

WHOLESALE GAS PRICE SURVEY 2018 EDITION

**A GLOBAL REVIEW OF PRICE
FORMATION MECHANISMS**

2005 TO 2017

JUNE 2018

WORLD GAS CONFERENCE 2018 EDITION



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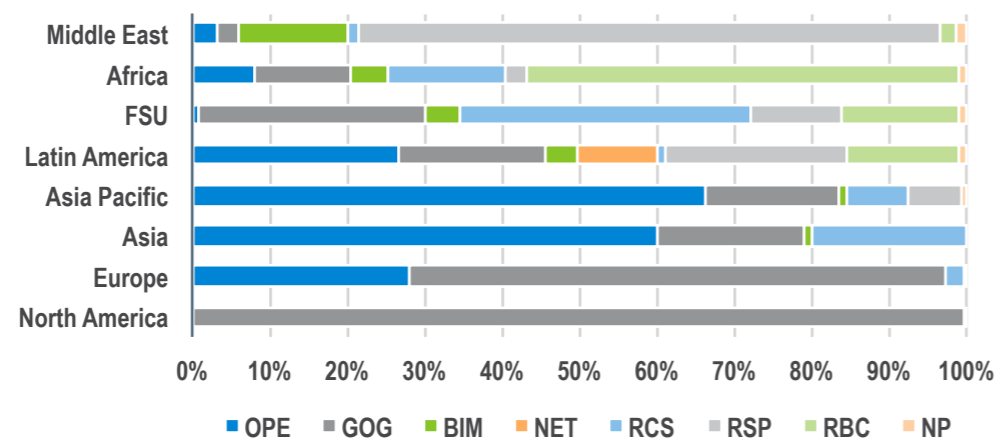
1 Key Findings

The 2017 IGU Wholesale Gas Price survey is the tenth to be undertaken in a series which began at the start of the 2006 to 2009 triennium culminating in the World Gas Conference in Buenos Aires. Prior to the 2017 survey, previous surveys were undertaken for the years 2005, 2007, 2009, 2010, and then annually from 2012. The ten surveys are now indicating the changing trends in wholesale price formation mechanisms over a period of rapid and significant change in the global gas market.

The share of gas on gas competition stands at 46% of total world gas consumption...

The 2017 survey showed again that gas on gas competition has the largest share in the world gas market. Out of total world consumption of some 3,740 bcm, gas on gas competition has a share of 46%, totalling over 1,700 bcm, dominated by North America at 950 bcm, followed by Europe at some 380 bcm and the Former Soviet Union at around 190 bcm (albeit largely a different type of gas-on-gas competition with multiple buyers and sellers entering into bilateral agreements as opposed to a trading market). In all gas on gas competition can now be found in some 54 countries, in one form or another, and in all regions of the world.

Figure 1.1 Regional Price Formation 2017



The different types of price formation mechanism are described below.

TYPES OF PRICE FORMATION MECHANISMS	
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 are any spot LNG cargoes, 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 this would be one year. There may be a written contract in place but often the arrangement is at the Government or state-owned company level. Usually 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.
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, 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.



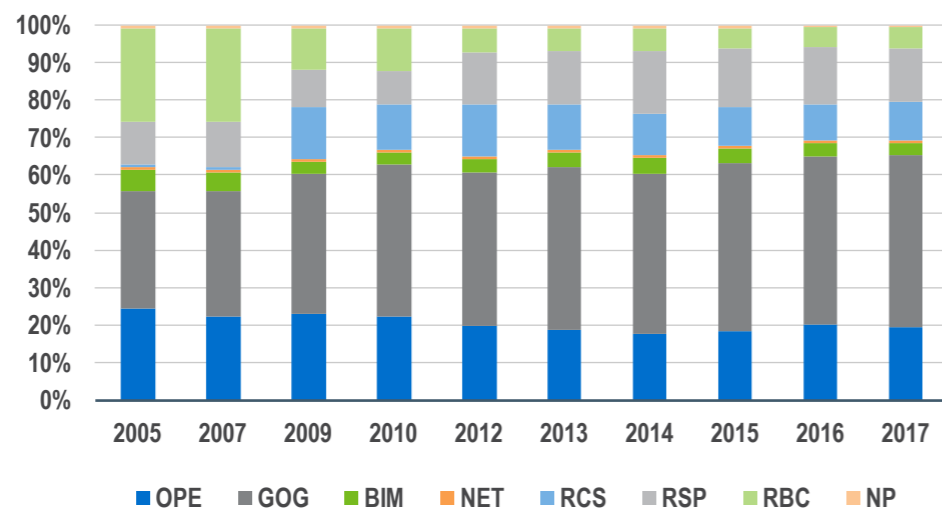
The share of oil price escalation or oil indexation stands at some 19.5%, and totals around 730 bcm and is predominantly Asia Pacific (270 bcm), Asia (230 bcm) and Europe (155 bcm). Oil price escalation is widespread being found in some 59 countries, and in all regions except North America.

The three regulated categories – regulation cost of service, regulation social and political and regulation below cost – account in total for some 30%, or around 1,130 bcm; with regulation cost of service in 17 countries, mainly the Former Soviet Union (Russia), Asia (China) and Asia Pacific (Malaysia); regulation social and political in 23 countries, with the Middle East dominating – Iran, Saudi Arabia, Oman and the UAE; and regulation below cost in 13 countries, mainly the Former Soviet Union – Kazakhstan, Turkmenistan and Uzbekistan, Africa – Egypt and Algeria, and Latin America – Venezuela.

...the share of gas on gas competition rose again between 2016 and 2017

The share of gas on gas competition rose by one percentage point between the 2016 and 2017 surveys, as a result of a sharp rise in the share in Europe, reflecting changing contractual terms and increasing consumption in predominantly gas-on-gas competition markets, a rise in Asia Pacific, because of increasing spot LNG imports, an increase in China, as direct sales to large users at negotiated market prices were allowed from domestic production, and a rise in the FSU, as Ukraine imported hub priced gas from Europe. The oil price escalation share fell by half a percentage point in 2017, with the continued decline in Europe and the change in China, being partially offset by an increase in Asia Pacific, as Malaysia and Indonesia moved to more oil price escalation in domestic pricing. The regulated categories share was unchanged between 2016 and 2017, but within that, regulated cost of service increased at the expense of regulated social and political as a result of changing Malaysian price mechanisms.

Figure 1.2 World Price Formation 2005 to 2017

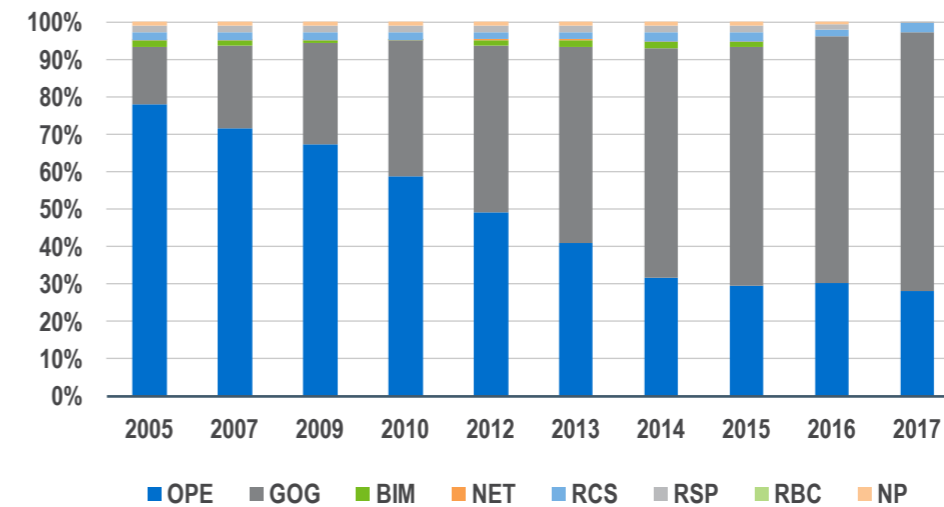


Overall over the 2005 to 2017 period, the share of gas on gas competition has risen by almost 15 percentage points, while oil price escalation has declined by 5 percentage points. Bilateral monopoly has declined by 2.5 percentage points, while in the regulated categories regulation cost of service has risen by 10 percentage points, regulation social and political has risen by nearly 3 percentage points and regulation below cost has declined by almost 20 percentage points.

In Europe gas on gas competition has risen to 70% of total consumption, with oil price escalation at less than half this level....

The major overall changes, in the 2005 to 2017 period, have been the continuous move away from formal oil price escalation to gas on gas competition in Europe, and also in Russia as the independents and Gazprom competed for sales to large eligible customers such as power plants, with China also in 2017 allowing direct sales to large users at negotiated market prices. This is clearly a different kind of gas on gas competition from the liquid trading markets in North America and Europe but reflects the fact that there are multiple buyers and sellers, distinguishing it from the bilateral monopoly category, where there would be a single dominant buyer and/or seller.

Figure 1.3 Europe Price Formation 2005 to 2017



In Europe the move from formal oil price escalation to gas on gas competition, has seen the latter's share increasing from 15% in 2005 – when oil price escalation was 78% – to 70% in 2017 – when oil price escalation had declined to 28%. The changes have reflected a number of factors over the years; switching of domestic gas produced and consumed in a number of countries – Netherlands, Germany, UK and Italy especially – away from oil price escalation, a decline in the volume of gas imported under the traditional oil indexed contracts, being replaced by imports of spot gas and increasing volumes traded at hubs, followed by the ending of contracts or the renegotiation of the terms to include a proportion of hub/spot price indexation in the pricing terms, or even a move to 100% hub price indexation, and in some cases, a reduction in the take-or-pay levels. The renegotiations have also seen the introduction of hybrid pricing formulas where oil indexation is partly maintained but within a price corridor set by hub prices. The respondents to the survey allocate the hybrid contracts in part to gas-on-gas competition and in part to oil price escalation, depending on how narrow or wide the price corridor is.



The change in price formation mechanisms in Europe was not universal across the region. Northwest Europe¹ has seen the most dramatic change in price formation mechanisms, with a complete reversal from 72% oil price escalation and 28% gas on gas competition in 2005 to 8% oil price escalation and 92% gas on gas competition in 2017, as a result of increased hub trading and contract renegotiations, as noted above. Central Europe² has also, more recently, seen significant changes. Oil price escalation has declined from 85% in 2005 to 25% in 2017, while gas on gas competition has increased from almost zero in 2005 to 73% in 2017, principally reflecting increased imports of spot gas, some re-exported from Germany, and contract renegotiations. There has been less change in other areas of Europe such as the Mediterranean³, where oil price escalation has declined from 100% in 2005 to around 61% in 2017 with gas on gas competition rising from nothing to 39%, largely reflecting spot LNG imports with significant changes in pipeline imports into Italy in the last couple of years, as a result of contract renegotiations with both Gazprom and Sonatrach. In Southeast Europe⁴ there is around 11% gas on gas competition, with recent increases in Croatia.

...but oil price escalation has gained ground in Asia and Asia Pacific...

While oil price escalation has lost share in Europe, there have been large gains in share in Asia with a rise from 35% in 2005 to almost 69% in 2016, initially as China began importing more LNG and pipeline gas from Turkmenistan, but largely reflecting the domestic pricing reform, initially in two Chinese provinces, followed by rolling these changes out to the whole of China for most sectors. The share fell back to 60% in 2017 with the switch to gas-on-gas competition in China, with the beginning of market-priced direct sales negotiated bilaterally between upstream producers and large users.

In Asia Pacific the increase in oil price escalation has largely been at the expense of regulated pricing, principally in Malaysia and Indonesia.

....regulated pricing continues to move away from subsidies in many regions

Apart from the changes concerning gas on gas competition and oil price escalation in Europe, Asia and Asia Pacific, there have also been significant changes in the regulated pricing categories. The increases in regulated pricing and policy changes in Russia not only saw a switch towards gas on gas competition, but also a switch from the subsidised regulation below cost in 2009 to regulation cost of service as Gazprom finally stopped losing money on their domestic gas sales, although with the freeze in regulated prices in 2014, there was a partial switch back to regulation social and political.

There were also significant changes in China as pricing reforms, again around the 2009 period, saw domestic production prices being more formally regulated and the price formation mechanism changing from regulation social and political to regulation cost of service, before the significant move to oil price escalation. Similarly, in Iran prices were raised significantly with the category changing from regulation below cost to regulation social and political in 2012, and a similar change in Nigeria in 2014, as prices increased, and gas-on-gas competition was introduced.

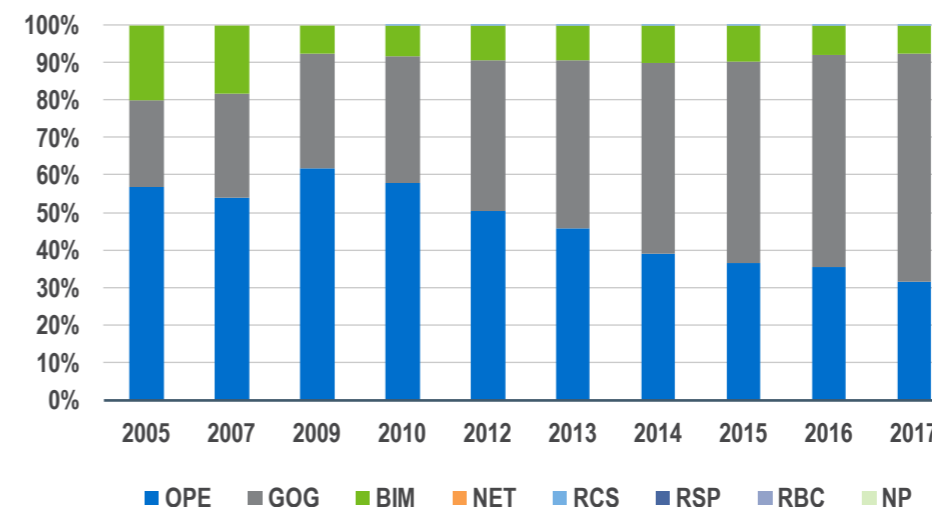
1 Belgium, Denmark, France, Germany, Ireland, Netherlands, UK
 2 Austria, Czech Republic, Hungary, Poland, Slovakia, Switzerland
 3 Greece, Italy, Portugal, Spain, Turkey
 4 Bosnia, Bulgaria, Croatia, FYROM, Romania, Serbia, Slovenia

Pipeline trade has seen a continuous shift to gas on gas competition, but oil price escalation has largely held its share in LNG trade

In pipeline imports there has been a largely continuous rise in gas on gas competition at the expense of oil price escalation, rising from 23% in 2005 to 61% in 2017, as oil price escalation declined from 57% to 32%. However, the decline in oil price escalation has been partly offset by a switch from bilateral monopoly in intra-FSU trade in 2009, and more recently the imports of pipeline gas from Turkmenistan to China, and in 2016, the change in one of the gas contracts from Russia to Turkey.

The rise in gas on gas competition at the expense of oil price escalation has been almost entirely in the European market as the Northwest Europe countries began switching to gas on gas competition and more recently the Central Europe countries and, in 2014, Italy. In respect of pipeline imports into Europe gas on gas competition in 2017 has a 71% share compared to 29% for oil price escalation. This is in marked contrast to 2005 when it was 91% oil price escalation and only 7% gas on gas competition. In 2017, Ukraine switched to importing gas from Europe at hub prices, reducing the oil price escalation share in the Former Soviet Union.

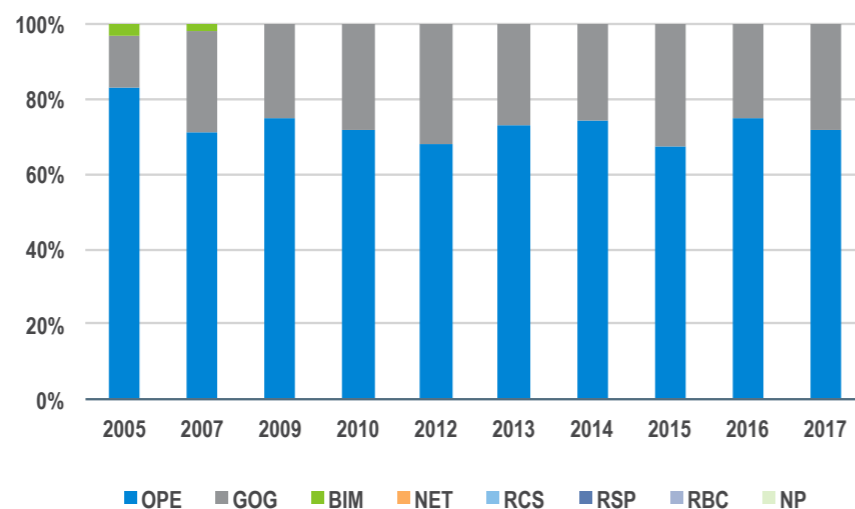
Figure 1.4 Pipeline Imports 2005 to 2017



In contrast oil price escalation has largely held its share in the LNG market, since 2007, averaging 72%, compared to 28% for gas on gas competition.



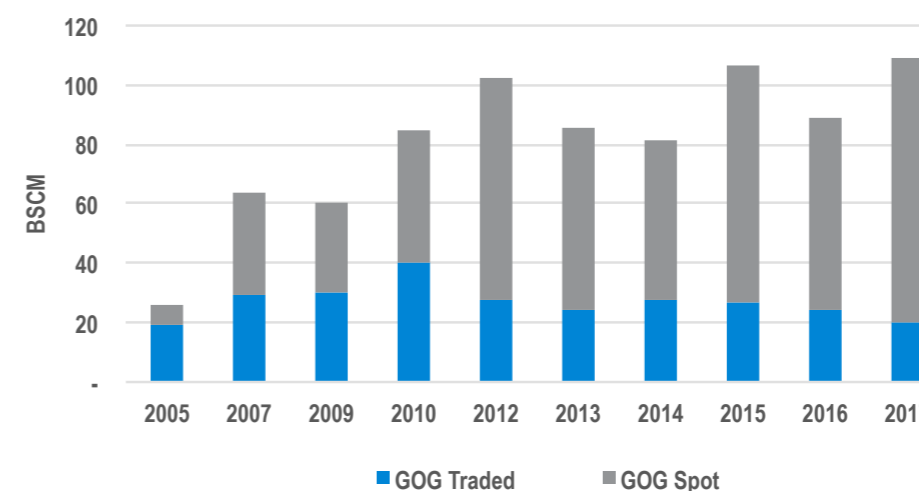
Figure 1.5 LNG Imports 2005 to 2017



The respective shares have fluctuated over the years as the LNG market grew, sometimes more oil indexed contracts sometimes more gas on gas competition. The gas on gas competition share can be divided into LNG going into traded markets such as the USA, in the early years, and European markets such as the UK, Belgium and Netherlands, and then spot LNG cargoes into the traditional LNG markets where oil indexed contracts dominate. The share of LNG trade going into traded markets has largely been in decline since 2010, while spot LNG gas been on the increase. The traded markets share has declined as less LNG went to the USA and then as Northwest Europe has taken less LNG. The increase in the gas on gas competition share in 2017 reflected the sharp rise in spot LNG more than offsetting the decline in LNG into Northwest Europe's traded markets.

The rise in gas on gas competition, driven by spot LNG, might be expected to continue as more flexible US LNG hits the market.

Figure 1.6 Spot and Traded Markets LNG 2005 to 2017



Wholesale prices, outside North America, rose pretty continuously between 2005 and 2014, declined in most regions in 2015 and 2016, before rebounding in 2017

Wholesale price levels, in most regions, reached their peak in 2013 or 2014. This rise was across all regions apart from North America, where the dramatic increase in shale gas supply has led to sharp falls in prices – with a small rebound in 2013. The rise in prices in Europe and Asia Pacific has been well documented and studied, but prices have also risen in Asia, largely due to increases in prices in China, both as more gas was imported and regulated domestic prices increased, and in India for similar reasons.

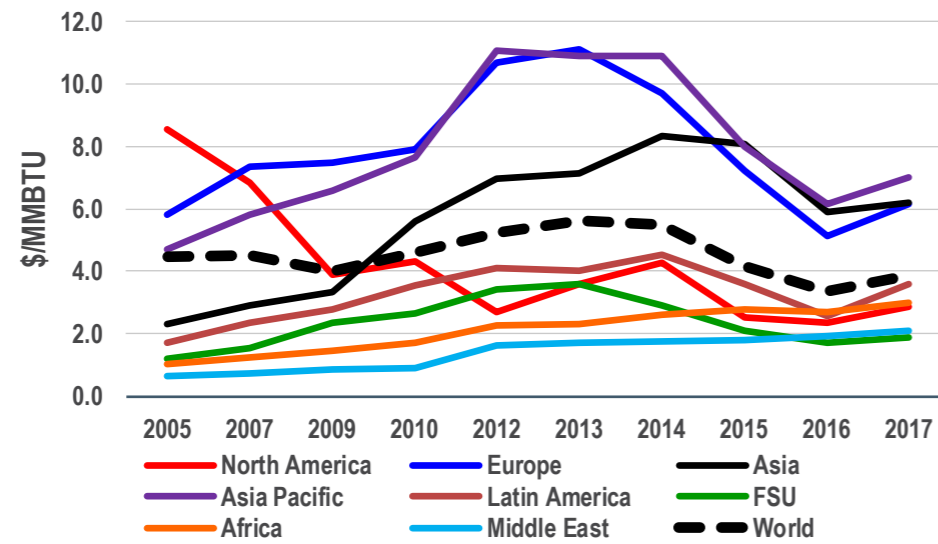
In 2014, though, prices in Europe began to decline as the market weakened and, in the FSU especially, as the rouble depreciated. This accelerated in 2015 and 2016, and prices also fell back in North America and Asia Pacific on the back of weak demand, abundant supply and the impact of the sharp fall in oil prices. However, some regions did not see the 2015 and 2016 fall in prices. These were Asia, as pricing reforms and inertia increased and kept prices up in China and India, the Middle East – as regulated prices were increased in Bahrain, Oman and Iran, with other prices staying stable – and Africa – where prices have increased in Egypt, Nigeria and more recently Algeria.

