growth by region 2004-2010, 2010-2016 and 2016-2022

	OECD Americas	Latin America	OECD Europe	Middle East	FSU/ non-OECD Europe	Africa	China	Non-OECD Asia	OECD Asia Oceania	Global growth
2004-2010	64	26	44	135	33	28	65	81	43	519
2010-2016	117	24	-68	103	-26	21	99	23	26	319
2016-2022	55	13	-2	71	8	26	134	63	-12	357

Notes: Negative figures have a decreasing meaning. Shaded squares represent the areas of the broad Atlantic Basin.

Source: own elaboration from (IEA, 2017a).

almost 50% between 2016 and 2020, and therefore Mexico´s gas pipeline network is undergoing a major expansion (Xu & Bell, 2018). Thanks to the OECD Americas, the Atlantic Basin has now a relevant role in gas supply.

Production from FSU/non-OECD Europe will probably increase in 2022, mainly driven by the increasing exports from Russia and the Caspian region to China and to the OECD Europe. The Middle East will contribute almost 20% of global incremental growth in gas production in the period from 2016 to 2022. China will also show robust growth at an annual average of 6.6%, adding almost 65 bcm to the global gas output (IEA, 2017a).

Global gas demand

Global gas demand is projected to increase by 1.6% annually on average (around 60 bcm per year) over the period 2016-2022. With demand increasing by 10% over the period, total gas consumption is expected to amount to 3,986 bcm by 2022. By sector, natural gas demand growth will be led by industry and the power sector and supported by both continued industrialization in developing economies together with gas gaining share as some countries switch away from coal. The fastest rate of growth of gas demand is in the transport sector (in trucking and marine transport). Even though this increase is small in absolute terms (BP energy economics, 2018).

Table 7. Natural gas international exports evolution

	Total		Pipeline		LNG		% of LNG in exports
	bcm	% of production	bcm	% of production	bcm	% of production	
1970	45.68	4.4	42.93	4.1	2.69	0.3	5.9
1975	125.37	9.9	112.35	8.9	13.05	1	10.4
1980	200.98	13.2	169.64	11.1	31.34	2.1	15.6
1985	228.85	13.1	177.97	10.2	50.88	2.9	22.2
1990	307.43	15.4	235.29	11.8	72.14	3.6	23.5
1995	391.69	18.3	298.45	14	93.24	4.3	23.8
2000	652.3	26	505.7	19.9	146.06	5.75	22.4
2005	847.9	29.5	669.32	23.33	178.58	6.22	21.06
2010	983.73	30	684.37	20.85	299.36	9.12	30.43
2015	1,051.68	29.6	724.48	20.45	327.2	9.23	31.1

Source: own elaboration from IEA and (Álvarez Pelegry & Balbás Peláez, 2003).

US, Mexico and Canada demand will surpass 1,000 bcm by 2022, meaning that one quarter of the global gas will be used in North America, the only developed region where gas demand is growing (IEA, 2017a).

Europe demand will probably decrease while Middle East and Asia as a whole will see a considerable increase of gas demand. Indeed, demand for natural gas in the Middle East is expected to surpass demand in OECD Europe. Asia is expected to account the vast majority of the demand increase by 2040 (BP energy economics, 2018).

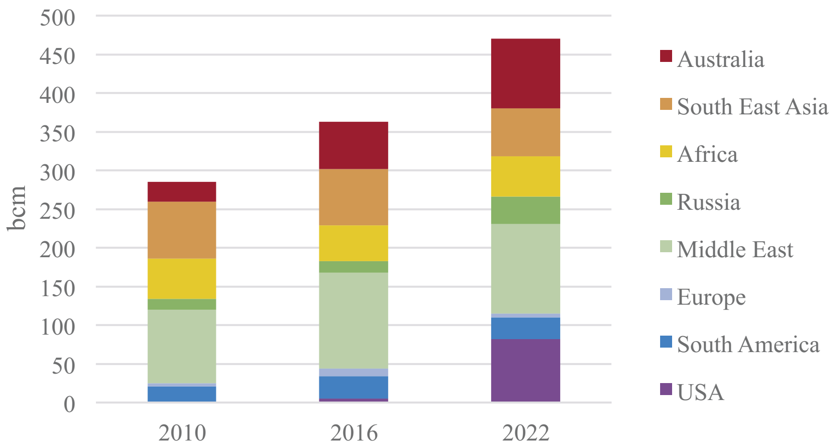
Therefore, the US is again the main driver in the future LNG demand of the Atlantic Basin, led by growth in industry, together with Latin America and Africa in the South Atlantic.

LNG exports

As mentioned, gas and LNG exports have increased over time. In 2016, top LNG exporters were Qatar (100.4 bcm) and Australia (57.6 bcm)[6]. The Atlantic Basin represented 17.7% of total exports.

6. Other relevant exporters were: Malaysia (32.5 bcm), Nigeria (24.2 bcm), Indonesia (21.6 bcm), Algeria (15 bcm), Russia (14 bcm), Trinidad and Tobago (13.8 bcm), Oman (10.5 bcm) and Papua New Guinea (9.6 bcm).

Graph 1. World LNG exports by region, 2016-2022



Source: own elaboration from (IEA, 2017b).

Traditionally LNG exports have come predominantly from non-OECD countries. However the new role of Australia and the US together with the stagnation of LNG export capacity in non-OECD countries will result in a more balanced picture as can be observed in next graph.

Australia has been the game changer, with an exported volume that more than doubled from 2011 to 2016 (IEA, 2017a).

OECD Americas will see a huge increase of LNG exports coming mainly from the US as a result of the shale gas boom. In this regard, the US has been a net gas exporter for 2017 and is expected to continue to export more natural gas than it imports throughout 2018 as exports of natural gas by pipeline to Mexico and of LNG will increase. Imports from Canada will decline (Xu & Bell, 2018) as gas from the Appalachian basin and other northern US producing areas is displacing US imports from Canada.

Latin America (particularly Trinidad and Tobago), Middle East and OECD Europe (Norway) will experience a slight decrease in LNG exports by the end of 2022, falling by around 6% from 2016 (IEA, 2017a). The highest decrease in LNG exports will be coming from non-OECD Asia region.

In Africa, LNG exports from Nigeria and Equatorial Guinea will remain relatively flat, and LNG exports from Angola and Cameroon will be con-

centrated in the period from 2019 to 2022. LNG exports from Algeria are expected to decrease due in part to the expiration of long-term contracts. This happens precisely when the market faces the largest glut, and it may struggle to sell uncontracted LNG in the market.

In spite of the evolution of Trinidad and Tobago and the EU, the increases in LNG exports from OECD Americas will imply a greater weight of the Atlantic Basin in the LNG future trade. However Qatar will continue to provide over 25% of LNG globally and Australia will be the second biggest individual exporter with 24% growth (Stadnicka & Janiszewska-Kiewra, 2018).