In 2016 Asia prices also declined as the delayed effects of the oil price decline impacted China prices and also the fall in spot prices affected the India domestic pricing formula. FSU prices declined further reflecting currency weakness, but Africa and Middle East prices continued to rise. Average wholesale prices at the world level were \$3.35 per MMBTU in 2016 which was the lowest level recorded in all the surveys.

2017 has seen prices rebounding back in all regions, but mainly in the areas of market pricing as oil prices increased and spot markets tightened. Prices also increased, however, in the more regulated regions such as the FSU, Africa and the Middle East, as authorities continued policies to increase prices to more market or economic levels. The average world wholesale price in 2017 was \$3.89 per MMBTU – higher than in 2016 but still below the average price in all other surveys.

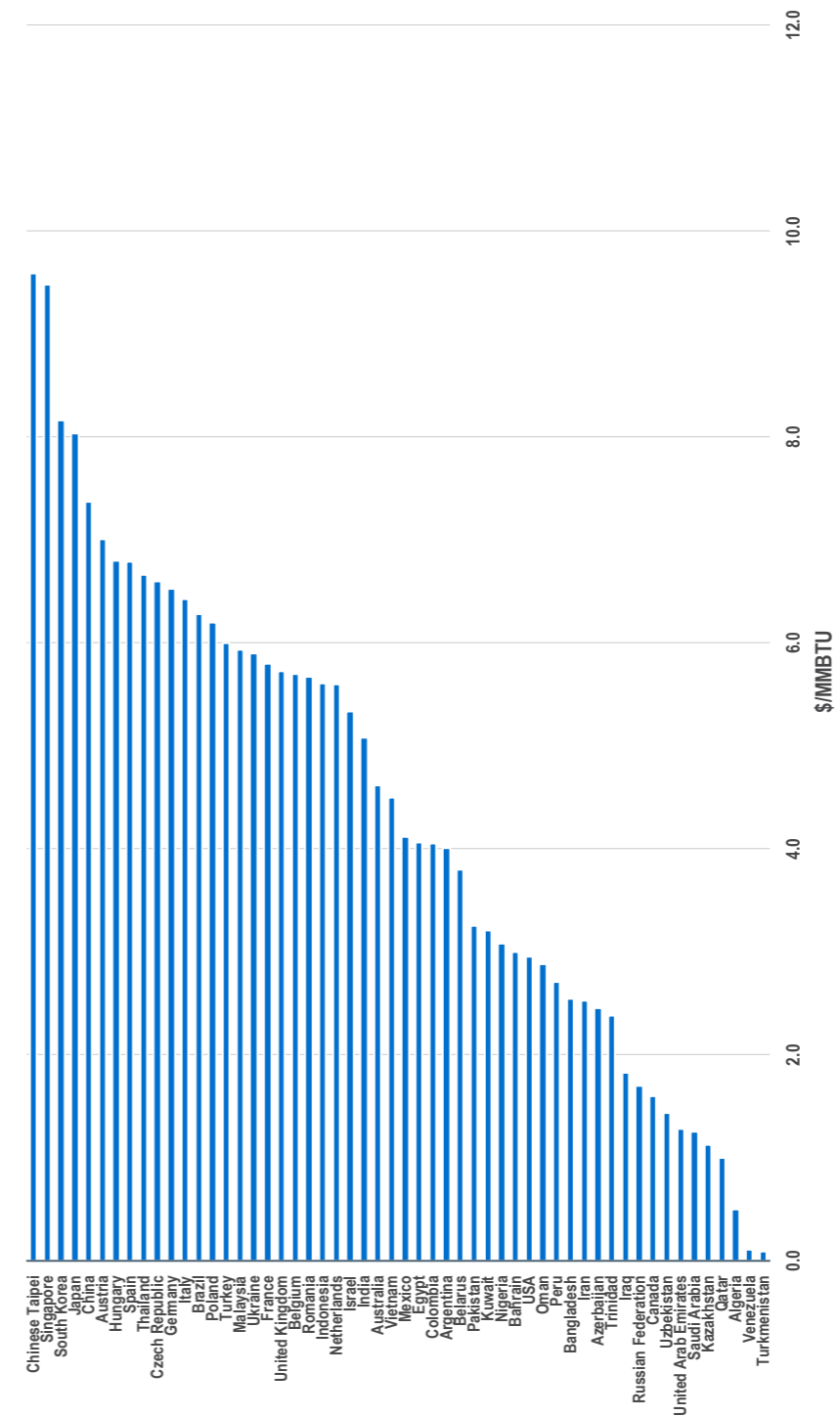


Figure 1.7 Wholesale Price Levels 2005 to 2017 by Region



The highest wholesale prices in 2017 were again found in the main LNG importing countries in Asia Pacific – South Korea, Japan and Chinese Taipei – plus Singapore and China. These were followed by some European countries and Thailand. In Northwest Europe countries, where gas on gas competition dominates, prices are somewhat lower than the rest of Europe, but still a lot higher than in the USA and Canada, where prices are even below those in Egypt, Nigeria, and some Middle East countries. Prices in India are now much lower as a result of the renegotiation of the Qatar contract and the price formula for some domestic gas. Prices in Russia have fallen well below other countries, which, in previous years, they had been above, as a consequence of the large rouble depreciation, although dollar prices were higher in 2017. At the bottom of the chart are generally countries where wholesale prices were subject to some form of regulation and often below the cost of production and transportation – Turkmenistan, Algeria and Venezuela.

Figure 1.8 Wholesale Price by Country 2017





Global gas prices have been converging over the period since 2005..

In the period 2005 to 2017, it is generally recognised that the global natural gas markets have become more integrated through increased LNG trade, increased market related pricing and gas hub development. It might be expected, therefore, that global gas prices would converge, as markets became more integrated. However, the conventional wisdom is that of global gas price divergence, based on a few regional gas price markers such as Henry Hub, NBP and Japanese import prices.

However, analysis, using the price survey data, shows that global gas prices have been converging continuously since 2005, indicating further globalisation of the gas markets. It is also concluded that there is more gas price convergence amongst countries (1) with market related pricing, (2) which are connected with the global gas market through gas imports, (3) with oil-indexed gas prices, and (4) within Europe.

The trend of global gas price convergence is more distinct when we exclude the data of the, effectively disconnected, North American countries. The pace of price convergence is even faster amongst countries with regulated gas prices than amongst countries with market related prices. This is an indication that prices in countries with regulated prices are getting more aligned with global gas prices, probably through the elimination of subsidies and the increase of prices to more economic levels.

2. Introduction

2.1 BACKGROUND

The 2017 IGU Wholesale Gas Price survey is the tenth to be undertaken in a series which began 12 years ago, at the start of the 2006 to 2009 triennium culminating in the World Gas Conference in Buenos Aires. Prior to the 2017 survey, previous surveys were undertaken for the years 2005, 2007, 2009, 2010, and then annually from 2012. The ten surveys have confirmed the significant changes in wholesale price formation mechanisms during a period of key developments and upheaval in the global gas market. In the 2017 survey responses were received for around 84 out of 112 countries, but these responses covered 92% of total world consumption. Data on the remaining countries, where responses were not received, was researched by members of the Gas Pricing Group⁵ and /or based on past responses.

2.2 TYPES OF PRICE FORMATION MECHANISMS

In preparation for the initial 2005 survey, a series of discussions were held at the PGCB meetings, in 2006 and early 2007, on the definition of different types of price formation. It was decided to use for categorisation purposes the wholesale pricing mechanisms described in Box 1.

In the discussion of regions, the IGU regional definitions are used and there is a map in the Appendix which shows the regions. A key point to note is that the Asia region is China and the Indian sub-continent and Asia Pacific is the rest of what is often called Asia.

2.3 REPORT LAYOUT

[Section 3](#) of the report covers the results at the World level of the 2017 survey for the different categories – domestic production, pipeline imports, LNG imports, total imports and total consumption. A comparison of the results across all ten surveys, at the World level, is then analysed to identify key trends, concluding with an analysis of changes in the GOG category.

[Section 4](#) of the report covers wholesale price levels including a discussion and analysis of the results of the 2017 survey, by region, price formation mechanism and country, and then comparisons over all ten surveys.

[Section 5](#) of the report contains an analysis of global gas price convergence over the ten surveys.

[Section 6](#) of the report looks at the individual regions (IGU definitions) results for the 2017 survey and comparisons across all ten surveys for the price formation mechanisms.

[Appendix A](#) describes the survey methodology, including the data collection method, the IGU regional definitions, the definitions of the price formation mechanisms and the analytical framework.

⁵ The Wholesale Gas Pricing Group began life as Sub Group 2 of PGCB and was chaired in the period leading up to the 2009 World Gas Conference by Runar Tjersland of Statoil and since 2009 by Mike Fulwood, formerly of Nexant, but now a Senior Research Fellow at the Oxford Institute for Energy Studies and a Fellow at the Center on Global Energy Policy at Columbia University. It is now part of the IGU's Strategy Committee and has been re-titled as the Gas Pricing Group.



BOX 1: TYPES OF PRICE FORMATION MECHANISMS

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 are spot LNG cargoes, 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. Usually 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.

3. World Results

3.1 INTRODUCTION

- This section covers the full results and analysis at the World level for wholesale price formation mechanisms and comprises three parts:
- Results for the 2017 survey at the World level for the different categories – domestic production, pipeline imports, LNG imports, total imports and total consumption;
- Comparisons and analysis of the results of the surveys from 2005 to 2017; and
- An analysis of changes in the gas-on-gas competition (GOG) category.

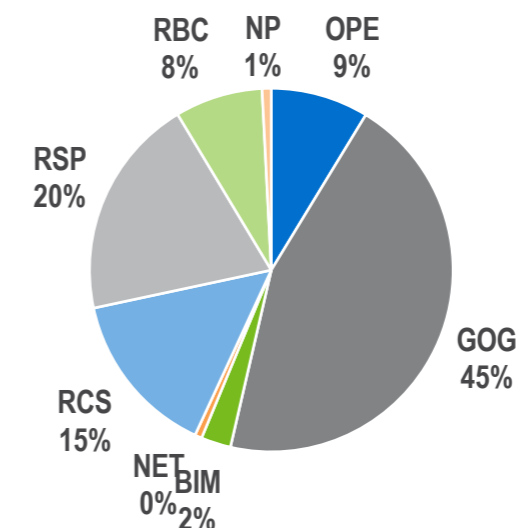
The results for previous surveys may, in some cases, appear slightly different from what has been published in previous reports. This reflects mostly revisions to IEA data on consumption, production, imports and exports but can also reflect retrospective changes to price formation classification when survey respondents have a better appreciation of the classification definitions as they reflect upon the results from the surveys overall.

3.2 2017 SURVEY RESULTS

3.2.1 DOMESTIC PRODUCTION

Domestic production in 2017 accounted for some 72% of total world consumption – around 2,680 bcm.

Figure 3.1 World Price Formation 2017 – Domestic Production





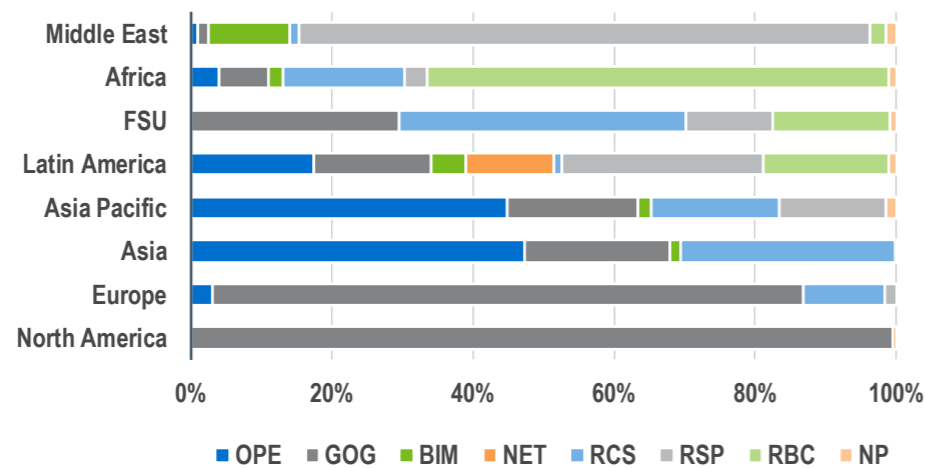
The percentage shares of the mechanisms for each region are shown in Figure 3.2 below.

GOG has the largest share in domestic production at 45%, totalling some 1,200 bcm, with North America accounting for 813 bcm – around two thirds of the total. The next largest share is in the Former Soviet Union, where the sales of gas in Russia to the large eligible customers by either Gazprom or the independent producers is classified as GOG (see the section on Former Soviet Union in the regional analysis for further discussion), accounting for some 180 bcm. The balance is in Europe at 88 bcm – principally the Netherlands and UK, Asia at 50 bcm – India and in 2017 China (see section on Asia in the regional analysis for further discussion), Asia Pacific at 34 bcm – Australia and New Zealand, and Latin America at 22 bcm – mainly Argentina and Colombia.

OPE has a relatively small share in domestic production at 9%, totalling some 233 bcm, with 115 bcm in Asia – China and Pakistan mainly, 82 bcm in Asia Pacific – Thailand, Indonesia, Vietnam, Philippines, Australia and Malaysia, 24 bcm in Latin America – Brazil and Colombia, 5 bcm in Africa, mainly Tunisia, the Middle East, in Israel, and Europe – small amounts in a few countries.

The regulated categories – RCS, RSP and RBC – in total account for 42% of domestic production, with RCS principally in the Former Soviet Union, Asia and Asia Pacific, RSP principally in the Middle East, Former Soviet Union, Latin America and Asia Pacific and RBC in the Former Soviet Union, Africa, Latin America and the Middle East. A more detailed breakdown of the regulated categories is contained in the regional analysis sections.

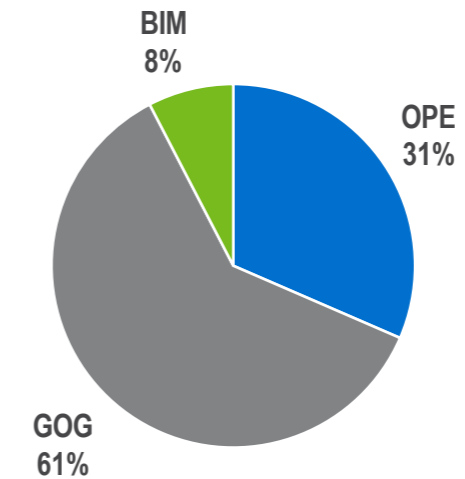
Figure 3.2 Regional Price Formation 2017 – Domestic Production



3.2.2 PIPELINE IMPORTS

Pipeline imports in 2017 accounted for some 18% of total world consumption – around 675 bcm⁶.

Figure 3.3 World Price Formation 2017 – Pipeline Imports



Pipeline imports are split between just three categories – OPE, GOG and BIM⁷. The regional breakdown is shown in figure 3.4 below.

GOG is over 60% of all pipeline imports, totalling some 411 bcm, with Europe at 273 bcm, North America 128 bcm and the Former Soviet Union 10 bcm (Ukraine imports from Europe). Most of the European gas importing countries, have some element of GOG pipeline imports with the top four countries being Germany, Italy, France and UK.

OPE is around 31% of all pipeline imports, totalling some 212 bcm, mostly in Europe with some 109 bcm – Turkey, Italy, Spain and Germany being the main contributors. Asia accounts for some 48 bcm – China, 22 bcm in Asia Pacific – Thailand, Singapore and Malaysia, and 16 bcm in Latin America – mainly Brazil and Argentina. There are also small quantities in other regions, apart from North America, including countries such as Russia, Iran and Tunisia.

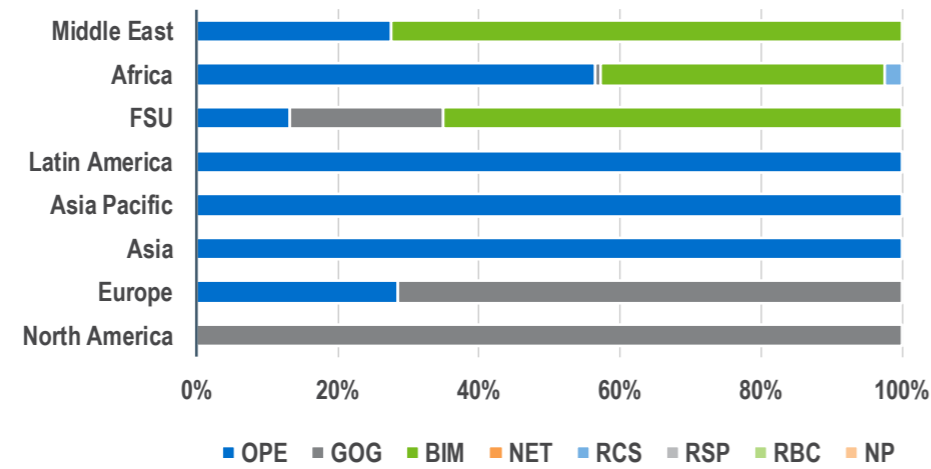
BIM has the balance of 8%, totalling some 52 bcm. This is mainly in the Former Soviet Union and the Middle East with just two routes – Russia to Belarus and Qatar to the UAE – comprising most of it.

⁶ This figure represents the total effective net pipeline imports for all countries. Many countries will produce gas and import by pipeline and LNG and also export by pipeline from the “pool” of all sources of supply. Gross pipeline imports in total in 2017 were almost 785 bcm so effectively 110 bcm was “re-exported” by pipeline.

⁷ There is a very small amount of RCS in Africa reflecting the regulated transportation tariff element of pipeline gas from Nigeria to Ghana.



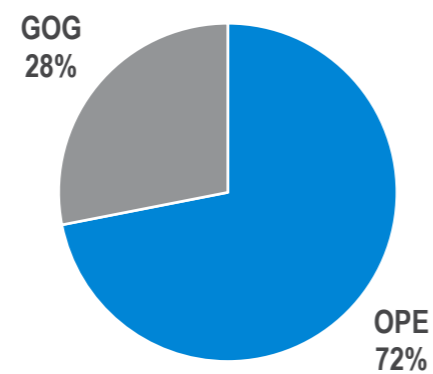
Figure 3.4 Regional Price Formation 2017 – Pipeline Imports



3.2.3 LNG IMPORTS

LNG imports in 2017 accounted for some 10% of total world consumption – around 390 bcm⁸.

Figure 3.5 World Price Formation 2017 – LNG Imports



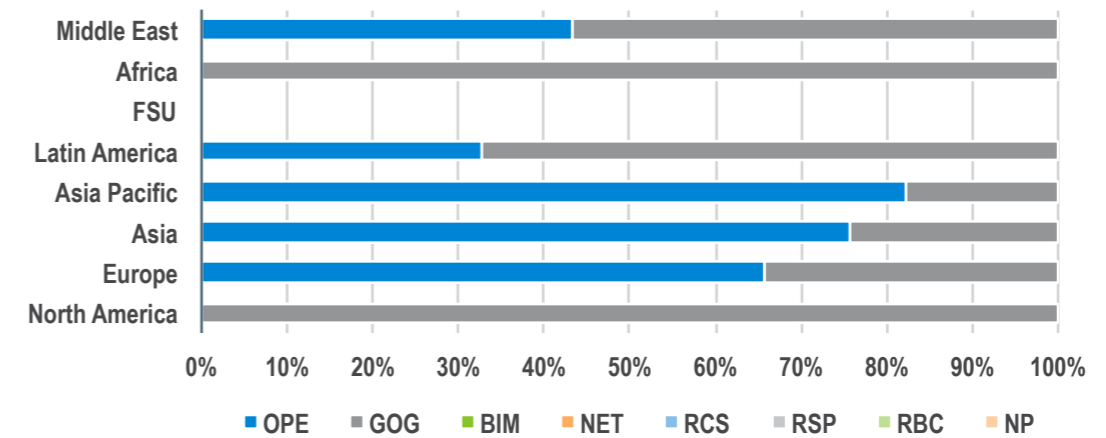
LNG imports are split 72% OPE and 28% GOG. The regional breakdown is shown in Figure 3.6 below.

OPE at some 280 bcm is mostly Asia Pacific – Japan, Korea and Chinese Taipei, followed by Asia – China and India – and Europe – mainly Spain, Turkey, France and Italy.

⁸ As for pipeline imports, the figure represents total effective net LNG imports for all countries. Gross LNG imports (net of re-exported LNG) were some 397 bcm in 2017, with around 7 bcm being regasified and re-exported as pipeline gas.

GOG totals some 109 bcm and can be divided into imports into North America and countries such as the UK, Belgium and Netherlands, where the domestic market pricing mechanism is GOG, and all other countries which are importing spot and short term priced LNG cargoes, which is almost every other LNG importing country – Japan taking the largest volume – but also includes countries like China, India, Egypt, Korea, Turkey, Argentina and Brazil.

Figure 3.6 Regional Price Formation 2017 – LNG Imports

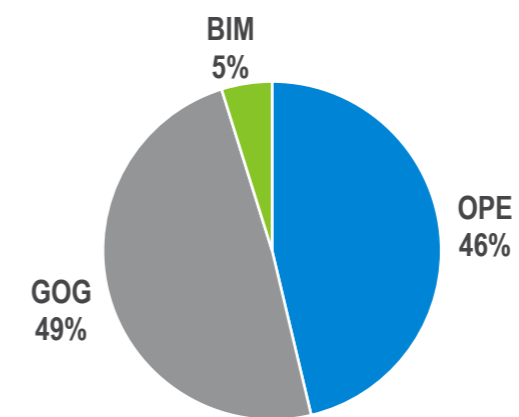


3.2.4 TOTAL IMPORTS

Total imports in 2017 accounted for some 28% of total world consumption – 1,065 bcm.

Total imports are the sum of pipeline and LNG imports and comprise the three categories of GOG (49%), OPE (47%) and BIM (5%).

Figure 3.7 World Price Formation 2017 – Total Imports





The table below shows the regional and category breakdown in volume terms.

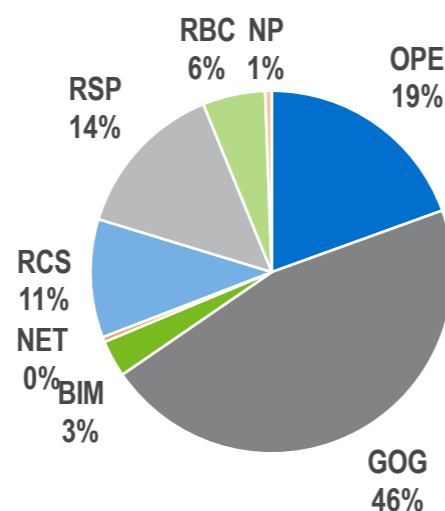
Table 3.1 World Price Formation 2017 – Total Imports

REGION	TOTAL IMPORTS			
	OPE	GOG	BIM	TOT
NORTH AMERICA	0.0	135.1	0.0	135.1
EUROPE	151.0	295.3	0.0	446.3
ASIA	108.6	19.5	0.0	128.1
ASIA PACIFIC	189.1	36.4	0.0	225.5
LATIN AMERICA	20.4	9	0.0	29.4
FSU	6.1	10.0	29.9	46.0
AFRICA	6.0	8.4	4.3	18.9
MIDDLE EAST	11.8	6.9	17.3	36
TOTAL	492.9	520.6	51.5	1065.2

3.2.5 TOTAL CONSUMPTION

Total consumption in 2017 was around 3,740 bcm.

Figure 3.8 World Price Formation 2017 – Total Consumption



GOG has the largest share at 46%, totalling around 1,720 bcm, dominated by North America at 949 bcm, followed by Europe at some 383 bcm and the Former Soviet Union at 190 bcm. In all GOG can now be found in some 54 countries, in one form or another, and in all regions.

The OPE share at 19%, totals around 729 bcm and is predominantly Asia Pacific (270 bcm), Asia (228 bcm) and Europe (154 bcm). OPE is widespread being found in some 59 countries, including most countries in Europe, and in all regions except North America.

The regulated categories – RCS, RSP and RBC – account in total for some 31%, around 1,133 bcm:

- RCS totals some 395 bcm and is in 17 countries, mainly the Former Soviet Union (Russia) and Asia (China and Bangladesh), followed by Asia Pacific (Malaysia) and Africa (Egypt and Nigeria);
- RSP totals some 529 bcm and is in 23 countries, with the Middle East dominating – Iran, Saudi Arabia, UAE and Oman – followed by the Former Soviet Union – Russia – and Latin America – mainly Argentina, with some in Asia Pacific – Indonesia;
- RBC totals some 209 bcm and is in 13 countries, mainly the Former Soviet Union – Kazakhstan, Turkmenistan and Uzbekistan, Africa – Egypt and Algeria – and Latin America – Venezuela.

The BIM share at 3% totals some 122 bcm and is in 22 countries, predominantly Middle East – Qatar, UAE and Israel, and the Former Soviet Union – largely Belarus.

The NET share at less than 1% totals some 17 bcm in just 1 country – Trinidad.

The NP share at 1% totals some 22 bcm in 9 countries, largely Mexico, Turkmenistan, Kuwait, and Brunei, where it is used in the energy industry in refining processes or enhanced oil recovery.

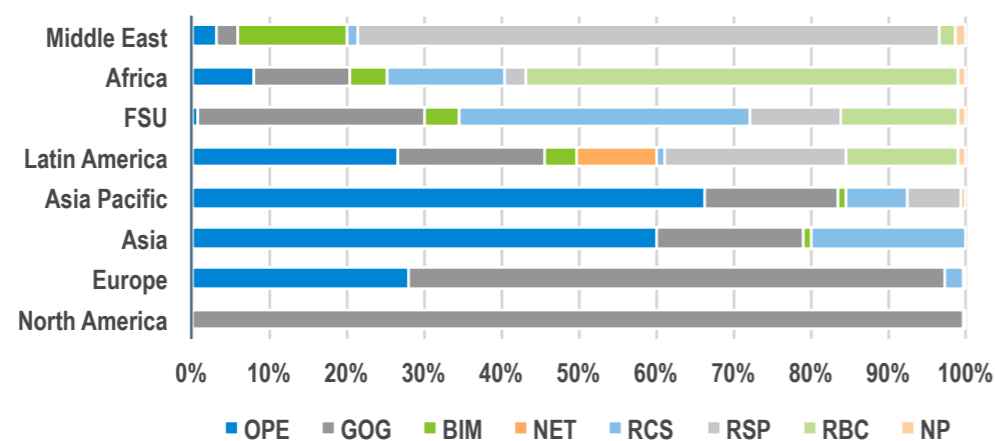


The table below shows the regional and category breakdown for total world consumption and figure 3.9 the regional breakdown in percentage terms.

Table 3.2 World Price Formation 2017 – Total Consumption

TOTAL CONSUMPTION										
REGION	OPE	GOG	BIM	NET	RCS	RSP	RBC	NP	NK	TOT
NORTH AMERICA	0.0	948.5	0.0	0.0	0.0	0.0	0.0	4.0	0.0	952.5
EUROPE	154.2	383.0	0.0	0.0	12.1	1.8	0.0	0.0	0.0	551.0
ASIA	223.9	69.9	3.8	0.0	74.5	0.2	0.0	0.0	0.0	372.2
ASIA PACIFIC	270.6	70.3	3.4	0.0	33.1	27.3	0.0	2.8	0.0	407.5
LATIN AMERICA	44.2	31.5	6.8	16.8	1.6	39.0	24.1	1.4	0.0	165.5
FSU	6.1	190.6	29.9	0.0	247.9	75.0	100.8	5.7	0.0	655.9
AFRICA	10.5	16.3	6.4	0.0	19.8	3.6	73.5	1.2	0.0	131.4
MIDDLE EAST	16.7	13.4	72.2	0.0	6.5	381.7	10.6	6.7	0.0	507.9
TOTAL	726.2	1,723.4	122.5	16.8	395.4	528.6	209.1	21.8	0.0	3,743.8

Figure 3.9 Regional Price Formation 2017 – Total Consumption



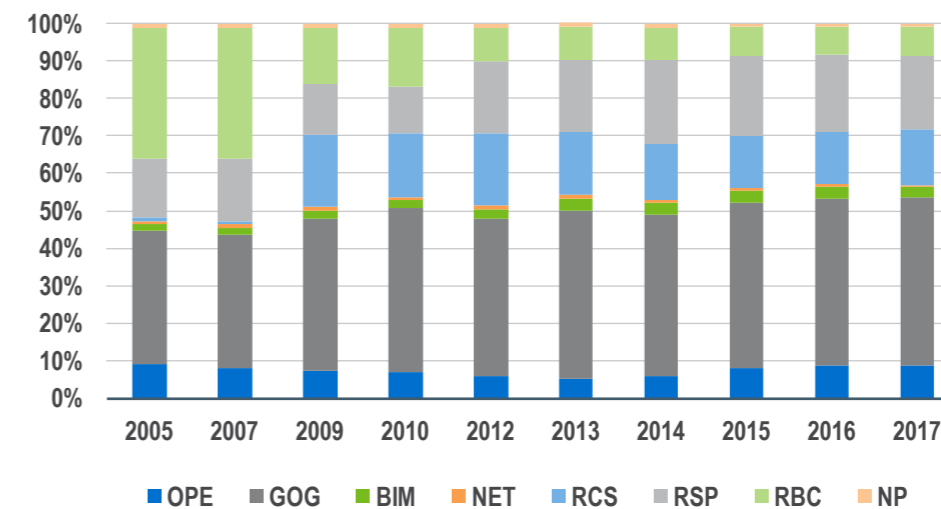
3.3 WORLD LEVEL COMPARISONS 2005 TO 2017

3.3.1 DOMESTIC PRODUCTION

The main changes in price formation over the nine surveys have been the general rise in GOG from 35% in 2005 to 45% in 2017. The share rose marginally in 2017, as the GOG share rose again in Europe and Asia. The OPE category is not particularly large in terms of domestic production and was broadly unchanged in 2017 as the decline in Asia, as part of China domestic production switched to GOG, offset by a rise in Asia Pacific in Malaysia – both these changes are discussed further in the regional section.

Over the period as a whole, GOG has gained share from the three regulated categories which in 2005 totalled some 52% compared to 42% in 2017. Half of this occurred in 2009 and 2010 when the GOG category increased in Russia at the expense of the regulated categories, as the market began to open up to independents more, and there was more effective competition between the independents and Gazprom for power sector and industrial customers. This was followed by the changes in India in 2015, as regulated pricing was replaced with a formula linked to international, predominantly hub, prices for key sectors, and China as pricing became more market-related. There has also been an increase in GOG in Latin America as well, principally in 2009.

Figure 3.10 World Price Formation 2005 to 2017 – Domestic Production



Within the regulated categories, there have been two main changes, in 2009 when Russia changed from RBC to RCS as prices were finally increased above the cost of production and transportation, and in 2012 when Iran increased prices sharply to move from RBC to RSP. RSP increased again in 2014 as prices to the population in Russia was switched away from RCS. IN 2017, there was also a change in Malaysia, away from RSP to RCS.

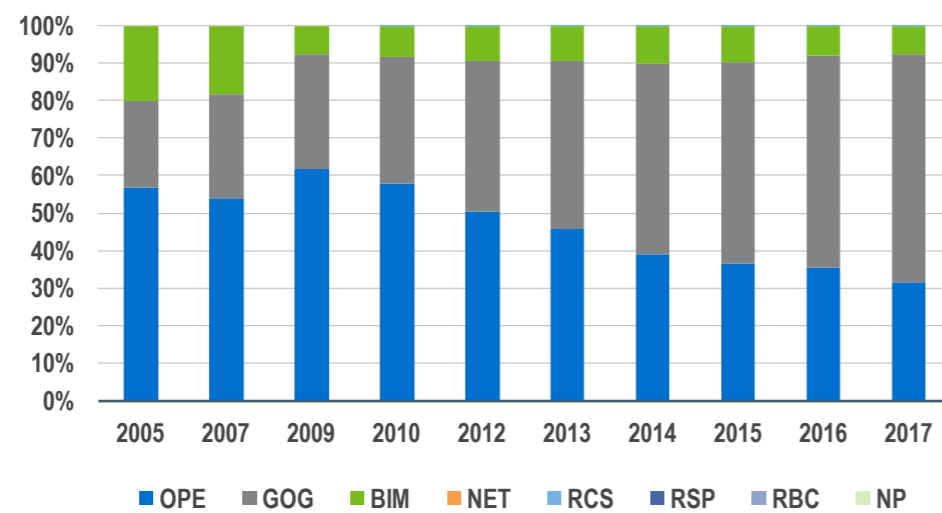


3.3.2 PIPELINE IMPORTS

The main changes in the nine surveys from 2005 to 2017 are the continued rise in GOG from 23% in 2005 to 61% in 2017, which has been at the expense of the OPE category. The decline in OPE was partly offset by a switch from BIM to OPE in intra-FSU trade in 2009, and more recently the imports of pipeline gas from Turkmenistan to China, and in 2016, the change in one of the gas contracts from Russia to Turkey. In 2017, however, the OPE share fell back again in Europe and the Former Soviet Union, as Ukraine switched to importing hub-price gas from Europe instead of oil-indexed gas from Russia.

The rise in GOG at the expense of OPE has been entirely in the European market, up until the Ukraine change in 2017, as the Northwest Europe countries began switching to GOG and more recently the Central Europe countries and, in 2014 and 2017, Italy. In respect of pipeline imports into Europe GOG in 2017 has a 71% share compared to 29% for OPE. This is in marked contrast to 2005 when it was 91% OPE and only 7% GOG.

Figure 3.11 World Price Formation 2005 to 2017 – Pipeline Imports



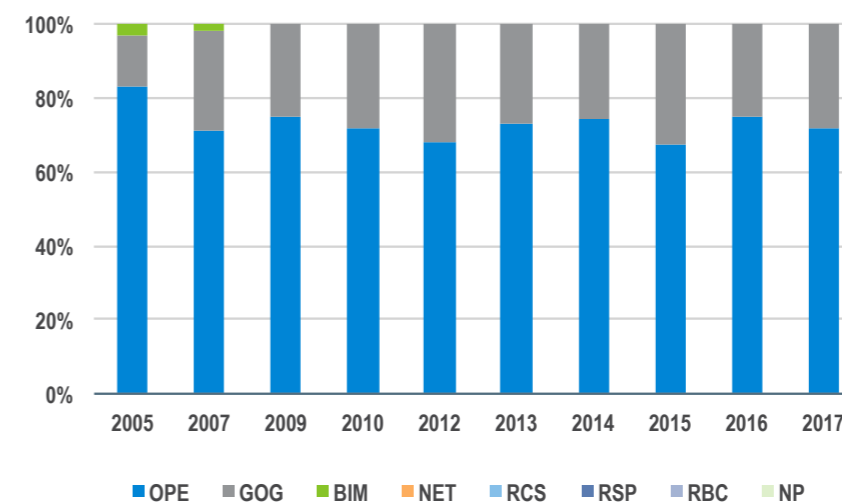
3.3.3 LNG IMPORTS

The main changes in the nine surveys from 2005 to 2017 are a rise in GOG from just over 13% in 2005 to 32% in 2012, which was largely at the expense of the OPE category, before it fell back in 2014 to 25%. In 2015 there was a recovery back to a 32% share, a fall in 2016 to 25%, before rising to 28% in 2017.

There was a significant increase in GOG between 2005 and 2007, which was principally due to a rise in spot LNG imports in Asia and Asia Pacific and a smaller rise in North American imports. Since 2007, there have been offsetting changes with North American LNG imports – which are all GOG – declining, European imports, principally to the UK increasing in 2009 and 2010 and relatively stability in Asia and Asia Pacific spot LNG imports. In 2012, as Europe’s LNG imports declined, these were more than offset in the GOG category by rising spot LNG imports in Asia and Asia Pacific. The decline in 2013 reflected the fall in the share of spot LNG imports and a decline in LNG imports into the UK, the USA and Canada. The further small decline in 2014 was principally due to lower spot LNG cargoes in Asia and Asia Pacific, with correspondingly higher OPE under long term contracts. The rebound in 2015 was largely due to more spot LNG cargoes in all markets but especially Japan and the new markets, as the fall in spot LNG prices preceded the decline in oil-linked contract prices. In 2016, the decline in GOG was a consequence of LNG trade becoming more contracted, with fewer spot LNG cargoes, which benefitted OPE. In 2017 this was reversed as spot LNG cargoes increased, in part due to the rise in Henry Hub priced US LNG exports.

The BIM category in 2005 and 2007 was the Qatar to India LNG contract which subsequently switched to OPE.

Figure 3.12 World Price Formation 2005 to 2017 – LNG Imports



The GOG share is comprised of LNG going to the traded markets of North America and in Europe the UK, Belgium and Netherlands, and spot LNG cargoes to the “traditional” LNG markets in Asia Pacific and Europe and some of the newer markets.



Figure 3.13 GOG LNG Imports 2005 to 2017

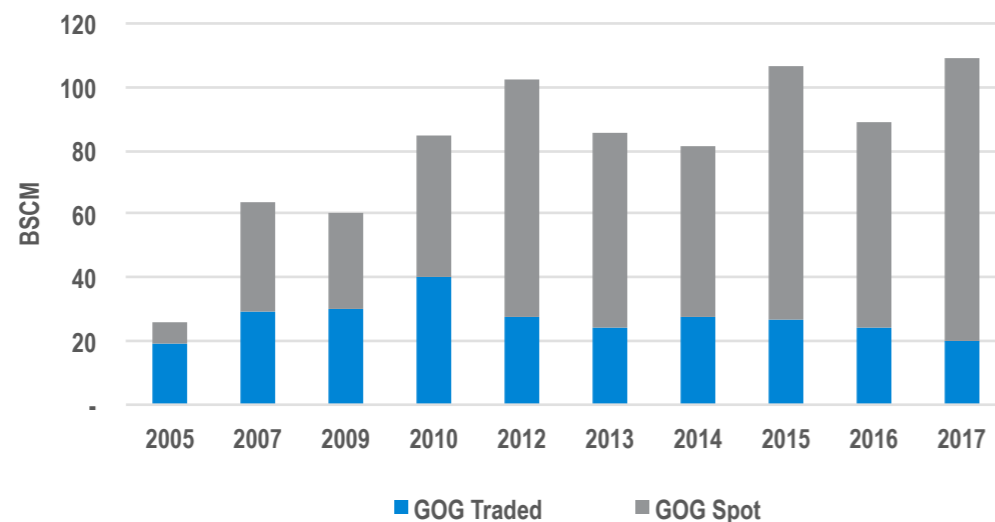
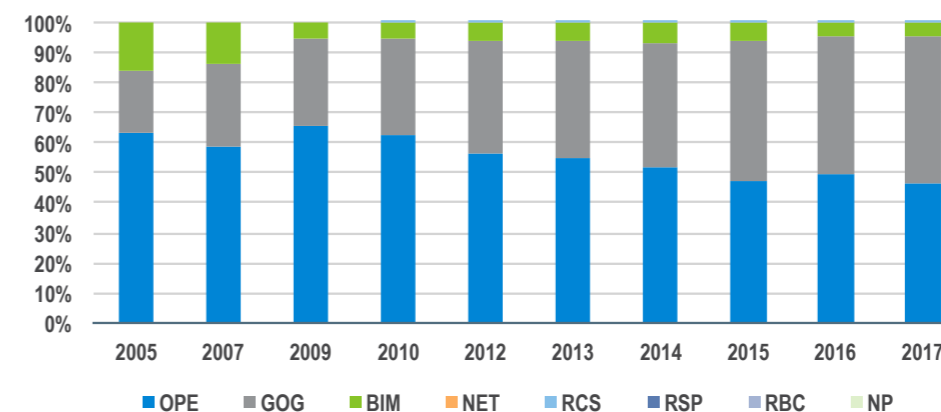


Figure 3.14 World Price Formation 2005 to 2017 – Total Imports



The volume of LNG going to the traded markets has been in decline since 2010, with the decline in US LNG imports, and from 2014 and 2015 as UK imports declined. In contrast, spot LNG cargoes have increased, especially in 2017 in Asia Pacific, Asia and parts of Europe plus the newer LNG importing countries in the Middle East.

3.3.4 TOTAL IMPORTS

Total imports are the sum of pipeline imports and LNG imports and have only comprised three categories – OPE, GOG and BIM – in all nine surveys from 2005 to 2017⁹. As well as the figure the table below shows the volume breakdown. OPE declined from 63% in 2005 to 59% in 2007 as GOG rose from just over 21% to 28% and then in 2009, OPE gained share rising to 66% as BIM fell from 14% to 6%, with GOG rising to 29%. Since then OPE has lost share by around 20 percentage points and GOG gained a similar share, in large part due to pipeline imports in Europe.