LNG imports

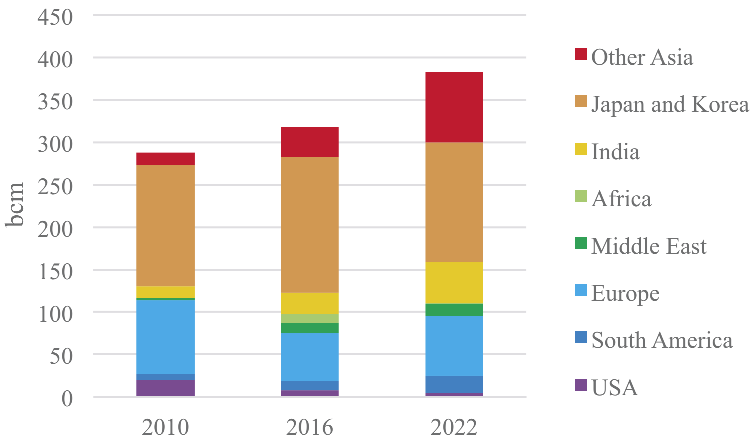
Global LNG imports are expected to grow until 2022. By 2022 some buyers will move their position towards a higher share of LNG in their natural gas supply, and new countries are expected to enter the LNG market (such as Bahrain, Bangladesh, Ghana, Haiti, Namibia, Panama, Philippines and Uruguay, four of them located in the narrow Atlantic Basin, and five in the broader one).

Even if OECD countries have traditionally been the largest source of global LNG demand, LNG import volumes of these countries have decreased and this tendency will probably continue (IEA, 2017a). By contrast, LNG demand of non-OECD countries has increased rapidly. In this regard, top LNG importers in 2016 were Japan (108.3 bcm), South Korea (43.8 bcm) and China (34.8 bcm)[7] (IGU, 2017b). Especially China and India increased their importance as importers in the period from 2011 to 2016, where China will probably be the main driver of the global LNG demand growth[8] and India is seen as an emerging LNG importer, capable of generating a meaningful demand increase.

In 2017, the Asia-Pacific Basin was the most relevant in terms of LNG imports. It will probably keep this relevance as next graph shows even if it is expected that Japan's and Korea's imports will probably decline in the near future.

7. Other countries with relevant regasification capacity are India (25 bcm), Taiwan (19.5 bcm), Spain (12.9 bcm), UK (9.6 bcm), Egypt (9.5 bcm), France (7.3 bcm), Turkey (7.3 bcm).
8. Relatively new importers will also show large increases in LNG demand. Bangladesh, Indonesia and the Philippines are supposed to join the LNG import list of countries and to start importing LNG before 2020 (IEA, 2017a).

Graph 2. World LNG imports by region, 2012-2022



Source: own elaboration from (IEA, 2017a).

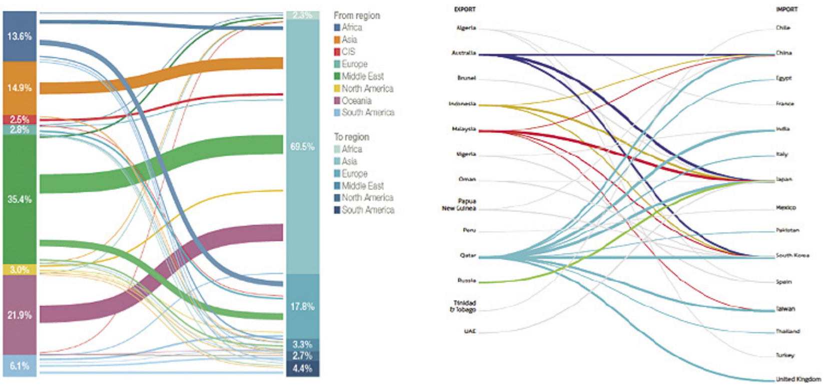
In 2016 the Atlantic Basin represented 24.7% of total imports. UK and Spain lost relevance and the principal changes in this basin were related to flows from the Persian Gulf and the Gulf of Guinea (Nigeria) to Europe and the US.

Stagnating demand and decreasing production will increase Europe's import needs. However it is expected that LNG contracted volumes in Europe will decrease by 2022, despite the fact that Finland, Lithuania, Malta, Poland and Sweden recently joined, as Uruguay, the list of LNG importers in Europe (IEA, 2017a). Europe's LNG demand has been and will be lower than the contracted LNG volumes, mainly because of weak gas demand and competition from pipeline gas. In this regard, Russia's Gazprom announced recently that the sea part of TurkStream first segment across the Black Sea had already been finished. For this country both the TurkStream and the North Stream 2 pipelines are vital to increase its presence in the European market (Energy Market Price, 2018).

In any case, Europe will remain a key market, both as a potential market of last demand for surplus LNG cargos and as a key hub of gas-on-gas competition between LNG and pipeline gas (BP energy economics, 2018).

Latin America will see some LNG demand increase with the addition of Colombia, Haiti, Panama and Uruguay. However, Canada, the US and

Graph 3. Global LNG flows (%) and major energy flows



Source: (Stadnicka & Janiszewska-Kiewra, 2018) (GIIGNL, 2017).

Mexico will lose relevance due to the competition with pipeline gas in the region and the emergence of US as an LNG exporter.

Though Ghana and Namibia, both in the Southern Atlantic, are assumed to start importing LNG in the coming years, overall African LNG demand in 2022 will be around 2 bcm, one fifth of the 2016 level, mainly because Egypt (in the broad Atlantic Basin) is expected to benefit from domestic production of its new gas fields and ease its existing importing needs substantially.

Graph 3 shows the main LNG trade flows.

LNG contracts

LNG contracted sales can be split in between short term (less than two years), medium term (between two years and five years) and long term (more than five years).

Another classification is made between flexible destinations, referring to short-, medium- or long-term contracts that are either taken free on board (FOB) at the liquefaction plant or where the buyer has flexibility in destina-

tion[9]. On the other hand, fixed destination refers to contracts with delivered ex ship (DES) terms and/or with a destination clause.

Spot or uncontracted may be referred to sales that are not sold under short-, medium- and long-term contracts. By being "uncontracted", these volumes are fully flexible (i.e. no destination clauses) and can be directed to the most profitable markets. As contracts remain the essential link between LNG supply and demand, the evolution of contractual terms has to be closely monitored to properly understand ongoing market changes.

Long term gas supply purchase agreements (GSPA)

Long term contracts have been the most usual way of contracting gas in the past and continue to be quite usual. Long term means here that the term of the contract is 15-25 years. This period has changed decreasing in the last years but continue to be significant of long-term contracts.