⁹ Apart from the very small RCS on the Nigeria to Ghana pipeline since 2010

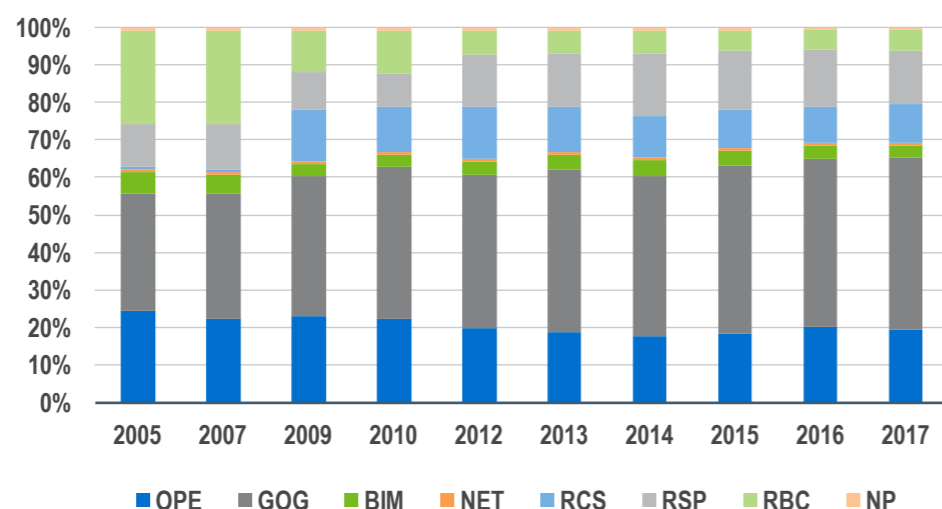
Table 3.3 World Price Formation 2005 to 2017 – Total Imports BCM

WORLD	TOTAL IMPORTS			TOT
	OPE	GOG	BIM	
2005	505.8	165.9	128.4	800.1
2007	503.0	236.8	117.9	857.7
2009	541.4	235.8	45.1	822.3
2010	574.4	297.2	52.4	924.2
2012	534.9	357.2	58.5	950.9
2013	525.9	371.6	60.5	958.2
2014	471.3	384.2	60.1	916.0
2015	446.1	437.4	58.9	942.9
2016	496.2	461.5	50.0	1007.8
2017	492.9	520.6	51.5	1065.2

3.3.5 TOTAL CONSUMPTION

The figure below shows the changes in the price formation mechanisms over the nine surveys from 2005 to 2017.

Figure 3.15 World Price Formation 2005 to 2017 – Total Consumption



The changes between each survey can be summarised as follows:

- Between 2005 and 2007, GOG increased its share by some 2 percentage points and OPE decreased by 2 percentage points reflecting faster growth in consumption in North America than most other regions, a switch from OPE to GOG in Europe, and to a lesser extent in Asia Pacific and Asia, and a very small move from regulated pricing to GOG in Russia and Latin America. RSP also increased its share by half a percentage point reflecting more rapid growth in consumption in the RSP countries;
- Between 2007 and 2009, GOG increased its share by a further 4 percentage points, at a time when total world consumption showed little change, mainly because of the change in Russia from RBC to GOG but also because of the continuing switch from OPE to GOG in Europe. OPE actually gained 1 percentage point with the loss in share in Europe being more than offset by a switch from BIM, which lost 2 percentage points overall, to OPE in intra-FSU trade. The other major change was the decline of 14 percentage points in RBC and a similar gain in RCS, mainly in Russia, but RCS also gained at the expenses of RSP, which lost almost 2 percentage points, as China's domestic production changed categories as prices increased as a consequence of regulatory change;
- Between 2009 and 2010, GOG increased its share by another 3 percentage points, with the continuing switch from OPE to GOG in Europe and further move in Russia away from RCS to GOG. OPE declined by half a percentage point with losses in share in Europe being partly offset by gains in shares in Asia, as China began importing pipeline gas and more LNG under contract, and Asia Pacific on the back of rapid growth in demand in Korea, Taiwan and Thailand;
- Between 2010 and 2012, GOG increased its share by just under half a percentage point, rising to just under 41%, with the continuing increase in share in Europe away from OPE,

and more spot LNG imports in Asia and Asia Pacific, being partly offset by a decline in share in Russia. OPE declined by 2.5 percentage points, based on the switch to GOG in Europe (and to BIM in Turkey, as a contract changed) coupled with declining European demand, only partly offset by a rising share in pipeline imports in China. RCS increased its share by 1.5 percentage points, principally in Russia but also as demand grew sharply in China. RSP increased its share by almost 5 percentage points, principally due to the change in pricing in Iran and rising demand in Saudi Arabia. RBC declined by a similar amount, reflecting the Iran pricing change.

- Between 2012 and 2013, GOG increased its share by over 2 percentage points, gaining from OPE as pricing mechanisms continued to switch in Europe, and from RCS in Russia as the independent producers recovered market share. OPE declined by another 1 percentage point reflecting the changes in Europe, partly offset by a small gain in the LNG import segment with spot LNG trade declining, and in China with the new pricing regime in two provinces. RCS declined by 1.5 percentage points, largely reflecting the change in Russia towards GOG and in China to OPE. The BIM category regained almost half a percentage point in share reflecting domestic production growth in Qatar.
- Between 2013 and 2014, the GOG share declined marginally as the continued switch away from OPE in Europe and more rapid consumption growth in North America was offset by a decline in the share of GOG in Russia towards regulated pricing, and fewer spot LNG cargoes. OPE was down by another 1 percentage point reflecting the changes in Europe, partly offset by an increase in China. RCS was down by 1 percentage point largely as a result of the switch to RSP in Russia and the RSP category was up by almost 2.5 percentage points, reflecting the Russia switch but also a change in Nigeria as well, away from RBC, coupled with more rapid consumption growth in RSP countries. RBC was unchanged, with the decline in Nigeria, being offset by rising consumption on Kazakhstan, Turkmenistan and Uzbekistan.
- Between 2014 and 2015, the GOG share increased by just under 1.5 percentage points reflecting rising gas consumption in North America and Europe, together with the continuing move away from OPE in Europe, the change in pricing in India and more spot LNG, partly offset by a decline in Australia as OPE netback contracts began to be introduced. OPE's share increased by just under half a percentage point, with the decline in Europe and lower share of LNG imports being more than offset by the change in the domestic pricing mechanism in China. The RCS share declined by just under 1 percentage point reflecting the changes in China, partly offset by moves to RCS in Egypt and Nigeria. RSP was down by 1 percentage point, principally reflecting the changes in pricing in India and Nigeria. RBC was lower by almost 1 percentage point, reflecting moves away in Bangladesh and partially in Egypt.
- Between 2015 and 2016, the GOG share rose by just under 1 percentage point, with an increase in the share in Europe and the Former Soviet Union, together with growing consumption in North America, being partly offset by declines in Asia and Asia Pacific, reflecting fewer pure spot LNG cargoes. The OPE share increased by 2 percentage points, reflecting a small rise in Europe at the expense of BIM (in Turkey), but principally in Asia and Asia Pacific, as the share in LNG imports increased, but also reflecting a rise in domestic production in China, as the full year effect of the change in city-gate pricing came through. The RCS share declined by a quarter of a percentage point, principally reflecting the changes in China, partly offset by a rise in Iran in gas as a feedstock to petrochemicals, and faster consumption growth in some countries with RCS pricing. The RSP share was down by a quarter of a percentage point as a result of declines in the Middle East – Iran – and the FSU, principally in Russia with switching to GOG and RCS. The RBC share was down very slightly on slower consumption growth.

- Between 2016 and 2017, the GOG share increased by 1 percentage point as a result of a continuing rise in Europe, at the expense of OPE, the rise in Asia as China introduced market pricing for direct sales from upstream producers to large users, the general recovery in spot LNG cargoes and the switch in Ukraine to imports of hub-priced gas from Europe. The OPE share declined by half a percentage point, with the losses to GOG being partly offset by an increase in Asia Pacific, mainly in Malaysia and Indonesia. The BIM share was down almost half a percentage point reflecting the switch in Indonesia to OPE. The RCS share increased by over half a percentage point, largely as a result of the change in Malaysia away from RSP, which was down almost 1 percentage point. RBC had a small quarter of a percentage point rise, reflecting consumption growth in the Former Soviet Union and more below cost pricing to power in Egypt.

Overall over the 2005 to 2017 period, OPE has declined by 5 percentage points, GOG has risen by almost 15 percentage points, BIM has declined by 2.5 percentage points, RCS has risen by 10 percentage points, RSP risen by 3 percentage points and RBC declined by 19.5 percentage points.

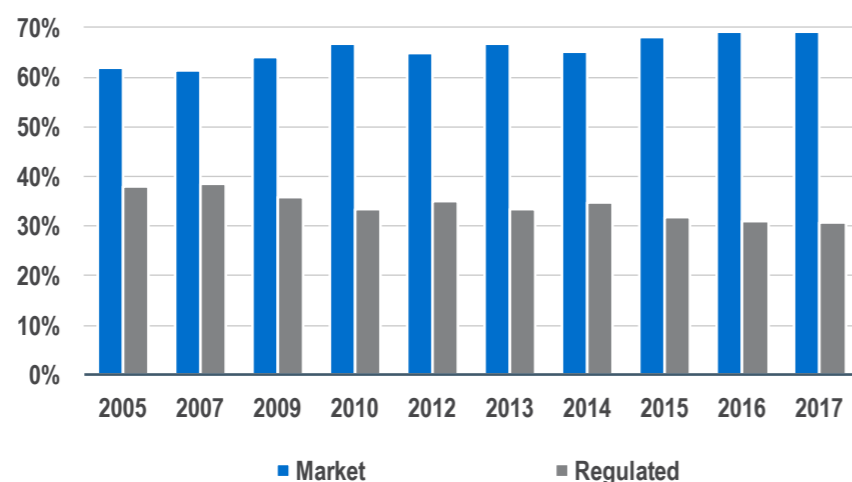
Table 3.4 World Price Formation 2005 to 2017 – Total Consumption BCM and %ages

WORLD	TOTAL CONSUMPTION								
	OPE	GOG	BIM	NET	RCS	RSP	RBC	NP	TOT
2005	696.3	891.4	166.9	16.7	22.7	323.4	716.2	23.1	2856.5
2007	679.2	1019.1	158.6	19.5	22.2	364.3	766.5	26.3	3055.8
2009	710.0	1143.6	93.7	19.4	431.4	309.0	333.7	26.3	3067.1
2010	743.8	1342.5	102.3	22.8	402.8	300.5	377.3	28.1	3320.1
2012	679.0	1413.0	123.7	24.2	476.9	482.2	227.1	27.0	3453.0
2013	659.4	1512.0	142.8	20.3	424.9	494.1	220.3	27.0	3500.9
2014	620.9	1504.2	145.3	20.1	390.3	584.2	220.7	28.4	3514.1
2015	652.4	1587.6	145.5	19.5	365.4	554.8	197.0	26.8	3549.0
2016	731.2	1634.5	133.5	18.5	361.4	548.8	192.3	23.6	3643.7
2017	726.2	1723.4	122.5	16.8	395.4	528.6	209.1	21.8	3743.8
2005	24.4%	31.2%	5.8%	0.6%	0.8%	11.3%	25.1%	0.8%	100.0%
2007	22.2%	33.4%	5.2%	0.6%	0.7%	11.9%	25.1%	0.9%	100.0%
2009	23.1%	37.3%	3.1%	0.6%	14.1%	10.1%	10.9%	0.9%	100.0%
2010	22.4%	40.4%	3.1%	0.7%	12.1%	9.1%	11.4%	0.8%	100.0%
2012	19.7%	40.9%	3.6%	0.7%	13.8%	14.0%	6.6%	0.8%	100.0%
2013	18.8%	43.2%	4.1%	0.6%	12.1%	14.1%	6.3%	0.8%	100.0%
2014	17.7%	42.8%	4.1%	0.6%	11.1%	16.6%	6.3%	0.8%	100.0%
2015	18.4%	44.7%	4.1%	0.6%	10.3%	15.6%	5.6%	0.8%	100.0%
2016	20.1%	44.9%	3.7%	0.5%	9.9%	15.1%	5.3%	0.6%	100.0%
2017	19.4%	46%	3.3%	0.4%	10.6%	14.1%	5.6%	0.6%	100.0%



While there have been a number of significant changes over the period of the surveys between the 8 categories, as described above, the changes have been almost wholly within larger groupings of categories, until very recently. The categories of OPE, GOG, BIM and NET can be broadly described as “market” pricing, while the categories of RCS, RSP, RBC and NP can be broadly described as “regulated” pricing. The figure below compares the changes in the “market” and “regulated” categories over the ten surveys.

Figure 3.16 Market and Regulated Pricing 2005 to 2017



The total of “market” pricing rose from 62% in 2005 to 69% in 2017, mirrored by a decline in “regulated” pricing, from 38% in 2005 to 31% in 2017. Changes in percentages between surveys can arise because of actual changes in price formation mechanism or because of more rapid growth in consumption in countries with a specific type of price formation mechanism. The switch to “market” pricing is down to the following:

- The move away from regulated pricing in the Russian market to GOG as the independent producers began to compete with each other and Gazprom to sell gas to the power sector and large industrials – this was partly reversed in 2014 with more “regulated” pricing;
- A similar move in Argentina, to GOG, as the eligible market opened up, and more recently in Nigeria;
- The recent changes, since 2013, in China where there was initially a move to OPE in 2 provinces away from RCS which in 2014 became nationwide for incremental production over 2012 levels and then in 2015 for all sectors except residential and fertilizers – some of this OPE in 2017 switched to GOG;
- The pricing reforms in India, which began in late 2014, moving pricing away from RSP to GOG; and
- The rise in new LNG importers, importing at OPE and/or GOG, to enhance or replace domestic production which was regulated.

3.4 ANALYSIS OF CHANGES IN GAS-ON-GAS COMPETITION

The rise in GOG from 31% of total world consumption in 2005 to 46% in 2017 and in which regions, has been discussed in some detail above. It has been noted earlier that GOG is not one homogeneous category and can be considered to comprise the following types of pricing mechanisms:

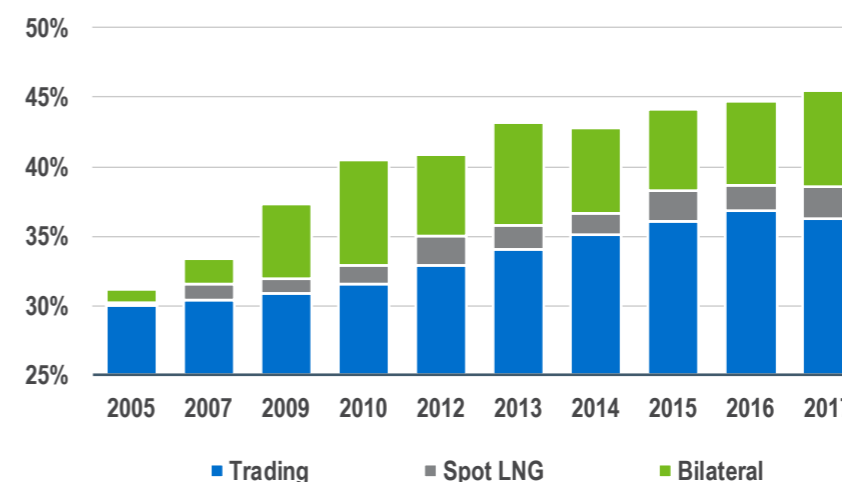
Trading – what is generally thought of as GOG where the price is determined by the interplay of supply and demand and is traded over a variety of different periods (daily, monthly, annually or other periods). Trading takes place at physical hubs (e.g. Henry Hub) or notional hubs (e.g. NBP in the UK). This will also include longer term contracts where the price is linked to hub prices in markets where there is hub trading.

Bilateral – there is no trading market or hub but there are multiple buyers and sellers – distinguishing this from BIM – providing the competitive element. This is largely in Australia, Russia, Argentina and now China.

Spot LNG – simply spot LNG cargoes into markets where there are no trading hubs, but the price of the cargoes reflects the current supply-demand situation.

The figure below breaks down the GOG percentages over the ten surveys into these 3 categories.

Figure 3.17 Changes in GOG by Type 2005 to 2017¹⁰



The Trading category is by far the largest – dominated by North America and increasingly Europe – and has increased from 30% of total world consumption in 2005 to 36.3% in 2017 – a rise of just over 6 percentage points. The Bilateral category has risen from 0.9% to 7% – a rise of 6 percentage points, while the Spot LNG category has risen from 0.2% to 2.3% – a rise of 2 percentage points. The total rise in GOG between 2005 and 2017 has been 14.7 percentage points. For the first time the Trading category share actually declined in 2017, with the continuing switch in Europe away from OPE, being offset by lower consumption in North America. The rise in GOG being driven by the rise in the Bilateral and Spot LNG categories.

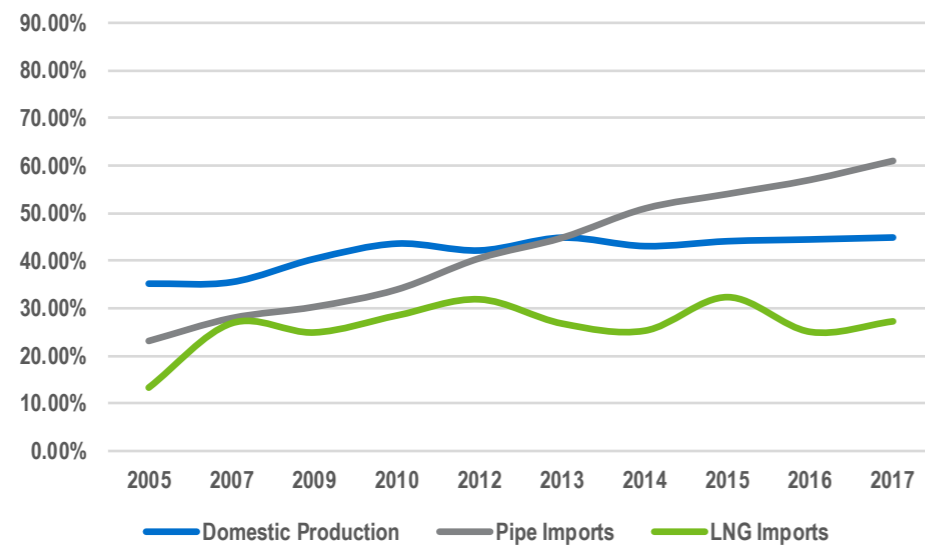
¹⁰ In order to emphasise changes the vertical axis starts at 25%



Well over one third of the rise in GOG has come from the Bilateral category and is largely in Russia together with much smaller changes, in volume terms, in Argentina and, latterly, Nigeria and Chin. The rise in the Trading category is almost entirely due to changes in the European market, both in terms of increased trading volumes and contract renegotiations, although at the end of 2014 indexation to hub prices in India, away from RSP for domestic production, also increased the Trading category. The changes in the Spot LNG category have been variable over time reaching a peak of 2.2% in 2012 before falling back in 2013 and 2014 as the number of spot LNG cargoes declined. The share then rebounded in 2015, as spot LNG cargoes recovered¹¹, declined again in 2016 as LNG trade became more contracted, followed by a sharp rebound in 2017.

In terms of the three different categories of consumption – domestic production, pipeline imports and LNG imports, the figure below shows the changes over the ten surveys.

Figure 3.18 Changes in GOG by Consumption Category 2005 to 2017

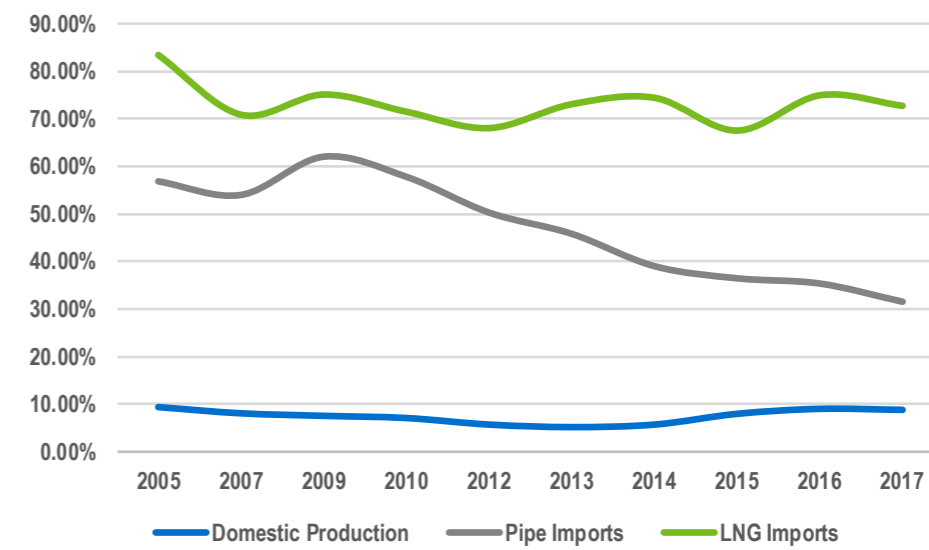


Apart from the rise in domestic production share between 2007 and 2010, as a result of the changes in Russia and, to a lesser extent, in Europe, the share of GOG has been relatively stable. Similarly, the share in LNG imports has also not changed much since 2007, fluctuating largely in response to changes in spot LNG cargoes. The big rise has been in pipeline imports, almost all in Europe.

The similar chart for changes in OPE, is the mirror image of the GOG chart for LNG imports, and for pipeline imports. For domestic production, the share declined continuously from 2005 to 2013, principally down to the changes in Europe, before recovering by some 3.5 percentage points through to 2016, principally reflecting the pricing changes in China and, to a lesser extent in Australia and Vietnam. In 2017 the share fell back slightly as the switch to GOG from OPE in China, outweighed the switch to OPE from regulated pricing in Indonesia and Malaysia.

¹¹ The definition of Spot LNG in this survey is not the same as the GIIGNL definition of spot and short term contracts. In this survey, spot LNG excludes the short term contracts element i.e. contracts over one year but less than four years, of the GIIGNL reports. In addition, since LNG imported by the trading markets of North America and Northwest Europe is classified in the "Trading" category, there may be significant volumes, of what might be regarded as spot, not included in the "Spot LNG" category.

Figure 3.19 Changes in OPE by Consumption Category 2005 to 2017





4. Wholesale Price Levels

4.1 INTRODUCTION

This section covers the full results and analysis on wholesale price levels at the overall World level and comprises:

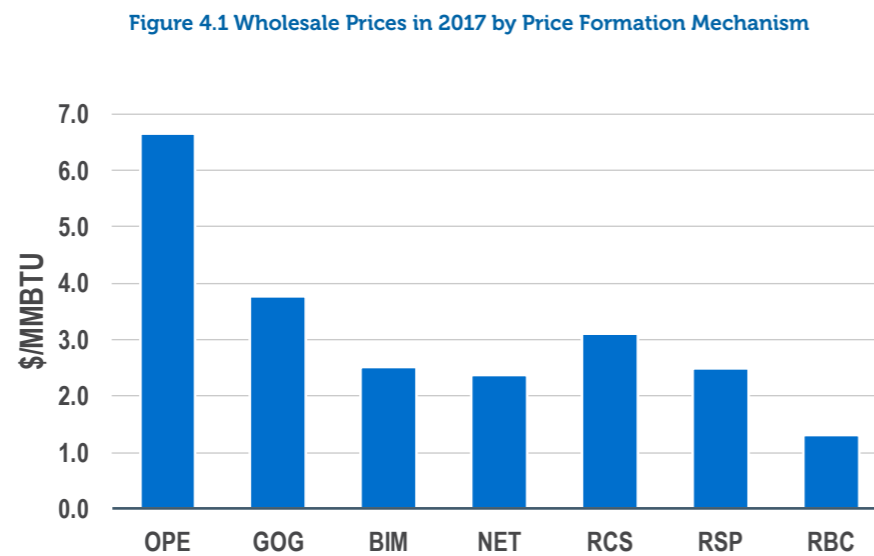
- The results for the 2017 survey; and
- Comparisons across the ten surveys.

In considering wholesale price levels across regions, countries or price formation mechanisms, it should be noted that the wholesale price can cover different points in the gas chain – wellhead price, border price, hub price, city-gate price – so the comparison of price levels is not always “like for like”. **Comparisons, therefore, should be treated with utmost caution and taken only as a broad indication.**

4.2 2017 SURVEY RESULTS

4.2.1 PRICE LEVELS BY PRICE FORMATION MECHANISM

The figure below shows a snapshot of wholesale prices for 2017 by price formation mechanism¹².



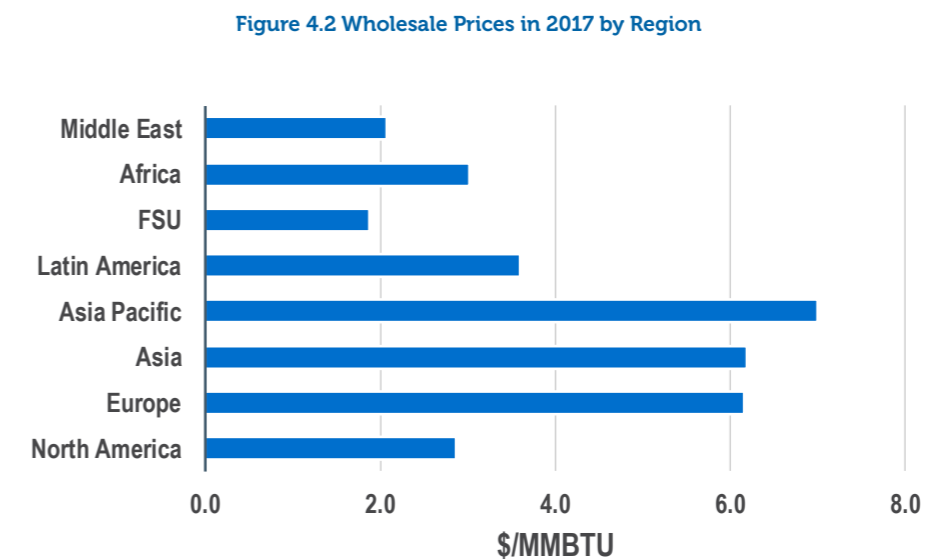
¹² It should be noted that on an individual country basis no break down has been made of the price level for different price formation mechanisms within the country, so the same price level is applied to all mechanisms. This simplifying assumption is not considered to have any material influence on the conclusions.

The highest prices, by some margin, are in the OPE category, which, at \$6.44 per MMBTU, is over \$2.50 higher than the GOG category which is \$3.78, which is slightly above the RCS category. However, the price level in the GOG category is heavily influenced by the relatively low prices in 2017 in North America and Russia. If these were excluded then the balance of GOG prices would be, on average, \$5.90 much closer to the OPE levels but still some \$0.50 lower.

In the regulated categories, it can be seen that the prices in the RCS category are higher than those in RSP and, in turn, RBC – which were the lowest at \$1.31 per MMBTU in 2017.

4.2.2 PRICE LEVELS BY REGION AND COUNTRY

The figure below shows a snapshot of wholesale prices for 2017 by IGU region.

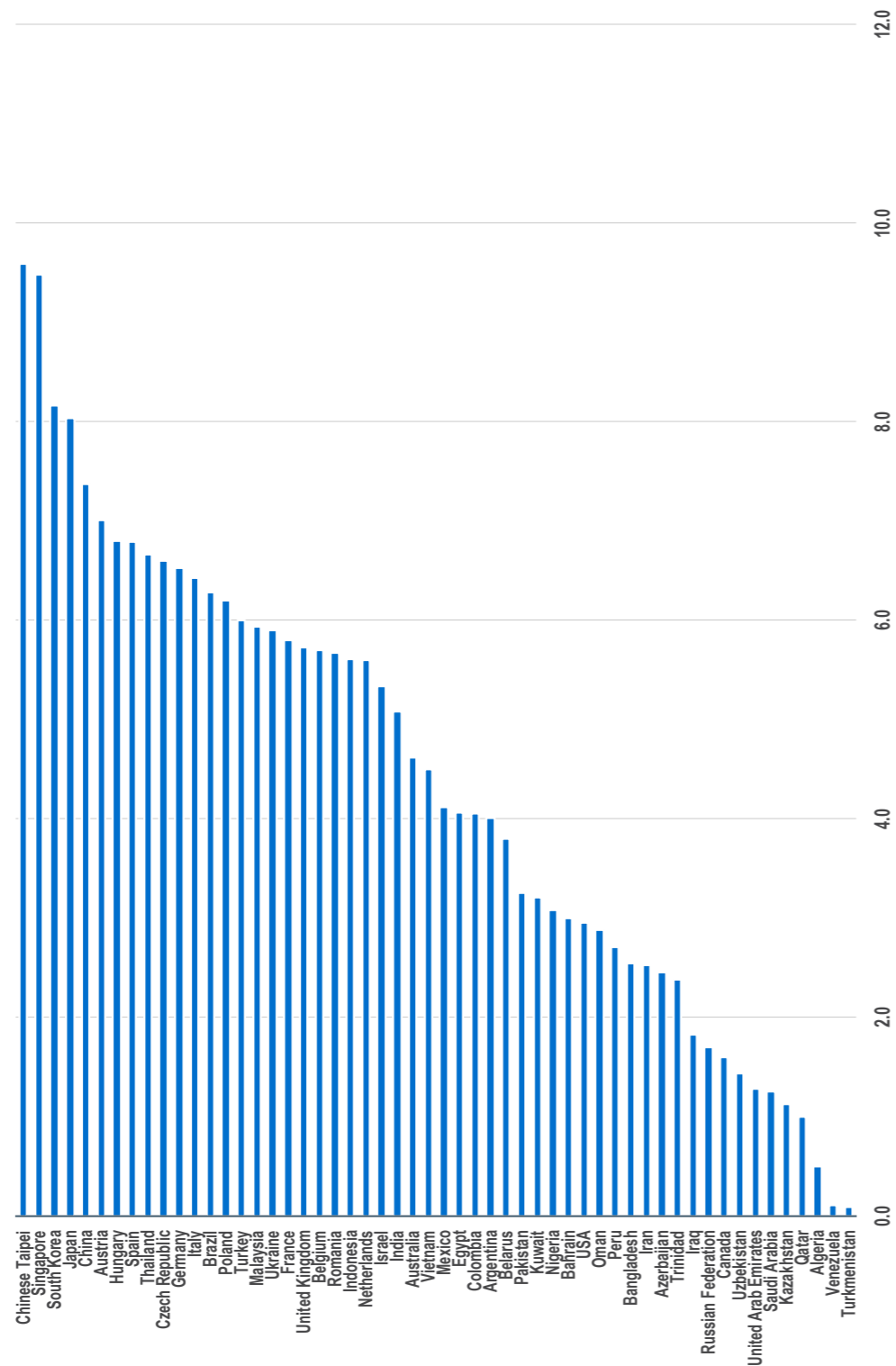


Wholesale prices can obviously vary significantly from year to year, but Asia Pacific and Asia had average prices over \$6.00. OPE is the primary pricing mechanism in both regions. Prices in Europe, which has the next largest share of OPE, was just below the Asia price. Prices in North America in 2017 were below the average for Latin America and even Africa. Prices in the Former Soviet Union, in \$ terms, continued to be lower than in the Middle East, reflecting the continued currency weaknesses.

These conclusions are further reinforced when wholesale prices are viewed at the country level. The figure below includes all countries with consumption greater than 8 bcm in 2017.



Figure 4.3 Wholesale Prices in 2017 by Country



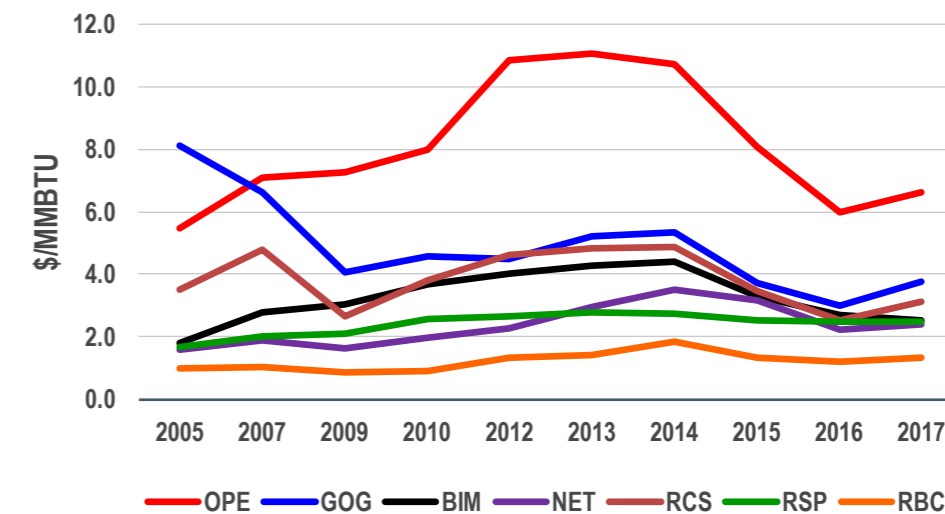
The highest wholesale prices in 2017 were again found in the main LNG importing countries in Asia Pacific – Chinese Taipei, South Korea and Japan – plus Singapore and China. These were followed by some Central European countries plus Thailand. In Northwest Europe countries, where GOG dominates, prices are somewhat lower than the rest of Europe, but still a lot higher than in the USA and Canada, where prices are even below those in Egypt, Nigeria, Indonesia and Malaysia and some Middle East countries. Prices in Russia have fallen well below other countries, which, in previous years, they had been above, as a consequence of the large rouble depreciation. At the bottom of the chart are generally countries where wholesale prices were subject to some form of regulation and often below the cost of production and transportation – Turkmenistan, Algeria and Venezuela.

4.3 COMPARISONS 2005 TO 2017

4.3.1 CHANGES IN WHOLESALE PRICES BY PRICE FORMATION MECHANISMS

The figure below compares changes in wholesale price levels across the ten surveys by price formation mechanisms.

Figure 4.4 Wholesale Price Levels 2005 to 2017 by Price Formation Mechanism

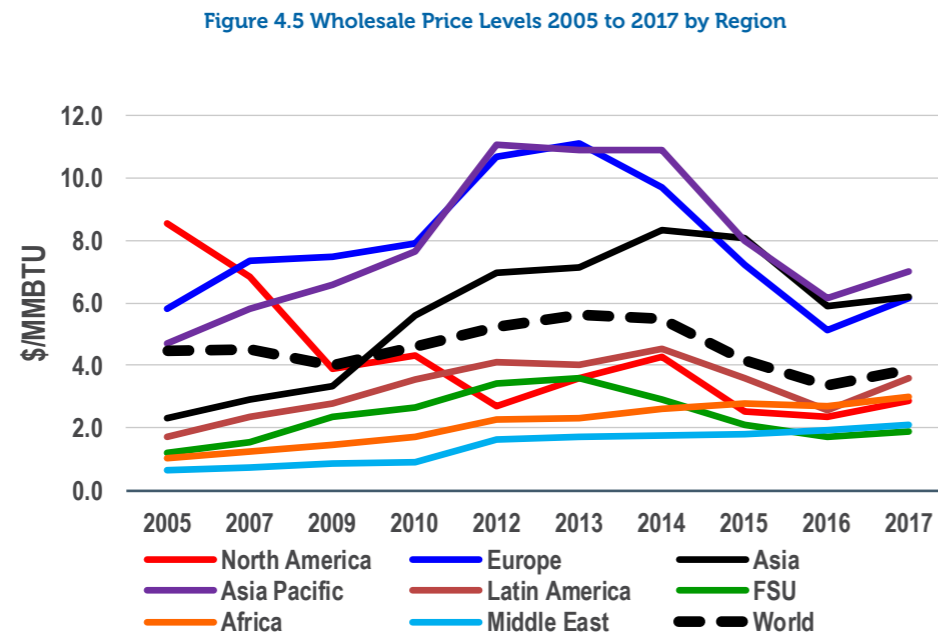


In 2005 the highest prices by price formation mechanism were for GOG at \$8.13 per MMBTU, but these declined between 2005 and 2009, before levelling off at around \$4.50, followed by small rise to the \$5.20 range in 2013 and 2014 and sharp declines and 2016 reaching \$3.01. There was a rise in 2017 to \$3.78, with prices rising in all markets. In contrast OPE prices rose significantly from \$5.50 per MMBTU in 2005 to over \$11.00 in 2013, as oil prices increased, remaining around that level through 2014, before declining to around \$8.00 in 2015 and \$6.00 in 2016, following the oil price fall. OPE prices also rose back in 2017 to \$6.64, as oil prices recovered. There were also general increases in prices over time in the regulated price categories as well, through to 2014, although in 2015 and 2016 this trend was reversed, principally due to sharp dollar declines in the FSU as currencies depreciated. These again were reversed in 2017 as some predominantly regulated countries increased prices.



4.3.2 CHANGES IN WHOLESALE PRICES BY REGION

The figure below compares changes in wholesale price levels across the ten surveys by region.



At the world level, on average, wholesale prices have risen between 2005 and 2013 from around \$4.48 per MMBTU to \$5.60. This rise was across all regions apart from North America, where the dramatic increase in shale gas supply has led to sharp falls in prices – with a small rebound in 2013. The rise in prices in Europe and Asia Pacific has been well documented and studied, but prices have also risen in Asia, largely due to increases in prices in China, both as more gas was imported and regulated domestic prices increased, and in India for similar reasons.

In 2014, though, prices in Europe began to decline as the market weakened and, in the FSU especially, as the rouble depreciated. This accelerated in 2015, and prices also fell back in North America and Asia Pacific on the back of weak demand, abundant supply and the impact of the

sharp fall in oil prices. However, some regions did not see the 2014 and 2015 fall in prices. These were Asia, as pricing reforms and inertia increased and kept prices up in China and India, the Middle East – as regulated prices were increased in Bahrain, Oman and Iran, with other prices staying stable – and Africa – where prices increased in Egypt, Nigeria and Algeria.

In 2016, prices declined further in all regions apart from Africa and the Middle East, with average world wholesale price falling to \$3.35 per MMBTU, the lowest level in all surveys which started in 2005.

In 2017, prices generally rose again in all regions as the global supply – demand situation tightened and oil prices rose. Price also increased, however, in the more regulated regions of the Former Soviet Union, Africa and the Middle East. The average world wholesale price in 2017 was \$3.89 per MMBTU – higher than in 2016 but still below the average price in all other surveys.



5. Global Gas Price Convergence

5.1 INTRODUCTION

In the period 2005 to 2017, it is generally recognised that the global natural gas markets have become more integrated through increased LNG trade, increased market related pricing and gas hub development. It might be expected, therefore, that global gas prices would converge, as markets became more integrated. However, the conventional wisdom is that of global gas price divergence, based on a few regional gas price markers such as Henry Hub, NBP and Japanese import prices. A casual look at figure 4.5 on wholesale price levels by region would appear to confirm the conventional wisdom, as the differentials between Asia Pacific and Europe prices, on the one hand, widened compared to most other regions.

This section contains an analysis of whether gas prices have been converging on a global basis over the years of the survey, using the wholesale price data from the ten surveys.

5.2 MEASURING PRICE CONVERGENCE

The wholesale price surveys have resulted in a unique database with data on gas price formation mechanisms, gas volumes, and annual average gas prices of well over 100 countries. The database enables analysis of different subsets of countries, categorized by properties such as price formation mechanism, region, and shares of imports. This has been used to shed more light on the apparent contradiction between the expectation of price convergence based on economic theory¹³ and market developments and the conventional market view of gas price divergence. The large number of countries available in the database, as well as the use of the coefficient of variation as a measure for price convergence can provide new insights.

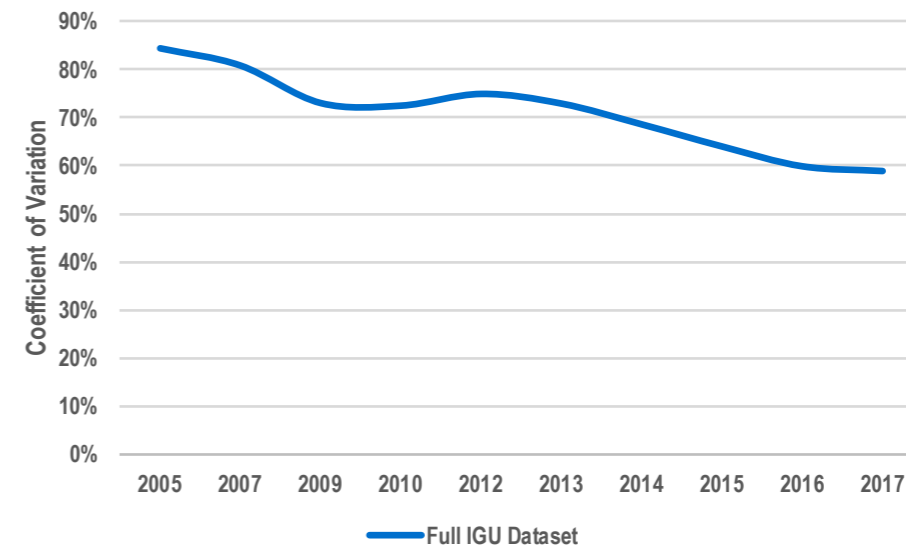
The coefficient of variation of prices of a dataset in a certain year is determined by the standard deviation divided by the mean value of these prices. The amount of absolute price variation (standard deviation) is thus measured relative to the average price in a certain year. A low coefficient of variation indicates a higher level of price convergence and vice-versa. This measure is particularly suitable for datasets with a limited number of data points (in our database 10 years), for a large number of price lines (in our database 109 countries), and the ability to subdivide into subsets of countries with different mean gas prices.

5.3 PRICE CONVERGENCE USING THE SURVEY DATA

In the period 2005 to 2017 the coefficient of variation of gas prices of 109 countries declined by 25%, indicating continuing global gas price convergence. This is consistent with our expectations based on the economic theory of the Law of One Price and can be seen as an indicator that the global gas markets actually are converging.

¹³ The economic theory of the Law of One Price states that, in a perfect market, potential arbitrage opportunities between countries are immediately exploited by market participants, leading to convergence to one single price. With growing LNG trade and more countries involved, it might be expected that global gas prices should have converged, due to increasing arbitrage possibilities and further market integration.

Figure 5.1 Global Gas Price Convergence



In order to be able to trade to exploit arbitrage opportunities (leading to gas price convergence), countries should be connected to the global gas market. Connectedness to the global gas market could be realized through physical gas imports or through market related pricing. We therefore looked at a subset of countries with a minimum level of gas imports (10%) and at a subset of countries with market related prices. The result is as expected, with the coefficient of variation being much lower in countries connected to the global gas market through physical imports and/or market related prices. Importing countries and market related pricing countries had very similar levels of convergence, with a large overlap in terms of data.