The following table registers the long-term contracts that export countries located in the Atlantic Basin had in 2016. The total contracted capacity in terms of millions of tons of LNG per annum is 78,759 MTPA, which represents 10.28% of total long and medium-term contracts. 94% of these contracts have a European buyer. Considering the contract end date, it can be said that in Europe the expiration of LNG contracts in the coming years will allow to rebalance long positions.

It is interesting to note the average duration of the contracts (around 20 years) and also that quite a number of these contracts began the supply before 2000-2002, and most before 2005-2006. Taking into account this consideration it may be assumed that at least in the initial contracts, gas prices were basically linked to oil prices or oil products as will be described later[10].

LNG contract flexibility

There is nowadays an interesting trend to improve flexibility in terms of the annual contract quantity and the development of short/medium term

9. Flexibility can also be considered from the point of view of the contracted volume. That is to say the percentage of 'take-or-pay' in relation to the annual contract quantity. Flexibility increases as 'take-or-pay' decreases the possibilities of make up or carry forward increase the flexibility of contracts.
10. For more information in this respect see chapter 6 of Álvarez Pelegry, E.; Balbas Pelaez, J. (2003). El gas natural. Del yacimiento al consumidor. Aprovisionamientos y cadena del gas natural licuado. S.L. CIE Inversiones editoriales Dossat-2000. ISBN: 9788489656451.

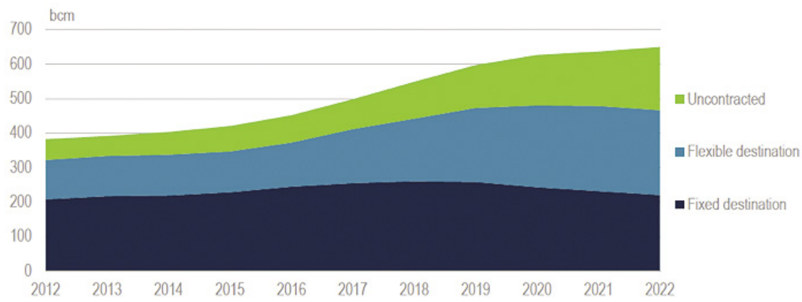
Table 8. Some long-term and medium-term contracts in force in 2016-2017 in the Atlantic Basin

Export country	Seller	Annual Contract Quantity (MTPA)	Earlier initial date	Late contract end date	Average duration	Type of contract
Algeria	Sonatrach	14.9	1972	2022	26	DES, CIF and FOB
Egypt	SEGAS	4.3	2005	2030	22,5	FOB
	ELNG T1	3.6	2005	2025	20	FOB
	ELNG T2	3.6	2006	2026	20	FOB
Equatorial Guinea	EGLNG	3.3	2006	2023	17	FOB
Nigeria	Nigeria LNG T1 &2	5.1	1999	2022	22	DES
	Nigeria LNG T3	2.7	2002	2024	21	DES
	Nigeria LNG T4 & 5	7.4	2006	2026	20	DES
	Nigeria LNG T6	4	2008	2027	19	DES
Norway	ENGIE	0.5	2007	Depletion	-	FOB
	Statoil	2.98	2006	Depletion	-	DES, FOB
	Total	0.7	2007	Depletion	-	FOB
Trinidad and Tobago	Atlantic LNG T1	2.66	1999	2018	19	FOB
	ENGIE	0.6	2000	2020	20	DES
	Atlantic T2 & 3	6.69	2002	2026	20	DES, FOB
	BP	0.75	2003	2023	20	DES
	Atlantic LNG T4	6	2006	2027	17	FOB
USA	Cheniere	9 + exceso de Sabine Pass	2016	2036	20	FOB

Notes: 1 MTPA ~ 1.3 bcm/year. Since March 2018 Statoil new name is Equinor.

Source: own elaboration from (GIIGNL, 2017).

Graph 4. LNG export contract volumes by destination flexibility, 2012-22



Source: (IEA, 2017b).

contracts (i.e. less than four years). The desire for flexibility both on supply and demand side is a key driver for understanding markets changes and how these changes might affect security of supply.

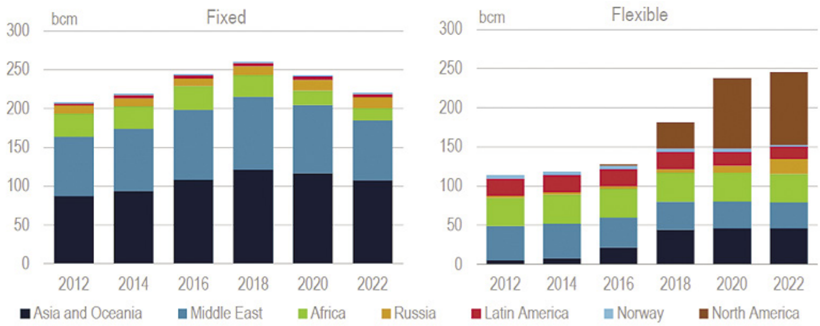
Over the next few years, opportunities for more flexibility would hence come from the contracts themselves. In fact, a greater proportion of new contracts have flexible terms, encouraged by both the innovative business models of the US suppliers and policies in the consuming countries and territories. It is expected that US LNG exports will, so to speak, revolutionize international LNG trade. Their contract structure (linked to the US gas spot price, no destination clauses and the use of tolling agreements) and the projected volumes will enable greater flexibility in the international LNG market and facilitate price convergence between regional markets (Cornot-Gandolphe, 2016).

Expiration of long-term contracts would also provide an opportunity to renegotiate terms towards more flexibility[11] (IEA, 2017b).

In the period from 2012 to 2017 the evolution observed in new signed contracts shows that the share of LNG contracted volumes without destination clauses in total trade has hardly changed being 34% in 2016. However, it should increase dramatically to 53% by 2022. By this year, flexible

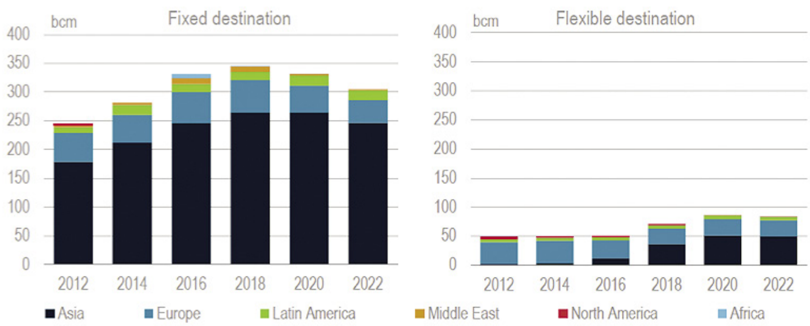
11. The two regions from where most of the contracts (fixed and flexible) are expiring over the coming years are the Middle East and Africa. The two countries seeing the most contracts expiring in the 2016-22 period are Malaysia (all fixed) and Algeria (-13 bcm/y fixed and -2bcm/y flexible).

Graph 5. LNG export contract volumes with fixed and flexible destination by region and country



Source: (IEA, 2017b).

Graph 6. LNG import contract volumes with fixed and flexible destination by region, 2012-2022



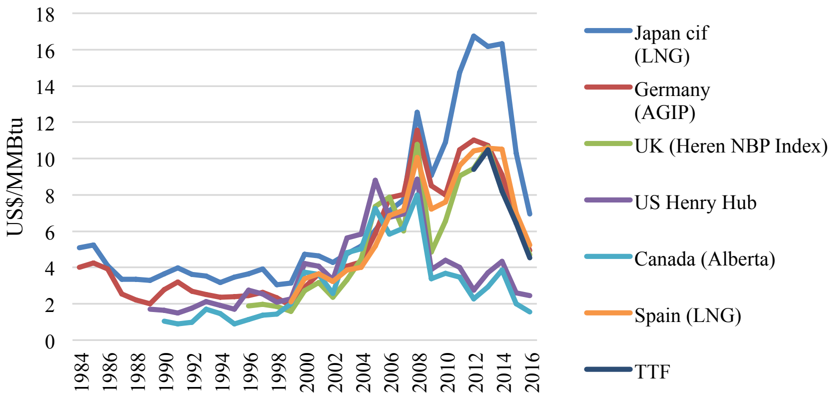
Source: (IEA, 2017b).

volumes would double, led by North America and mostly the US (IEA, 2017b).

Asian exporters appeared to be the least flexible (12%), while US volumes will be fully flexible as can be observed in next graph.

From the importers/customers' perspective, the share of flexible contracts at 13% in 2016, is less than half that of exporters. Although the volume of flexible destination contracts will almost double between 2016

Graph 7. Spot natural gas and LNG prices (US$/MMBtu)



Source: own elaboration from datacomex, my.Elexys.be and Platts in (BP, 2017).

and 2022, it would still account for a minority of currently known import contracts for 2022, with a share of 22% in terms of volume (bcm) (IEA, 2017b).

Inflexible volumes are expected to decrease both in Asia and Europe. This will be among others due to the abovementioned expiry of legacy contracts and development of flexible US contracts. For instance the contracts between US operators and European buyers, who saw an opportunity of diversifying and lowering the price of their LNG supplies, do not include destination clauses and the LNG can be sold on any market (Cornot-Gandolphe, 2016).

Other importing regions such as Africa, Latin America and the Middle East are currently relying on short-term and spot supplies, which are expected to prevail in the near future.

Flexibility can also be seen from the point of view of quantities that are not committed on take or pay or also as the spot and short-term LNG sales quantities which accounted for 29% of the market in 2015. In this regard, Russia, Algeria, the United Arab Emirates and Qatar should increase spare capacity, uncommitted to term contracts. Hence, they should be a reliable source of production flexibility in case demand or supply shocks occur (IEA, 2017b).

Gas prices and LNG supply chain costs

From the previous sections it should be clear that there have been dramatic changes in the last 15 years, not only because the volume of trade increased, but what is more important because the pattern of flows have changed very significantly. In this regard, gas prices and costs are key elements to explain trade, and particularly trade in the Atlantic Basin.

Gas prices

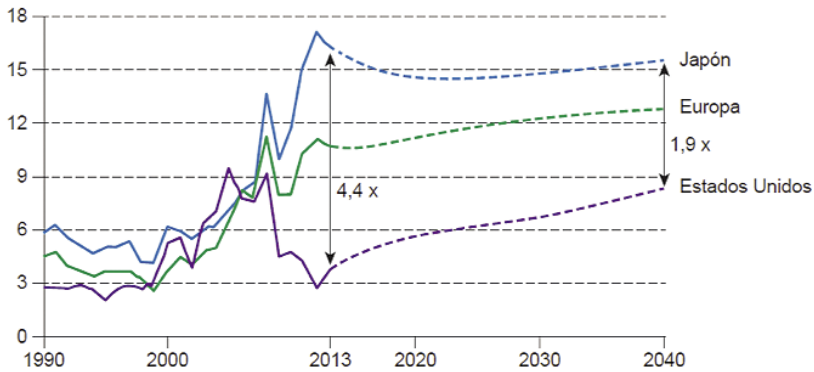
In 2013 there was a huge price divergence between regions, when prices in Japan were around four times US wholesale prices. Since 2015 convergence on prices was observed particularly between gas prices in Far East (i.e. China, Japan) and Europe (i.e. Spain, U.K), mainly due to the over-supply and the decline in the price of oil that have brought down natural gas prices in some regions.

Ample availability of LNG is putting pressure on traditional ways of pricing and marketing natural gas. As a consequence, in 2016 these differences had already decreased, more than expected and prices converged into lower levels than those forecasted. The Henry Hub natural gas price

Map 3. National natural gas market overview. World LNG estimated landed prices. January 2018

Note: landed prices are defined as received at the terminal, and are based on a netback calculation.
Source: (FERC, 2018).

Graph 8. Natural gas prices by region in the scenario of new policies (US$/MMBtu [2013])



Source: (OECD/IEA, 2014).

averaged US$ 2.27/MMBbtu from April 1 to July 25 th, 2016, compared with US$ 3.03/MMbtu during the same period in 2017 (Xu & Bell, 2018).

According to the IEA differences on prices by regions were going to be maintained in the long run, even if in 2014, for instance, projections showed a reduction of price differential from 4.4 to 1.9 by 2040. In any case, Japan would still have the highest prices and the United States the lowest ones.

Changes in trade flows described before are expected to lead to a more competitive international supply environment where some of the pricing and contractual rigidities that characterized long-distance gas trade in the past would be loosened. This change will be further accelerated by the expansion of US exports that have already been mentioned, which are not tied to any particular destination and so will play a major role in increasing the liquidity and flexibility of LNG trade.

As the growth of US export capacity is gradual, the consequences on gas markets will probably be felt from 2018 (Cornot-Gandolphe, 2016), with the corresponding implications for the relevance of the Atlantic Basin in global LNG trade where market flexibility is increasing (Barnes, 2018a).

Moreover, it is considered that with the launch of American LNG exports, Henry Hub pricing has emerged '*as a new international touchstone*'

Table 9. World gas price formation 2016

Region	OPE	GOG	BIM	Total gas consumption
North America	0.0	130.5	0.0	130.5
Europe	152.1	265.7	0.0	417.8
Asia	91.4	12.1	0.0	103.5
Asia Pacific	190.5	25.8	0.0	216.4
Latin America	20.9	8.8	1.0	30.7
FSU	21.7	0.0	29.7	51.4
Africa	4.5	9.6	3.8	17.9
Middle East	13.5	4.6	17.3	35.4
Total	494.6	457.2	51.7	1,003.6
%	49%	46%	5%	100%

Note: In terms of the allocation between different price formation mechanisms, the general rule is that the wholesale price at the "point of first sale" in the country is the one to be considered. For example, if gas enters a country under an OPE contract and is then re-traded at a hub it is still considered to be in the OPE category.