Figure 5.2 Price Convergence for Gas Importing Countries

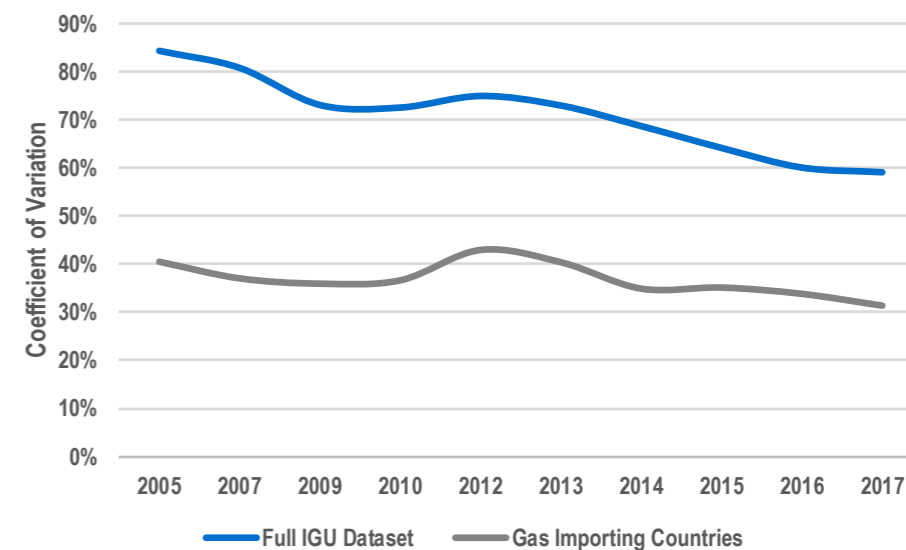
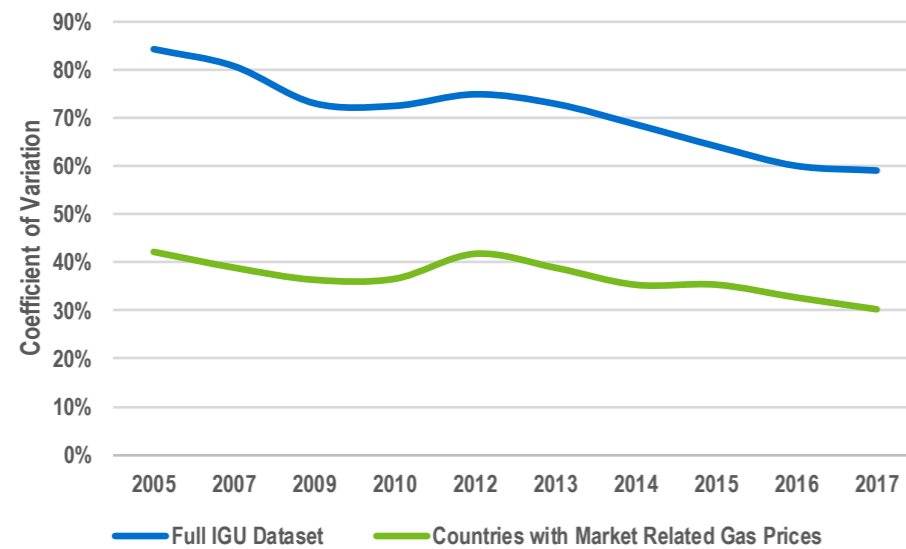




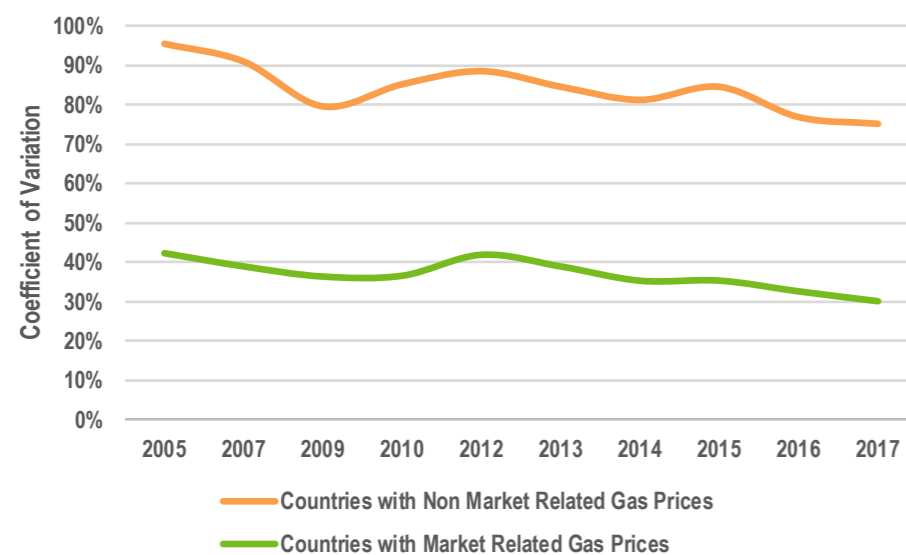
Figure 5.3 Price Convergence for Market Related Prices



We have defined countries with market related prices as countries where the majority of gas is priced through market related price formation mechanisms – OPE, GOG, BIM and NET – with OPE and GOG having by far the larger share. Non-market related prices mainly include the regulated price formation categories: RCS, RSP and RBC.

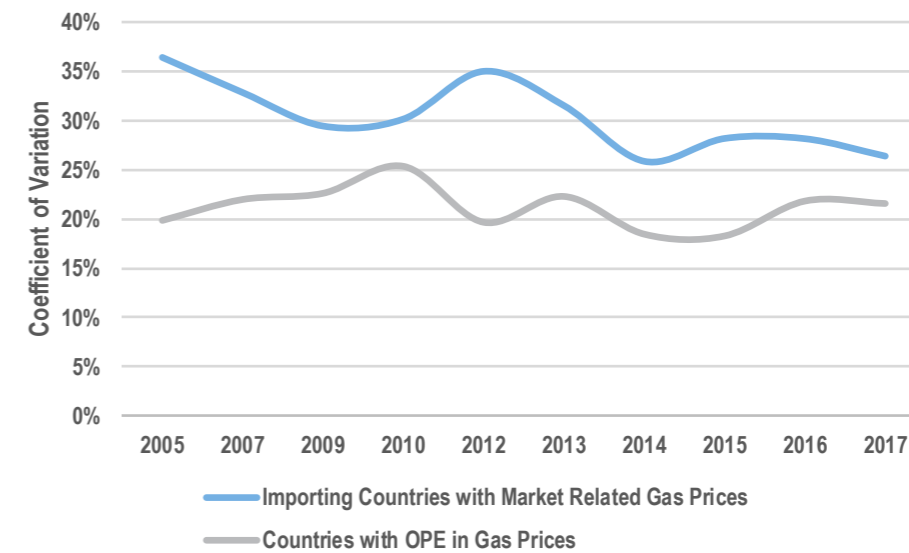
As shown in the following figure, gas prices in countries with non-market related prices actually have converged faster than countries with market related prices, albeit from a much higher level of divergence. This is an indication that prices in countries with regulated prices are getting more aligned with global gas prices generally, probably through the elimination of subsidies and the increase of prices to more economic levels.

Figure 5.4 Price Convergence for Non-Market Related Prices



When we look within the group of countries with gas imports as well as market related pricing, we see that a subset of countries with oil price escalation as the main price formation mechanism shows more price convergence i.e. a lower coefficient of variation. This is not surprising, since these prices are largely all indexed to crude oil, gasoil and/or fuel oil prices.

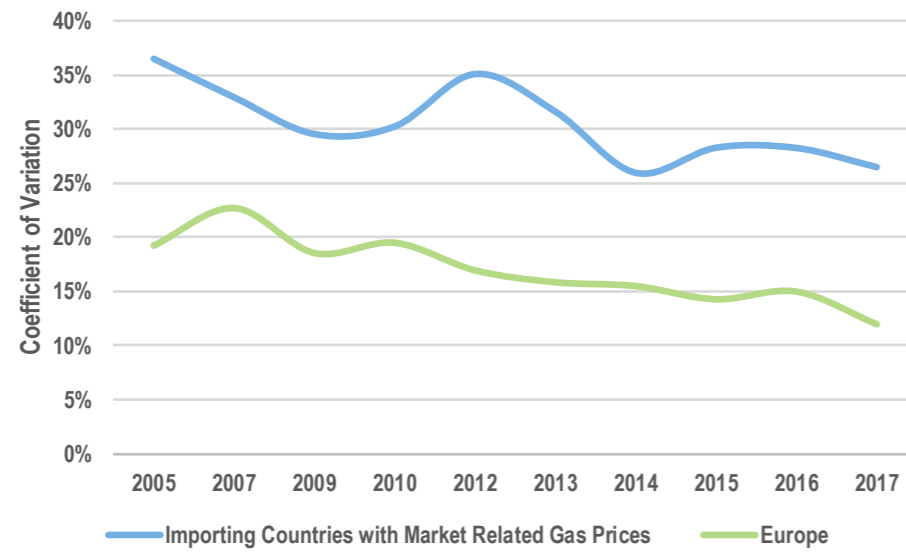
Figure 5.5 Price Convergence for OPE Prices



When we look at the different IGU regions, Europe is the only region with sufficient countries to make meaningful convergence calculations. Here we can conclude that there is more price convergence amongst gas importing countries with market related prices within Europe than on a global level, since the decline in the coefficient of variation had been greater than in all importing countries with market-based gas prices. This, again, is not surprising since intraregional trade of natural gas is usually easier and less costly than interregional trade.

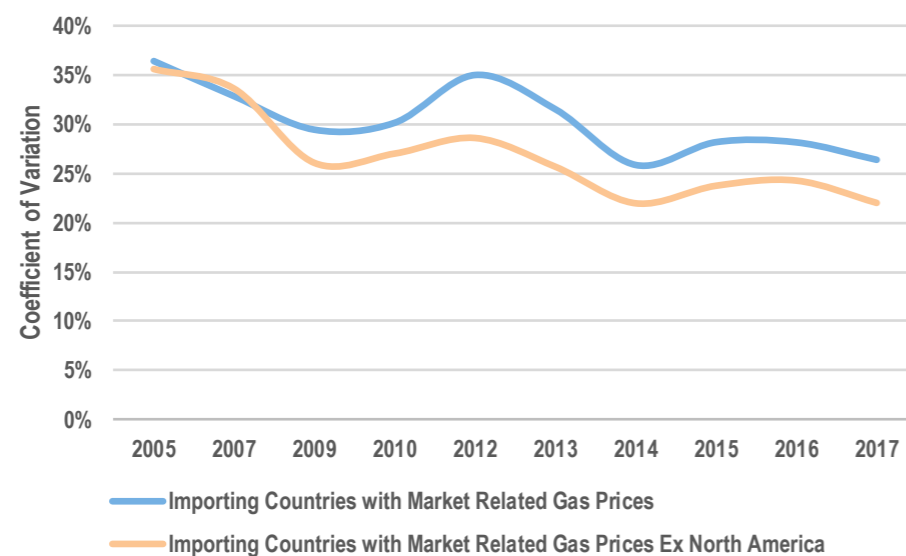


Figure 5.6 Price Convergence for Europe



In recent years, the shale gas revolution has made the North America region (Canada, Mexico and United States) virtually self-sufficient with little or no LNG imports. As a result, the region has become effectively disconnected from the global gas market. Looking at a subset of gas importing countries, without these three countries, shows that the trend of global gas price convergence is more distinct with no, effectively disconnected, North American countries. It is probably too soon, up to 2017, to see the influence yet of the recent start-up of large LNG exports from the USA. It will be interesting to further follow these developments in the coming years.

Figure 5.7 Price Convergence Excluding North America



5.4 CONCLUSIONS

This analysis shows that global gas prices have been converging continuously since 2005, indicating further globalisation of the gas markets. The trend of price convergence is against the conventional market wisdom of gas price divergence in the years up to 2015, but in line with developments such as the growth of LNG trade and increased market-related gas pricing.

It is also concluded that there is more gas price convergence amongst countries (1) with market related pricing, (2) which are connected with the global gas market through gas imports, (3) with oil-indexed gas prices, and (4) within Europe.

The trend of global gas price convergence in the period 2005 – 2017 is more distinct when we exclude the data of the, effectively disconnected, North American countries. The pace of price convergence is even faster amongst countries with regulated gas prices than amongst countries with market related prices. This is an indication that prices in countries with regulated prices are getting more aligned with global gas prices, probably through the elimination of subsidies and the increase of prices to more economic levels.



6. Regional Level Results

6.1 INTRODUCTION

This section covers the regional level results for the eight IGU regions and for each region the results of the 2017 survey are discussed, followed by a comparison of the results of the nine surveys undertaken from 2005 to 2017.

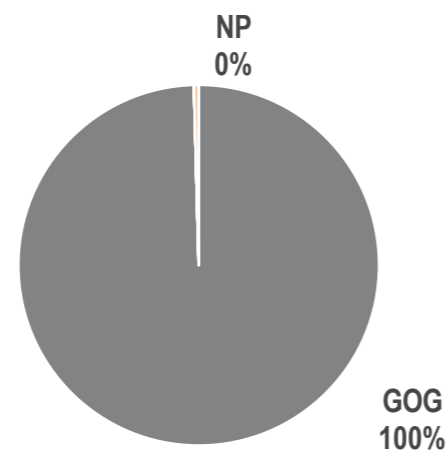
The results for previous surveys may, in some cases, appear slightly different from what has been published in previous reports. This reflects mostly revisions to IEA data on consumption, production, imports and exports but can also reflect retrospective changes to price formation classification when survey respondents have a better appreciation of the classification definitions as they reflect upon the results from the surveys overall.

6.2 NORTH AMERICA

6.2.1 NORTH AMERICA 2017 SURVEY RESULTS

North America consumption in 2017 was some 25% of total world consumption – around 953 bcm.

Figure 6.1 North America Price Formation 2017

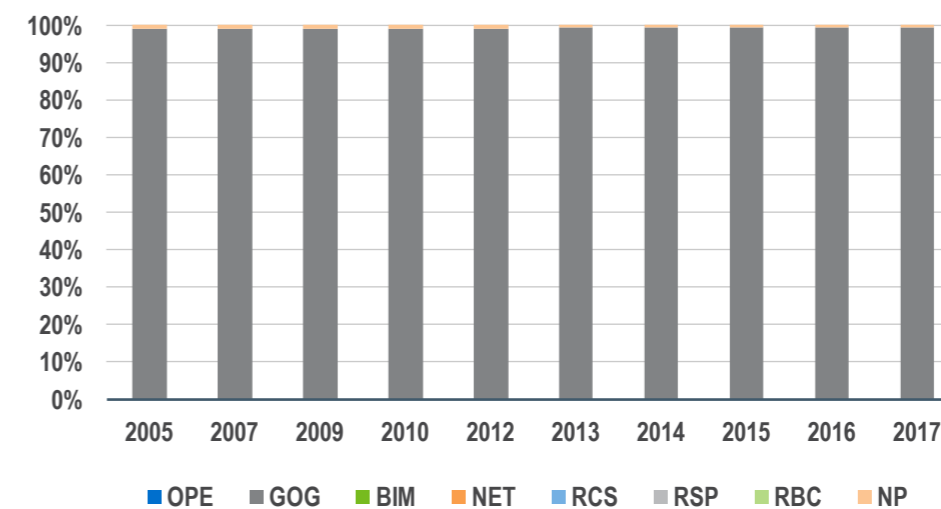


GOG clearly dominates the North American market with fully liquid trading markets in the USA and Canada. The wholesale price in Mexico used to be referenced to prices in the USA, but there are now reference prices based on trades in Mexico. The small amount of NP is in Mexico where Pemex uses the gas in the refinery process and for enhanced oil recovery.

6.2.2 NORTH AMERICA COMPARISON 2005 TO 2017

Price formation mechanisms have not changed at all, in effect, in North America over the nine surveys. Apart from the small amount – under 1% - of NP which, as noted earlier, is gas used by Pemex in refinery processes and enhanced oil recovery, North America was all GOG in 2005 and has remained so ever since. In fact, if the surveys had gone back even further, it is likely that the USA at least would have been GOG since the early 1990s.

Figure 6.2 North America Price Formation 2005 to 2017

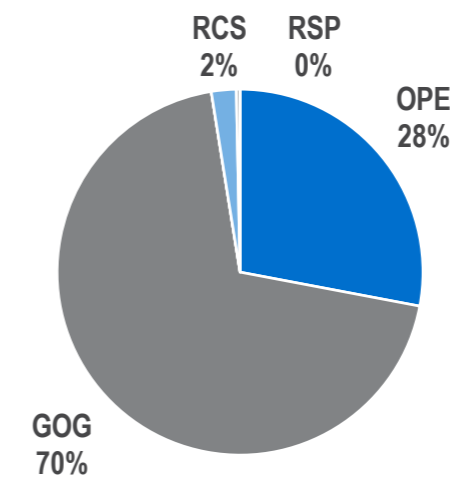


6.3 EUROPE

6.3.1 EUROPE 2017 SURVEY RESULTS

European consumption in 2017 was some 15% of total world consumption – around 551 bcm.

Figure 6.3 Europe Price Formation 2017





GOG remains the largest share in Europe, standing at 70%, totalling around 383 bcm. Some 88 bcm is domestic production, mainly Netherlands and UK, with some 273 bcm being pipeline imports, predominantly all the northwest European countries plus Italy in the Mediterranean area, but also increasingly the central European countries of Poland, Czech Republic, Slovakia, Austria and Hungary. LNG imports account for some 22 bcm, over 40% of which are into the trading markets of the UK, Belgium and Netherlands, with the remaining quantities being largely spot cargoes into the more traditional LNG importing countries.

OPE is now down to 28%, totalling around 154 bcm, and is predominantly pipeline imports (109 bcm) now into only two-thirds of the European countries, followed by LNG imports (42 bcm) into Spain, France, Italy, Turkey, Portugal, Poland and Greece, with domestic production (3 bcm) in a handful of countries.

RCS accounts for some 12 bcm and is domestic production in Romania, while RSP also accounts for some 2 bcm and is also domestic production in Hungary and Croatia.

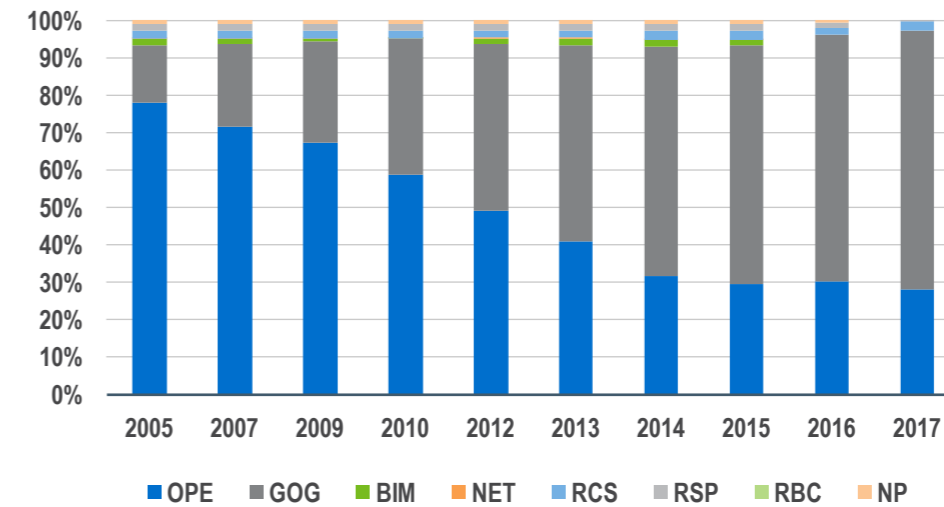
6.3.2 EUROPE COMPARISON 2005 TO 2017

Europe is one of the regions where the most significant changes in price formation mechanisms have taken place. There has been a broadly continuous move from OPE to GOG since 2005, with GOG's share increasing from 15% in 2005 – when OPE was 78% – to 70% in 2017 – when OPE had declined to 28%. The RCS category – domestic production in Romania – has remained at similar levels, but RSP declined in 2017 as it disappeared in the Polish market.

The changes have reflected a number of factors over the years; initially a decline in the volume of gas imported under the traditional oil indexed contracts, being replaced by imports of spot gas and increasing volumes traded at hubs, followed by the ending of contracts or the renegotiation of the terms to include a proportion of hub/spot price indexation in the pricing terms, or even a move to 100% hub price indexation, and in some cases, a reduction in the take-or-pay levels. The renegotiations have also seen the introduction of hybrid contracts - see Box 2 for more discussion.

The trend towards GOG and away from OPE, was reinforced by the continued decline in domestic production in the UK in the old legacy contracts, which were in the OPE category, to be replaced by pipeline and LNG imports, all at GOG.

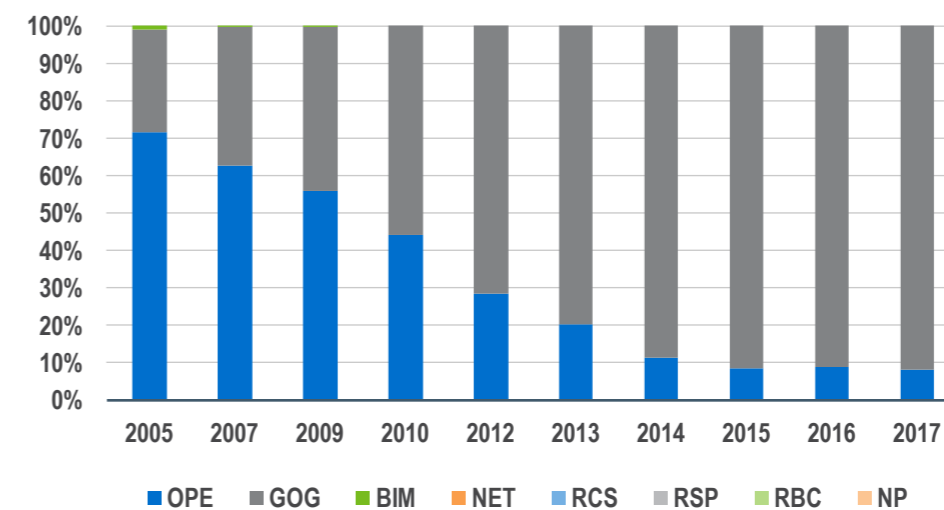
Figure 6.4 Europe Price Formation 2005 to 2017



The change in price formation mechanisms in Europe was not universal across the region. The figures below summarise the changes in the key sub-regions.