Source: (IGU, 2017c).

(Barnes, 2018b). Therefore, in a more globalized LNG market, the Henry Hub price could play a key role in determining future prices (Cornort-Gandolphe, 2018).

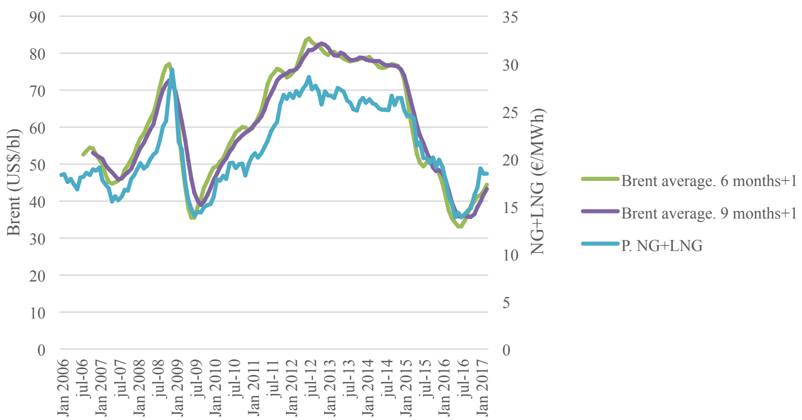
Gas price formation mechanisms

There are several price formation mechanisms that differ mainly from region to region as can be observed in next table, and that have influence on the pattern of trade. The main mechanisms are pricing based on oil price escalation or indexation (OPE), the gas-on-gas competition (GOG) and the bilateral monopoly (BIM).[12]

In the countries that make up the Atlantic Basin coexist different pricing mechanisms. In Europe there are two main ways of price formation. In the Northwest Europe from 2005 to 2016 there has been an evolution from OPE to GOG, but on the contrary, in the Mediterranean area the OPE formation of gas prices is still quite relevant (IGU, 2017c). This is clear for example in the case of Spain (in the Mediterranean area) which in 2016 imported 37.29 bcm of gas, of which 15.68 bcm of LNG. The relationship

12. For more information on price formation and regions see the Annex.

Graph 9. Comparison of the average price of NG+LNG in Spain and the Brent with lag



Source: own elaboration based on indexmundi and (CNMC, 2017).

between the price of imported LNG and oil is quite clear in the period from 2006 to 2016.

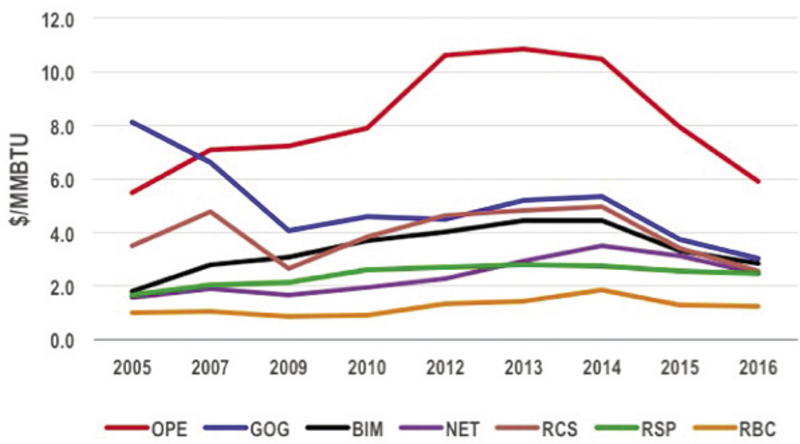
However, in North America, the mechanism employed is the GOG while Latin America and Africa are more diversified, as most of all the different mechanisms coexist, even though in Latin America OPE has a considerable weight.

The principal consequence of the existence of several pricing mechanisms is the difference on prices levels. This together with the various degrees of developments of internal wholesale gas markets (i.e. Henry hub in the US, Title Transfer Facility [TTF] in central Europe) explain, at least partially the prices differences. As can be seen in next graph during the period 2005-2016 gas prices have differed substantially depending on the mechanisms of price formation, and lower prices have been shown in those more developed wholesale markets.

Since 2009, the OPE mechanism results in the highest gas prices with the highest volatility and correlation with oil prices. The above graph shows the gas prices convergence of most of the mechanisms.

Nowadays it is particularly relevant for the Atlantic Basin the US LNG exports price formation. The trend towards shortening prices differences

Graph 10. Wholesale price levels 2005 to 2016 by price formation mechanism



Source: (IGU, 2017c).

among regions will be further accelerated by the expansion of US exports, which are not tied to any particular destination and are not oil indexed, as seen before (IEA, 2017a).

The cost of the LNG supply chain

This section deals with the several components of the LNG supply chain: gas prices in the export countries, the liquefaction cost, the LNG transport cost and the regasification cost. Thus the cost at the importing location/ importing country will be the outcome of adding these four components. This cost is related to prices, although these are determined whether by the fundamentals of supply and demand and/or by the bilateral contractual negotiations.

Gas price in exporting countries

In relation to gas price in exporting countries, there are notably differences among regions. For instance US LNG exports index their prices to the Henry Hub (HH) gas spot price, which among other advantages supposes a diversification from OPE contracts. Furthermore, most buyers signed toll-

ing agreements for 15-20 years or a use-or-pay basis (Cornot-Gandolphe, 2016), so if the buyer decide not to take the LNG, they will only have to pay a fixed fee (2.25-3 US$) instead of the full cost of the LNG in traditional contracts containing take-or-pay clauses.

In the US the gas-on-gas competition has made of the Henry Hub price a clear reference that has been incorporated to the CIF prices of some derivatives. So a formula of the type:

$$P_{LNG} = 1.15 \text{ x } HH + \text{B}$$

was proposed by Cheniere and has been mentioned by (Kuhn, 2013), where *HH* is the Henry Hub gas price and *B* represents a coefficient.

Other references such as the Gulf of Guinea are related to a basic price (P_0) plus an escalation referred to gas oil and fuel oil for different qualities in some ports of destination, such as Rotterdam. Likewise the analysis can be done from the cost of gas in origin side[13]. In this respect it must be taken into account that in some countries prices are determined by the national oil or national gas companies or by international oil/gas companies based on complex relations with the production sharing contracts or agreements.

Liquefaction cost

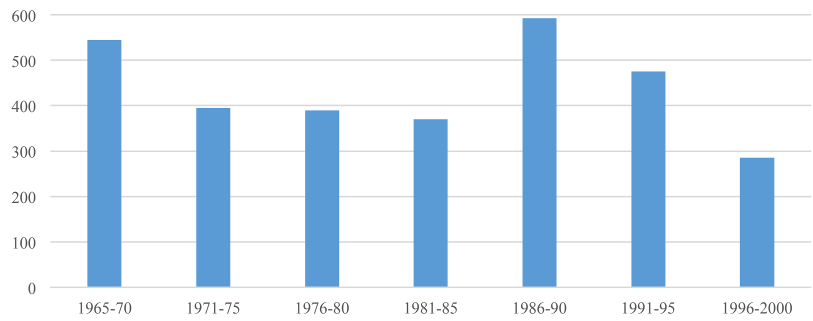
Liquefaction cost is a very important component, as it is the most expensive part of the LNG supply chain (Wood A. et al., 2018). Plant costs vary widely and depend on location, capacity and liquefaction process, the number of storage tanks, the access to skilled labour and the regulatory and permitting costs.

Estimations established this cost for 2000 on the calculation of agents debt of 20/80 and 60/40 of US$/MMBtu 1.4-1.0, assuming capital costs (CAPEX) of US$ 1,100-1,400 (Álvarez Pelegry & Balbás Peláez, 2003). At the time, the cost of the CAPEX was around 200 US$/tpa as can be seen in next graph.

However, this importance is now greater as there has been a dramatic increase of liquefaction cost as next graph shows. The increases have resulted in liquefaction costs, for instance, of 2.25-3.5 US$/MMBtu for Sabine Pass and Corpus Christi (Ripple, 2016).

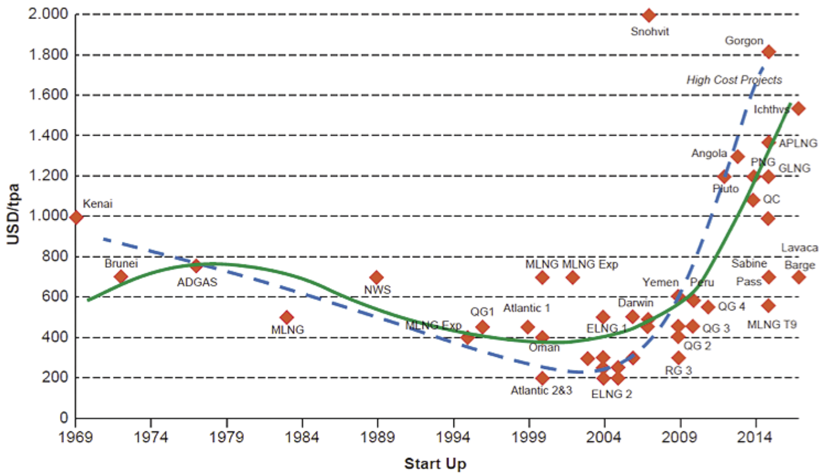
13. In this respect some references can be found in (Álvarez Pelegry & Balbás Peláez, 2003).

Graph 11. Evolution of liquefaction costs (US$/tpa)



Source: (Álvarez Pelegry & Balbás Peláez, 2003) from Global Octane and Merrill Lynch.

Graph 12. Liquefaction plant metric cost (tpa)



Source: (Songhurst, 2014).

The costs escalation has occurred worldwide, and not only in the Atlantic Basin, where the costs rose from US$461 in the period 2000-2008 to US$1,221 in 2009-2016. Projects in the Atlantic and Pacific Basin have experienced higher costs during 2009-2016 relative to 2000-2008 (IGU, 2017a).

Nowadays, the low price environment, reduces the margin for US LNG trade. Consequently, buyers that own capacity at the US export terminals have tried to renegotiate prices (Wood A. et al., 2018).

Shipping costs

Shipping costs are also a relevant part of the final costs for the LNG chain. Their share in the total cost of liquefied natural gas ranges between 10 to 35% of the final price paid for the natural gas. This component is more dynamic than other components of LNG price and include rental costs of methane carriers (charter rates in US$/day), fuel costs and operation and maintenance costs, harbour fees and charges related with freight by sea (i.e. crossing channels' fees) and insurance (Zajdler, 2015).

Assuming a given route, prices change mainly with the time charter rate. Short term rates rose dramatically in the early 2010 and later fell from US$/day 155,000 to 24,500 in 2015. Throughout 2017 short term charter rates increased from US$/day 25,000 to US$/day 47,000-78,000 depending mainly on the type of vessel (ST = Steam Turbine; DFDE = Dual Fuel Diesel Electric, more expensive) (Howard, 2018).

These differences in time charter rates, make for a same route (i.e. US Gulf Coast to UK) a transportation cost increase or decrease. Longer distances imply greater differences (Howard, 2018). That is to say that it is not the same the distances between US Gulf, the North African gas suppliers (mainly Algeria and to a less extent Libya and Egypt), Nigeria or the Persian Gulf (Qatar, Oman, Abu Dhabi) to Europe.

The above figures give an idea of the differences in transport prices or costs from the same origin. This discussion allows to introduce the matter of arbitrage. If gas prices on the Far East were higher enough than the European ones, gas sales (short term or spot) may finally go from the USA or Trinidad and Tobago in the Atlantic Basin to regasification plants in China instead to regasification plants in Europe. Then as long as gas price differentials increase the flows in the Atlantic Basin may decrease.

Table 10. Shipping (one-way) distances between Sabine Pass and destination ports, voyage days, time charter rates and transport cost (US$/MMbtu)

Loading Port	Discharge Port	Nautical Miles	Voyage days	Time charter rates	Time charter rates/MMbtu
Sabine Pass (US)	Isle of Grain (UK)	4,897	10.7	504,735	0.1336
	Gateway (NL)	5,002	11.0	515,557	0.1365
	Tokyo	15,762	34.6	1,624,592	0.4303
	Tokyo (via Panama Canal)	9,209	20.2	949,173	0.2514
	Tokyo (via Suez Canal)	14,521	31.8	1,496,682	0.3964
	Shangai	15,098	33.1	1,556,154	0.4122
	Shangai (via Panama Canal)	10,081	22.1	1,038,700	0.2751
	Shangai (via Suez Canal)	13,854	30.4	1,427,934	0.3782

Notes: 19 nautical miles per hour; 160.000 m3 of LNG, time charter rate = 47,000 US$. This table does not include the fuel´s cost.