Northwest Europe¹⁴ has seen the most dramatic change in price formation mechanisms, with a complete reversal in the ratio of OPE to GOG from 72% OPE and 28% GOG in 2005 to 8% OPE and 92% GOG in 2017, as a result of increased hub trading and contract renegotiations, as noted above.

Figure 6.5 Northwest Europe Price Formation 2005 to 2017



¹⁴ Belgium, Denmark, France, Germany, Ireland, Luxembourg, Netherlands, UK



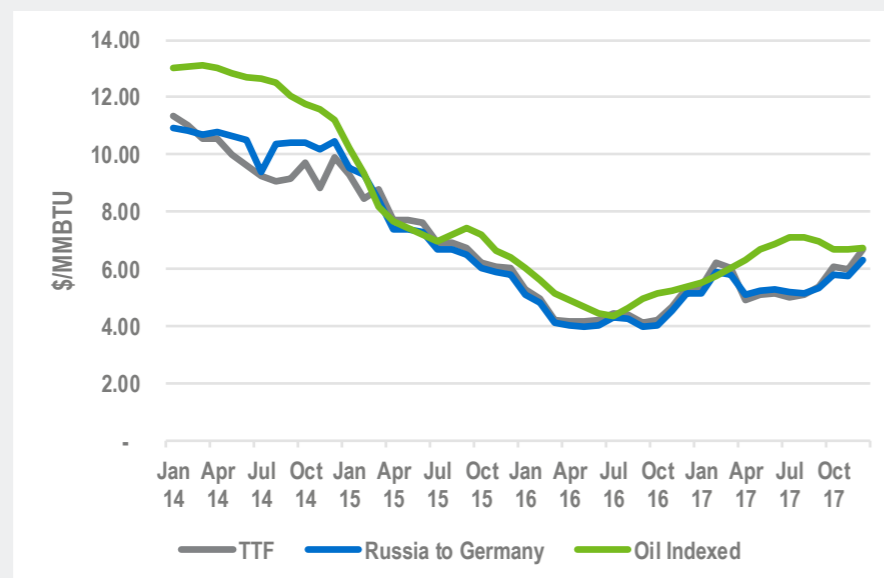
BOX 2: HYBRID CONTRACTS IN EUROPE

The introduction of hybrid contracts in Europe resulted from contract renegotiations, mainly between Gazprom and their buyers, but recently this has also been used by other suppliers to Europe. Under the pricing formulas, oil indexation is partly maintained but within a price corridor set by hub prices. Such contracts are sometimes called quasi-oil indexed but could equally be referred to as quasi-hub indexed. It is suggested to the respondents to the wholesale price survey that such hybrid contracts are split between GOG and OPE, with the proportions dependent on how narrow the price corridor is. For example, if the price corridor is very narrow, the contract is effectively only notionally linked to oil prices and therefore would be allocated more towards GOG. In contrast if the band is relatively wide then more would be allocated to OPE.

Gazprom recently suggested that one-third of its contracts are still oil indexed, one-third are hub-indexed and another third are hybrid contracts¹⁵. This is not that different to the results of this 2017 survey, which suggests some 36% are GOG i.e. hub-indexed or spot, with some 42% hybrid and the rest 22% oil indexed. However, the hybrid contracts would seem to split more in favour of GOG by 2 to 1 – 28% to GOG and 14% to OPE – by the survey respondents. This suggests for most countries that the price corridors are very narrow with actual prices in the contracts being largely driven by the hub prices.

This would seem to be borne out as far as Russian gas to Germany goes, as shown in the figure below.

Figure 6.6 Russia to Germany Prices v Hub and Oil Indexed

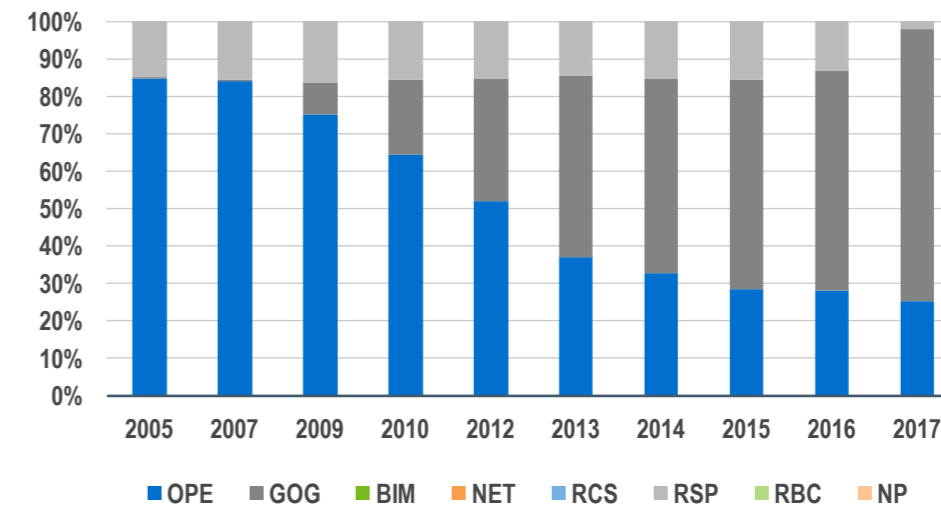


Source: Argus Media

Since the beginning of 2015 the average Russia to Germany price at the border has largely tracked the hub price as depicted by TTF, being generally somewhat below the oil indexed price, suggesting the price corridor is relatively narrow around the hub price, so much more like GOG than OPE.

15 <https://www.reuters.com/article/brief-russias-gazprom-calls-nord-stream/brief-russias-gazprom-calls-nord-stream-2-pipeline-risks-hypothetical-idUSR4N1PV002>

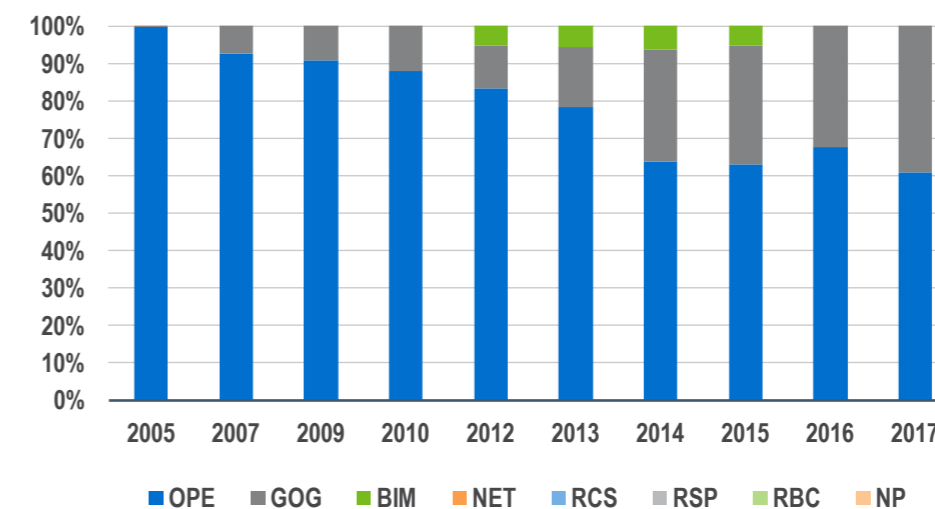
Figure 6.7 Central Europe Price Formation 2005 to 2017



Central Europe¹⁶ has also, more recently, seen significant changes. OPE has declined from 85% in 2005 to 25% in 2017, while GOG has increased from almost zero in 2005 to 73% in 2017, principally reflecting increased imports of spot gas, often from Germany, and contract renegotiations. However, in 2017 the GOG increase – 59% to 73% – was mostly down to the switch from RSP in Poland as a result of regulatory reform.

There has been much less change in other areas of Europe such as the Mediterranean¹⁷, where OPE has only declined from 100% in 2005 to a low of 61% in 2017, and GOG rising from nothing to around 39%. This initially reflected spot LNG imports in the sub-region and some spot pipeline imports into Italy, as well as changes in the pricing of domestic production in Italy. However, in 2014 this was further enhanced by the renegotiation of the main Russian contract into Italy, and in 2017, the change in the Algerian contract into Italy.

Figure 6.8 Mediterranean Price Formation 2005 to 2017



16 Austria, Czech Republic, Hungary, Poland, Slovakia, Switzerland

17 Greece, Italy, Portugal, Spain, Turkey



In Southeast Europe¹ a very small amount of GOG is shown, from 2014 on, in Croatia but in no other country. By 2017 GOG had reached 10%. There is a large element of RCS in Romania, with the lower level of OPE in 2009 and 2010 a consequence of lower demand for imports in Romania and the rise in 2012 reflecting a switch from BIM in Bulgaria, where until 2010 there was payment in kind for transit (BIM) which then became a cash payment with the gas being purchased under the same OPE terms as the other imported gas. OPE fell back again in 2013 and 2014 as imports declined in Romania, before stabilising in 2015. 2017 saw another decline for OPE, as Romanian imports fell.

Figure 6.9 Southeast Europe Price Formation 2005 to 2017

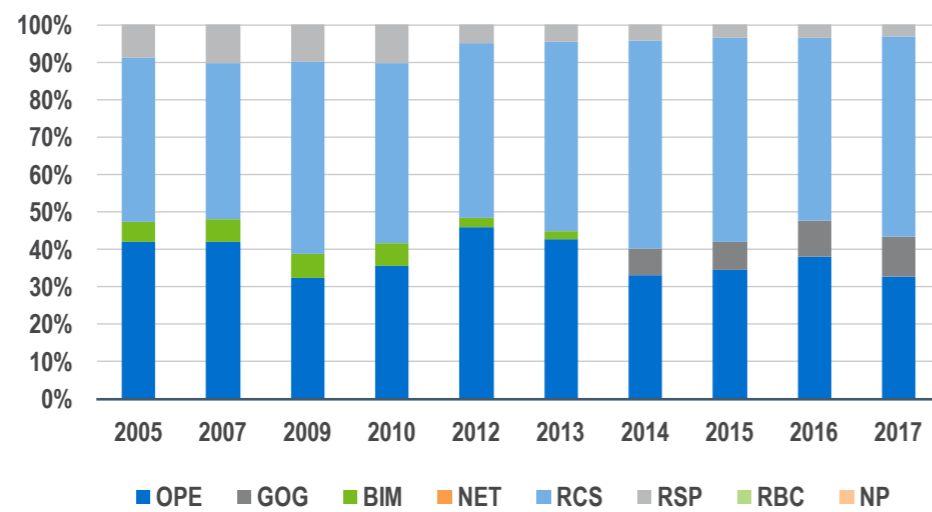
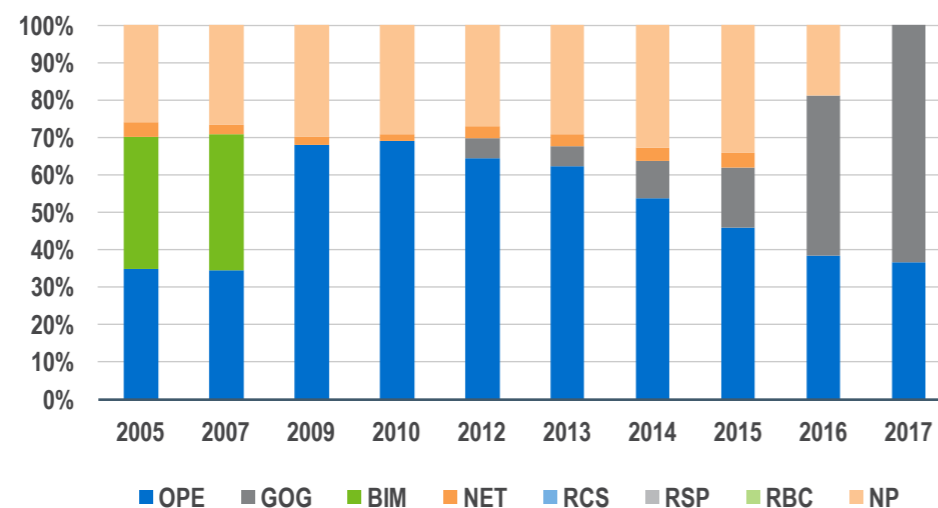


Figure 6.10 Scandinavia and Baltics Price Formation 2005 to 2017



¹ 18 Bosnia, Bulgaria, Croatia, FYROM, Romania, Serbia, Slovenia

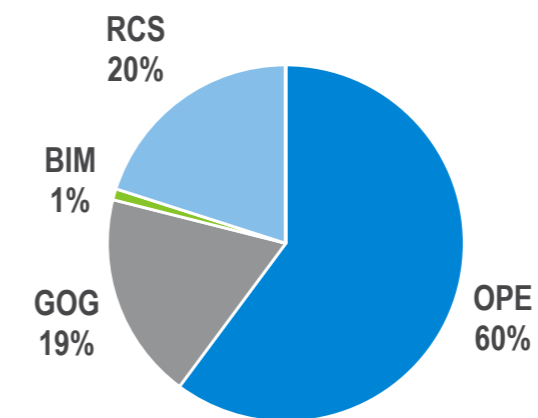
In Scandinavia and Baltics¹⁹, GOG has gained ground in recent years in Sweden, Norway and more recently in LNG imports into Lithuania and had risen to 46% in 2016, almost all at the expense of OPE, which is now down to 28%. The early switch in 2009 from BIM to OPE was in the contiguous Baltic States. The large gain in GOG in 2016 reflected, in part, the switch from NET to GOG in Norway, but largely the LNG imports into Lithuania linked to NBP prices. In 2017 GOG increased further to 63% with the move away from NP in Norway, as all domestic production now priced at European hub levels²⁰.

6.4 ASIA

6.4.1 ASIA 2017 SURVEY RESULTS

Asian consumption in 2017 was some 10% of total world consumption – around 372 bcm.

Figure 6.11 Asia Price Formation 2017



OPE at 60% totals some 224 bcm and is principally domestic production, pipeline and LNG imports in China, LNG imports together with a small amount of domestic production in India, and LNG imports and domestic production in Pakistan where the regulator sets gas wellhead prices but linked to the oil price.

GOG at 19%, some 70 bcm, is mainly domestic production in India, reflecting the mainly hub linked pricing formula, domestic production in China, reflecting the direct sales at market prices from upstream producers to large users in power and industry and spot LNG imports into India and China.

RCS accounts for some 20%, totalling around 75 bcm of domestic production, mostly in China with around 21 bcm in Bangladesh.

The small amount of BIM at 1% - 4 bcm – is in Bangladesh.

¹⁹ Estonia, Finland, Latvia, Lithuania, Norway, Sweden

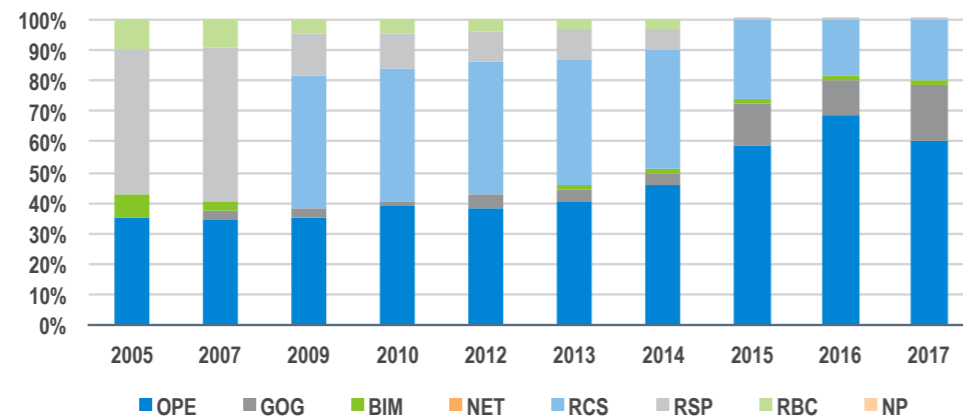
²⁰ Previously gas used in refineries and gas processing was thought not to be priced so allocated to NP



6.4.2 ASIA COMPARISON 2005 TO 2017

The changes in price formation mechanisms in Asia have been dominated by China and India. Firstly, there has been an increase in OPE from around 35% to 61% over the ten surveys, largely at the expense of the regulated categories and BIM. The move from BIM to OPE reflected the change in the pricing of the Qatar LNG contract to India between 2007 and 2009, while the more recent rise in 2010 and 2012 was due to the start of pipeline imports into China from Turkmenistan, which are oil indexed under the contract. The change from RSP to RCS in China in 2009 came as the regulator increased prices to economic levels. Finally, there was the further change in domestic production pricing, initially in two provinces in China, before extending nationwide to all sectors except residential and fertilizer, again increasing OPE to 69% in 2016. The rise in GOG in 2015 to some 14% reflected the pricing reform in India, linking domestic prices to a basket of market hub prices. GOG increased further in 2017 to 19%, partly as spot LNG imports increased in China and India, but largely reflecting the change in China domestic production noted above. This led to OPE falling back to 60% in 2017.

Figure 6.12 Asia Price Formation 2005 to 2017



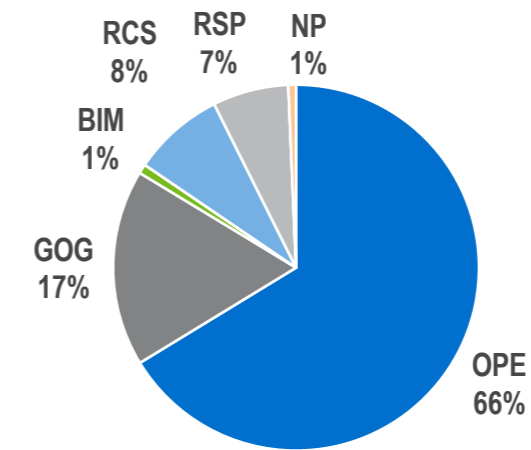
The changes in RSP – down from 48% in 2005 to almost zero in 2015 was almost all due to the change in price formation in China as regulated prices were increased to economic levels, and the more recent change in India. Initially, RCS was the beneficiary, rising to 43% by 2012, but this has since declined with the pricing changes in China, partly offset by the move to more RCS in Bangladesh. The decline in RBC, from 10% in 2005 to zero in 2016, largely reflected changes in pricing in Bangladesh in 2009 and 2015 to RCS via RSP.

6.5 ASIA PACIFIC

6.5.1 ASIA PACIFIC 2017 SURVEY RESULTS

Asia Pacific consumption in 2017 was some 11% of total world consumption – around 408 bcm.

Figure 6.13 Asia Pacific Price Formation 2017



OPE at 66% totals some 270 bcm, with LNG imports – predominantly in Japan, Korea and Taiwan, but also now including Indonesia, Singapore, Thailand and Malaysia – accounting for 189 bcm. Pipeline imports are some 21 bcm into Singapore, Thailand and Malaysia, while domestic production is 81 bcm – mostly Thailand but also Vietnam, Malaysia, Australia and the Philippines.

GOG at 17% totals some 71 bcm, of which 27 bcm is spot LNG imports mainly in Japan, Korea and Taiwan – but also some in Singapore and Malaysia, while the balance is domestic production in Australia and New Zealand.

BIM at 1% totals some 3 bcm, comprising domestic production in Japan.

RCS at 8% totals 33 bcm and is domestic production largely in Malaysia, while RSP at 7% totals some 27 bcm and is domestic production in Indonesia. NP at 1% or 3 bcm is domestic production in Brunei and PNG consumed in the energy industry.

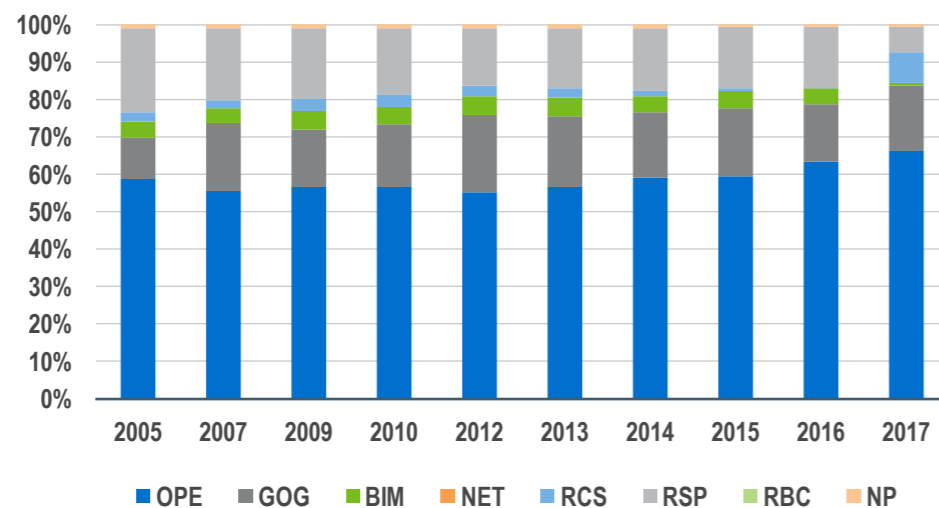


6.5.2 ASIA PACIFIC COMPARISON 2005 TO 2017

Until 2017, there were only minor changes in price formation mechanisms in Asia Pacific since 2005. GOG has risen from 11% to 15% in 2016, while OPE had increased marginally and RSP down from 23% to 16%. These changes were not consistent over time, but the rise in GOG has largely been the rise in spot LNG imports, mostly in Japan plus a smaller rise in Korea, with the variability reflecting the requirements for spot LNG. Spot LNG declined in 2016, as the rise in LNG trade was all contracted, linked to oil prices, together with more LNG being taken under existing oil indexed contracts. The fall in the RSP share to 2016 reflected the relatively sluggish growth in consumption in Indonesia and particularly Malaysia. The gradual decline in RCS to 2016 reflected the changing pricing in Vietnam towards OPE.