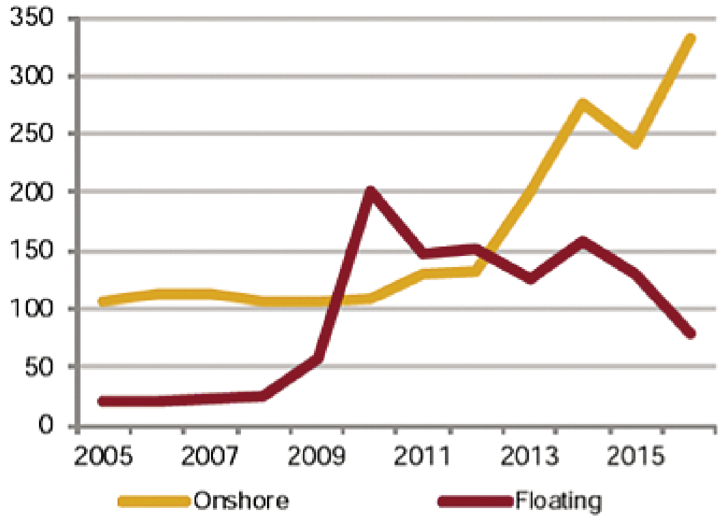
Source: own elaboration from (Howard, 2018).

As mentioned, fuel costs are also relevant, especially in those vessels that use part of the cargo to feed the propulsion. In this regard, when unloading cargo in the final port of discharge, the shipper retains a part of it to serve as fuel gas on the way back to the load port. This results in a reduced amount of delivered LNG. In consequence, the exporters stipulate the prices for the amounts actually delivered to import terminals. The price of the LNG intended to be used as propulsion engine fuel reduces transportation costs (Stanivuk, Tokic, & Soskic, 2013).

Regasification costs

Global LNG regasification capacity has increased following the demand. Over the past few years, new markets have been able to complete regasification projects fairly quickly using FSRU whose capital costs are lower than those of traditional regasification facilities as shown in next graph. However, operational costs (OPEX) of the floating facilities are higher.

Graph 13.Regasification costs based on Project Start dates (2005-2016) (US$/tonne)



Source: (IGU, 2017a).

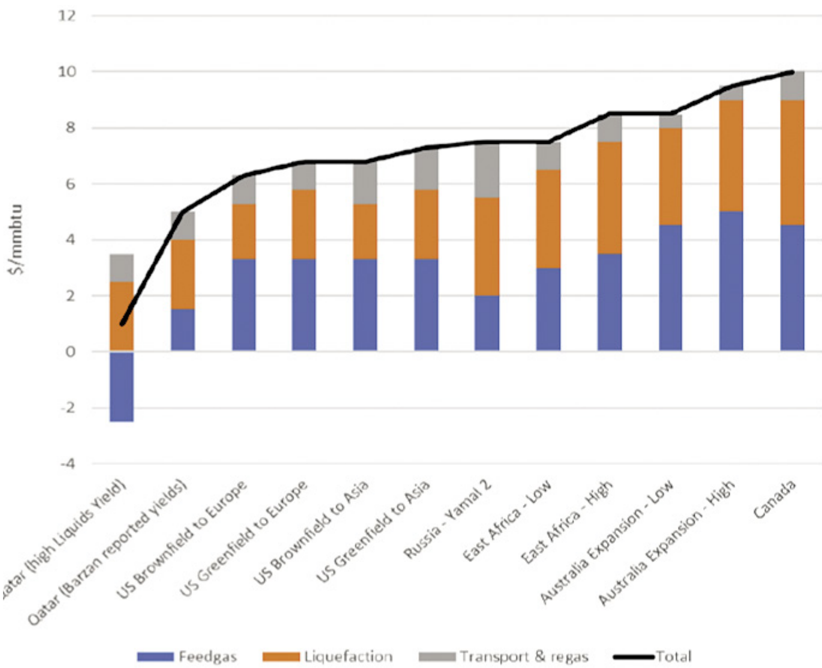
In 2016, the average capital costs of new onshore LNG import capacity was US$/tonne 334, which is significantly higher than the average of 2015 (US$/tonne 242). New onshore terminals with smaller storage units were expected to reduce overall CAPEX costs to US$/tonne 212 in 2017 and US$/tonne 285 in 2018. New floating terminals' CAPEX remained roughly steady declining from US$/tonne 158 in 2014 to US$/tonne 78 in 2016.

US LNG deliveries started in late February 2016. They were headed by the countries offering the highest margin after deducing from the landed LNG price. Europe where the LNG is in competition with pipeline gas imports, is at a disadvantage compared to other areas where competition occurs among LNG exporters, because the regasification cost has to be added.

The total cost of LNG

(Howard, 2018) estimated the breakdown cost of recent or new LNG projects, considering the cost components that have been mentioned until now. Gas costs range from 5 to 10 US$/MMbtu; US Greenfield to Europe is around 7 US$/MMBtu, with no much difference with US to Asia. In

Graph14. Estimated breakeven costs of recent or new LNG projects



Source: (Stern, 2017).

terms of costs there is potential in the Far East as time charter rates are not high, given the cost advantage of suppliers in the Atlantic Basin in comparison with the new higher cost projects in Australia.

It is interesting to note the price differentials with Asia, due mainly to transportation costs (US$/MMbtu 1.5) and regasification costs (i.e. in Japan LNG do not compete with gas by pipeline, as it is the case in Europe and therefore, regasification costs are not considered in the comparison as all the gas imported in Japan comes by sea).

In this regard for instance, since 2014, the premium paid by Asia has fallen and even disappeared in 2016. As a consequence, the reduction of prices in Asia has result in the improvement of the attractiveness of the European area for LNG exporters in the Atlantic Basin and in eliminating the economic incentive to reroute cargoes to Asia (Cornot-Gandolphe, 2016).

Table 11. Margins from the Cheniere export project (US$)

Delivered price to (MMBtu)	Europe	Asia
Gas	2.6	2.6
Transportation	1	2.5
Regasification	0.4	0
Total cost	4	5.1
Landed price	5 (TTF)	6.9 (JKM)
Margin	1	1.8

Note: the authors consider that in this table Europe represents Northern Europe and not the Mediterranean where OPE in the main pricing mechanism employed.

Source: (Abiteboul).

As seen, liquefaction costs together with gas price in export countries are the most relevant components of the total cost of LNG and have increased during the last years. However in terms of trade, transportation costs also play a relevant role. The balance of these elements will influence the final decision of where to sell the LNG.

Indeed, because LNG can be transported to markets in different parts of the world. LNG supplied under a long-term contract may be sold and delivered to customers in different destinations to those established in the contracts. This is due to the differences in gas prices between markets that create arbitrage opportunities. Flexibility will probably bring changes in this regard.

Perspectives of LNG in the Atlantic Basin

The Atlantic Basin has a significant role in global LNG trade. Gas reserves in the basin have increased from 1990 to 2015 by 24-35% (depending on the origin of the data). This increase although very significant is lower than the increase of reserves worldwide.

43% of liquefaction capacity was installed in the Atlantic Basin from 1964 to 1979, and in 2017 nearly one third of total liquefaction capacity and more than 40% of total regasification capacity was in this basin. 73% of LNG projects under construction were in the Atlantic Basin, and more than half in the United States. However, 20% of the regasification projects under construction are in the Atlantic.

In the context of global gas production and demand expected to increase annually in the period from 2016 to 2022, LNG exports have increased substantially in recent years and are expected to be around 450 bcm in 2022, from around 350 bcm in 2016, mainly driven by the US and Australia. LNG imports are also expected to grow. The Atlantic Basin represented nearly 18% of LNG exports and 25% of LNG imports.

The volume and diversity of LNG trade flows are increasing rapidly with the appearance of new exporting and importing countries that add new LNG capacity to a market where demand is declining in some of the large, traditional LNG importing countries.

In the Atlantic Basin the US will grow dramatically its gas demand as well as its LNG exports. Europe will play mainly as importer of gas from Russia and in the future from the Caspian region. The US LNG could be for Europe an instrument to reduce the continent´s current dependence on Russian gas. In any case, it is important for the EU to be an attractive market for LNG exporters and as a consequence, the development of the internal gas market is a necessity to achieve a correct security of supply.

The South Atlantic will increase its relevance. Latin America and Africa will probably increase demand and play a more active role in LNG trade; however, these territories will need considerable investments and the development of their own domestic markets. These territories also face other challenges such as accessing finance or the need of regulatory stability. In the meanwhile, exports from Western Africa will increase.

Besides the situation and perspectives of infrastructures (liquefaction and regasification plants, shipping vessels and pipelines) which set the physical basis for LNG trade as well as the fundamental economics of LNG supply and demand, three other factors shall influence the volumes and patterns of trade flows in the Atlantic Basin. Namely the type of contractual supply agreement, the pricing mechanisms and the cost of the LNG supply chain.

So first, in terms of capacities worldwide there is a global situation which will imply pressure for lower LNG prices. Technologies such as FRSU, FU and small liquefaction plants will mean more variety, more flexibility and more possibilities of LNG trade. However, the ability to increase LNG exports will also be driven by market conditions.

In relation to the contractual supply agreements the existence of long term contracts, with gas price formulas, in most of the cases presumably

linked to oil and oil products and with a great part of the volume contracted related to "take or pay" clauses will probably evolve to contracts gas-on-gas pricing, shorter term contracts, and more flexibility. In this sense, the US and Northern Europe are relevant.

Regarding the pricing mechanisms on both sides of the North Atlantic Basin different mechanisms are taking place GOG competition in North America and Northern Europe and OPE in the Mediterranean. Nevertheless, these mechanisms are evolving through a GOG in South Europe and towards considering the HH price as a reference on imports from the US.

This situation shall create dynamics of sales at different terms (from long, medium and short to spot) related not only to the fundamentals of gas supply and demand but also for oil and oil derivatives.

The third factor with influence over the volumes and patterns of trade in the Atlantic Basin is the costs of the LNG supply chain. The increasing costs of liquefaction plants and the variations in time charter rates, together with the cost of shipping depending on the routes (i.e. US-Europe vs. US-Far East) will also affect the dynamics of LNG trade. On the one hand bringing a certain floor price given the marginal cost of the supply chain, on the other by the arbitrage that may take place because of the price gaps between the Far East (Japan and South Korea) and the Atlantic Europe.

As a consequence, LNG prices, price indexation and flexibility mechanisms will shape the patterns of trade flows in the Atlantic Basin together with the gas exports from the US that will imply a clear advantage in cost that shall be translated into a competitive advantage. All in all, LNG markets shall be more interrelated and interconnected in terms of flows, volumes and prices.

Looking at the future, gas should play a key role in the transition towards a low carbon economy. Global demand and supply for gas and international trade, including a growing role of LNG, will increase in the medium term (2017-2022).

To conclude, one of the main challenges that the Atlantic Basin must face in terms of LNG trade is the fact that relations are still established principally within each of its constituent regions instead of between them. Perhaps shale gas in US will imply more interrelationship within North America (Canada, US, Mexico). This, together with the decrease of gas production in Europe and its increase in gas demand, shall shape an LNG dynamic area in the North Atlantic Basin. However, new dynamics should

be developed in the future in order to include the South Atlantic and achieve a more unified Atlantic Basin.

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Annex: Types of price formation mechanisms

Mechanism	Observations
Oil price escalation (OPE)	The price is linked, usually through a base price and an escalation clause, to competing fuels, typically crude oil, gas oil and/or fuel oil. In some cases coal prices can be used as can electricity prices.
Gas-on-gas competition (GOG)	The price is determined by the interplay of supply and demand – gas-on-gas competition – and is traded over a variety of different periods (daily, monthly, annually or other periods). Trading takes place at physical hubs (e.g. Henry Hub) or notional hubs (e.g. NBP in the UK). There are likely to be developed futures markets (NYMEX or ICE). Not all gas is bought and sold on a short term fixed price basis and there will be longer term contracts but these will use gas price indices to determine the monthly price, for example, rather than competing fuel indices. Also included in this category is spot LNG, any pricing which is linked to hub or spot prices and also bilateral agreements in markets where there are multiple buyers and sellers.
Bilateral monopoly (BIM)	The price is determined by bilateral discussions and agreements between a large seller and a large buyer, with the price being fixed for a period of time – typically one year. There may be a written contract in place but often the arrangement is at the Government or state-owned company level. Typically there would be a single dominant buyer or seller on at least one side of the transaction, to distinguish this category from GOG, where there would be multiple buyers and sellers trading bilaterally.

Netback from final product (NET)	The price received by the gas supplier is a function of the price received by the buyer for the final product the buyer produces. This may occur where the gas is used as a feedstock in chemical plants, such as ammonia or methanol, and is the major variable cost in producing the product.
Regulation cost of service (RCS)	The price is determined, or approved, formally by a regulatory authority, or possibly a Ministry, but the level is set to cover the "cost of service", including the recovery of investment and a reasonable rate of return.
Regulation: social and political (RSP)	The price is set, on an irregular basis, probably by a Ministry, on a political/social basis, in response to the need to cover increasing costs, or possibly as a revenue raising exercise – a hybrid between RCS and RBC.
Regulation below cost (RBC)	The price is knowingly set below the average cost of producing and transporting the gas often as a form of state subsidy to the population.
No price (NP)	The gas produced is either provided free to the population and industry, possibly as a feedstock for chemical and fertilizer plants, or in refinery processes and enhanced oil recovery. The gas produced maybe associated with oil and/or liquids and treated as a by-product.
Not known (NK)	No data or evidence.
Source: (IGU, 2017c)	