In 2017, however, there were significant changes in Malaysia, with pricing moving to RCS and OPE in domestic production away from RSP. In LNG there was a significant increase in spot LNG imports in Japan but especially in Korea.

Figure 6.14 Asia Pacific Price Formation 2005 to 2017

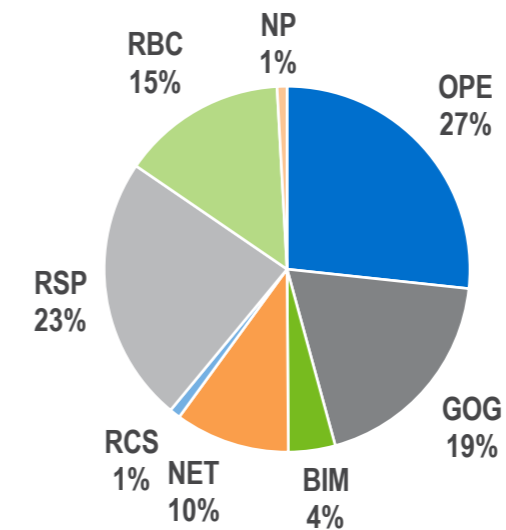


6.6 LATIN AMERICA

6.6.1 LATIN AMERICA 2017 SURVEY RESULTS

Latin America consumption in 2017 was some 4.5% of total world consumption – around 165 bcm.

Figure 6.15 Latin America Price Formation 2017



OPE at 27% totals some 44 bcm, mainly domestic production in Brazil and Colombia, pipeline imports into Brazil and Argentina and a proportion of LNG imports into Chile and Argentina.

GOG at 19% totals some 32 bcm, of which 23 bcm is domestic production in Argentina, Colombia, Chile and Peru. The balance is LNG imports into Brazil, Argentina, Puerto Rico and Dominican Republic.

BIM at 4% totals some 7 bcm and is almost all domestic production to the power sector in Trinidad, plus a small amount in Colombia. NET at 10% totals some 17 bcm and is the balance of domestic production in Trinidad used as a feedstock in petrochemicals.

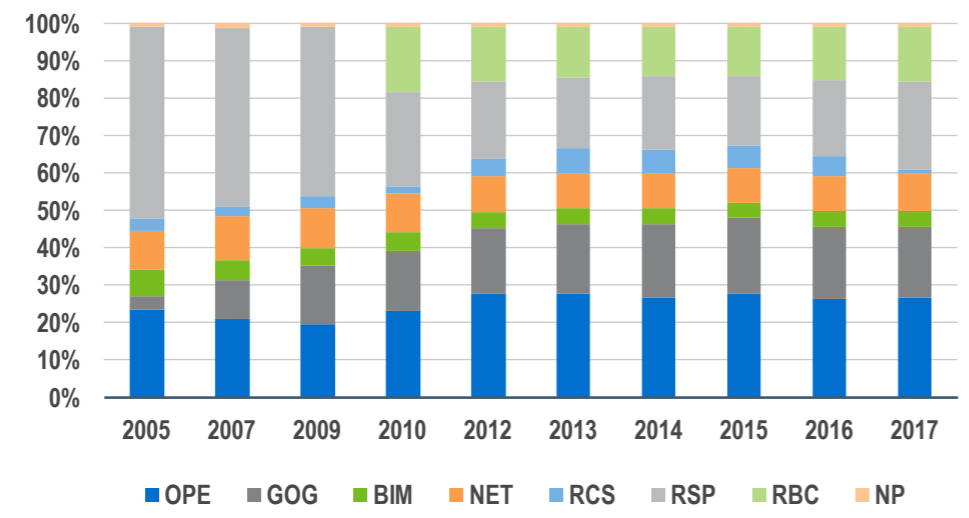
RSP at 24% totals some 39 bcm and comprises domestic production in Argentina, Peru, Ecuador and Bolivia, plus a small amount in Brazil. RBC at 15% totals some 24 bcm and is domestic production in Venezuela and a small amount in Chile, while RCS at 1% totals some 2 bcm and is domestic production in Colombia. NP at 1% or 1 bcm is Cuban domestic production.



6.6.2 LATIN AMERICA COMPARISON 2005 TO 2017

The changes in price formation mechanisms in Latin America have seen a rise in GOG from 4% to 19%, a decline in RSP from 52% to 24% and a rise in RBC from 0% to 15% - the latter almost all in Venezuela. The rise in GOG in part is due to rising spot LNG imports in Argentina and Brazil, and a switch away from RSP to GOG in Argentina, and to a lesser extent from RCS to GOG in Colombia. In Argentina, this reflected producers and marketing entities, being allowed to sell gas at unregulated prices to large eligible customers, such as power plants.

Figure 6.16 Latin America Price Formation 2005 to 2017



RCS at 38% is the largest share, totalling some 248 bcm and is almost all the major proportion of domestic production in Russia together with most of the domestic production in Azerbaijan. RBC at 15% or 100 bcm is domestic production in Kazakhstan, Turkmenistan, Uzbekistan and a small amount in Azerbaijan, while RSP at 11% or 75 bcm is a proportion of Russia domestic production (sold to the population) and Ukraine domestic production.

GOG at 29% totals some 191 bcm and is largely domestic production to the eligible large customer market in Russia, but also pipeline imports into Ukraine at hub prices from Europe.

OPE at 1% or 6 bcm is all pipeline imports into Russia, while BIM at 5% or 30 bcm represents other pipeline imports in the FSU region, principally from Russia to Belarus, but also Armenia, Georgia, Kazakhstan, Kyrgyzstan, Moldova and Tajikistan.

NP at 1% or 6 bcm is part of domestic production in Turkmenistan.

6.7.2 FORMER SOVIET UNION COMPARISON 2005 TO 2017

The Former Soviet Union is another region, like Europe, where there have been significant changes in price formation mechanisms, largely based around Russia. From having domestic production completely in the RBC category in 2005, there was a switch to GOG as the independent producers began to compete with each other and Gazprom to sell gas to the power sector and large industrials, and the rising Gazprom regulated prices saw a switch from RBC to RCS, although in 2014 the regulated pricing to the population saw a move from RCS to RSP, maintained in 2015 and 2016. The other change was in intra-FSU trade where pricing switched from BIM to OPE, particularly in the Russia to Ukraine trade, and then in 2017 when Ukraine began importing from Europe at hub prices so switch to GOG from OPE.

6.7 FORMER SOVIET UNION

6.7.1 FORMER SOVIET UNION 2017 SURVEY RESULTS

Former Soviet Union consumption in 2017 was some 17.5% of total world consumption – around 656 bcm.

Figure 6.17 Former Soviet Union Price Formation 2017

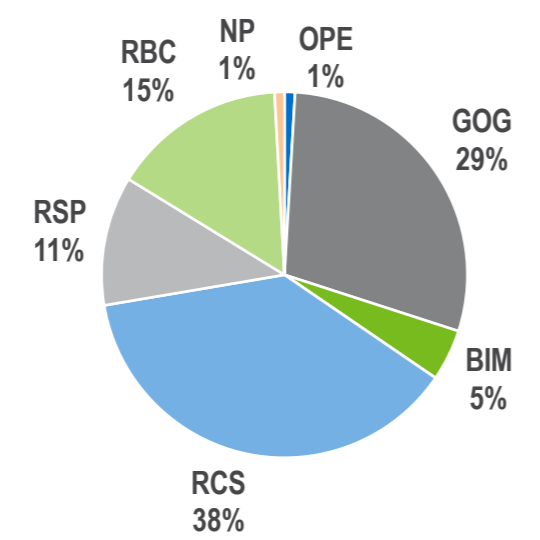
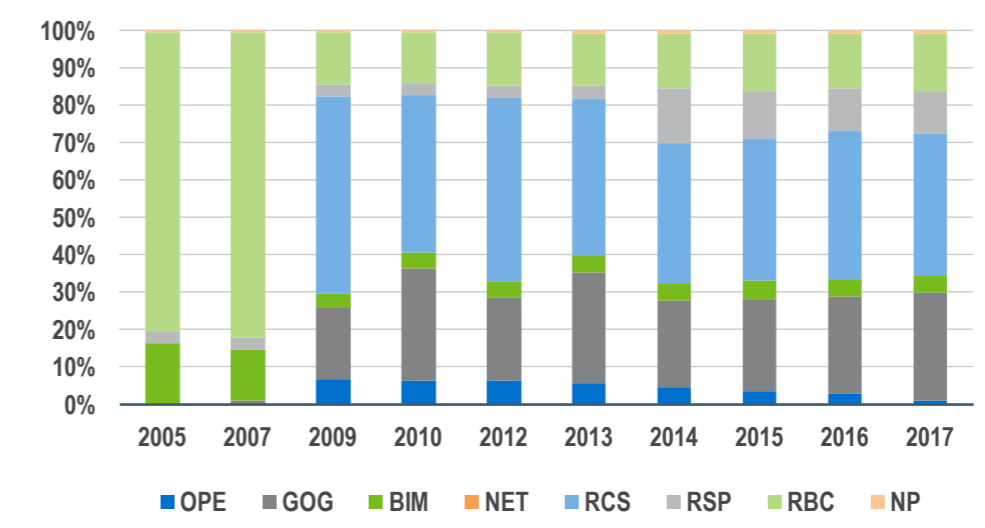


Figure 6.18 Former Soviet Union Price Formation 2005 to 2017



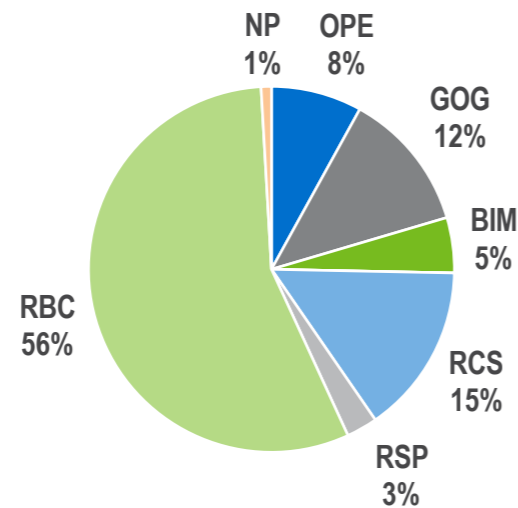


6.8 AFRICA

6.8.1 AFRICA 2017 SURVEY RESULTS

African consumption in 2017 was some 3.5% of total world consumption – around 131 bcm.

Figure 6.19 Africa Price Formation 2017



RBC at 56% or some 74 bcm, has the largest share and is domestic production in Egypt, Algeria and Libya.

RCS at 15% or some 20 bcm is domestic production in Egypt and Nigeria plus part of pipeline imports from Nigeria to Ghana, Benin and Togo.

RSP at 3% or some 4 bcm is domestic production in Equatorial Guinea, Gabon, Ghana, Morocco, Mozambique and Tanzania.

OPE at 8% or some 10 bcm comprises part of the pipeline imports into Tunisia and Morocco from Algeria, from Nigeria to Ghana, Benin and Togo, and into Egypt from Jordan, as well as domestic production in Tunisia, South Africa and part of Ivory Coast and Tanzania.

GOG at 12% or some 16 bcm is part of domestic production in Nigeria (sales to the non-power sector) and spot LNG imports into Egypt.

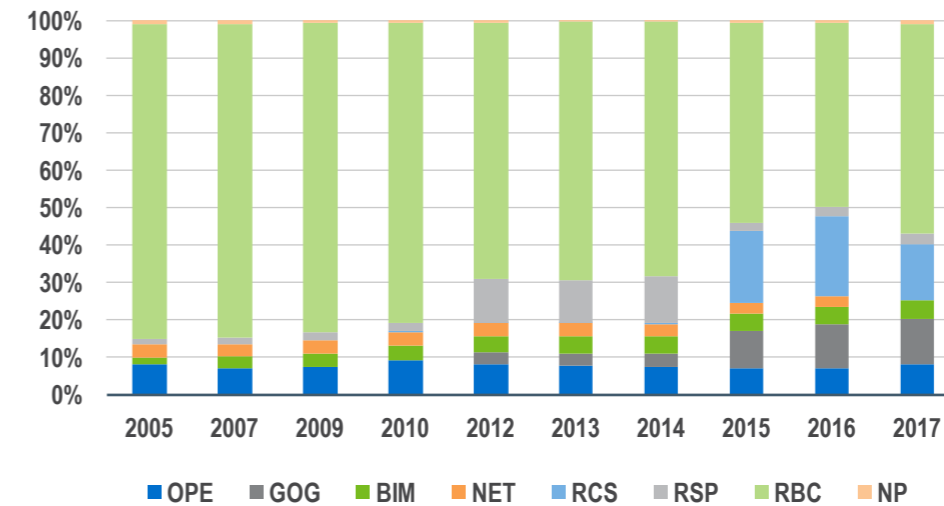
BIM at 5% or some 6 bcm is pipeline imports into South Africa from Mozambique and the balance of domestic production in Ivory Coast, plus domestic production in Cameroon.

NP at 1% is Angola.

6.8.2 AFRICA COMPARISON 2005 TO 2017

There was very little change in price formation mechanisms in Africa between 2005 and 2014, apart from the switch to RSP from RBC in 2012 in Nigeria, with some GOG as non-power markets were freed up. However, in 2015, Nigerian domestic production moved again from RSP to RCS as prices to power plants were increased, and also in Egypt there was a similar partial move away from RBC to RCS in some sectors, plus the start-up of spot LNG imports. In 2017, RBC gained at the expense of RCS and NET in Egypt as prices to the power sector were kept down and regulated to fertilizer plants. The region remains dominated, however, by RBC, with gas prices largely subsidised.

Figure 6.20 Africa Price Formation 2005 to 2017



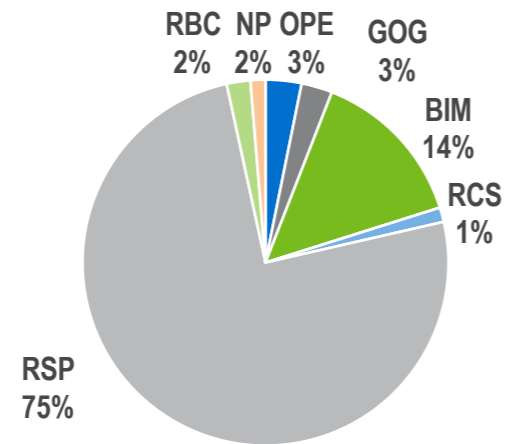


6.9 MIDDLE EAST

6.9.1 MIDDLE EAST 2017 SURVEY RESULTS

Middle East consumption in 2017 was some 14% of total world consumption – around 508 bcm.

Figure 6.21 Middle East Price Formation 2017



RSP at 75% or 382 bcm dominates the region and is domestic production in Iran, Saudi Arabia and the UAE with smaller amounts in Oman, Bahrain and Kuwait.

RBC at 2% or 11 bcm is domestic production in Iraq and Syria.

BIM at 14% or 72 bcm is partly pipeline imports from Qatar to UAE and Oman and domestic production in Qatar and part of Israel.

OPE at 3% or 16 bcm is largely pipeline imports into Iran from Turkmenistan, some LNG imports into UAE, Jordan and Kuwait, and the balance of domestic production in Israel.

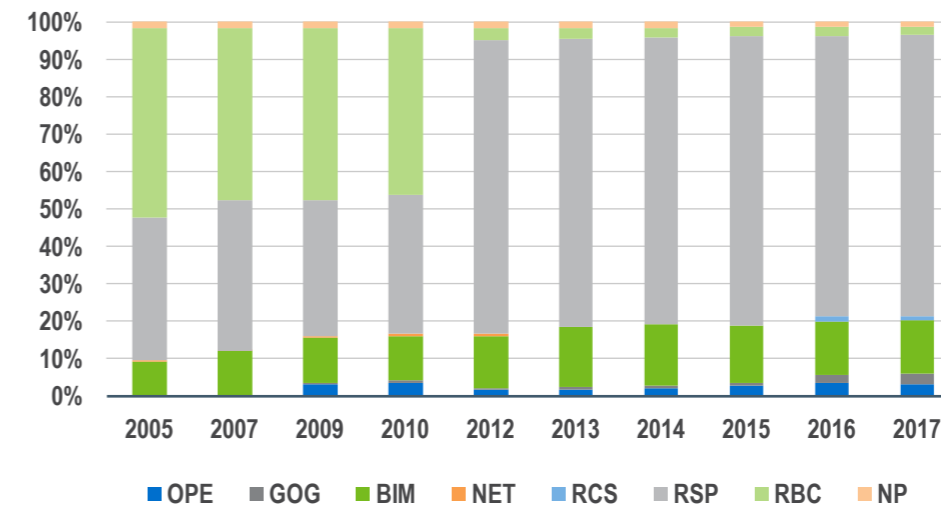
GOG at 3% or 14 bcm includes spot LNG imports into Jordan, Kuwait, UAE and Israel, and in 2016, domestic production delivered to petrochemical plants in Iran, where prices are partly linked to international hub prices.

NP at just over 1% or 7 bcm is largely gas used in enhanced oil recovery and refineries in Kuwait and Yemen.

6.9.2 MIDDLE EAST COMPARISON 2005 TO 2017

The changes in price formation mechanisms in the Middle East have almost totally taken place between 2010 and 2012, when prices were increased significantly in Iran, moving from the RBC category to the RSP category. The other change was in small quantities of OPE and GOG as LNG began to be imported into Kuwait, UAE and, in 2015, into Jordan, plus the change in gas pricing to petrochemical plants in Iran. LNG imports are, however, slowly increasing in the region which is introducing more market related pricing in the form of both OPE and GOG.

Figure 6.22 Middle East Price Formation 2005 to 2017



Appendix A: Survey Methodology

The idea for a survey of wholesale gas price formation mechanisms arose at the beginning of the triennium leading to the 2009 World Gas Conference. The Strategy, Economics and Regulation Programme Committee (PGCB) had set up a new sub-group to consider gas pricing, with a key remit to carry out a comprehensive analysis of gas price formation mechanisms. The sub-group decided to carry out a survey of current pricing mechanisms around the world, not only for gas traded internationally, but also for gas produced and consumed within countries. IGU members were surveyed and provided the data and the survey responses were collated and analysed by Nexant. The 2009 World Gas Conference in Buenos Aires presented the results of the surveys for the years 2005 and 2007. Two further surveys for the years 2009 and 2010 were undertaken and presented at the 2012 World Gas Conference in Kuala Lumpur. Three surveys were undertaken and presented at the 2015 World Gas Conference in Paris, covering the years 2012, 2013 and 2014. The 2015 was the first in the triennium for the 2018 World Gas Conference to be held in Washington DC, 2016 was the second and 2017 the third. In the 2017 survey responses were received for around 84 out of 112 countries²¹, but these responses covered 92% of total world consumption. Data on the remaining countries, where responses were not received, was researched by members of the Gas Pricing Group and /or based on past responses.

A.1 DATA COLLECTION

The focus of the gas pricing sub-group, and the surveys, was very much on wholesale prices, which can cover a wide range. In fully liberalised traded markets, such as the USA and the UK, the wholesale price would typically be a hub price (e.g. Henry Hub or the NBP). In many other countries, where gas is imported, it could typically be a border price. The more difficult cases are countries where all gas consumed is supplied from domestic production, with no international trade (either imports or exports) and the concept of a wholesale price is not recognised. In such cases the wholesale price could be approximated by wellhead prices or city-gate prices. Generally the wholesale price is likely to be determined somewhere between the entry to the main high pressure transmission system and the exit points to local distribution companies or very large end users.

The initial data collection was done on a country basis. The data were then collated to a regional level using the standard IGU regions shown in the figure below. Most of the regions are defined along the usual geographic lines, although the IGU includes Mexico in North America, and divides Asia into a region including the Indian sub-continent plus China, called Asia, and another region including the rest of Asia plus Australasia which is called Asia Pacific.

In terms of the allocation between different price formation mechanisms in any country, the general rule is that the wholesale price at the “point of first sale” in the country should be considered. For example, if gas enters a country under an oil-indexed contract and is then re-traded at a hub it is still considered to be in the oil price escalation (OPE) category.

²¹ Jamaica and Malta were added this year

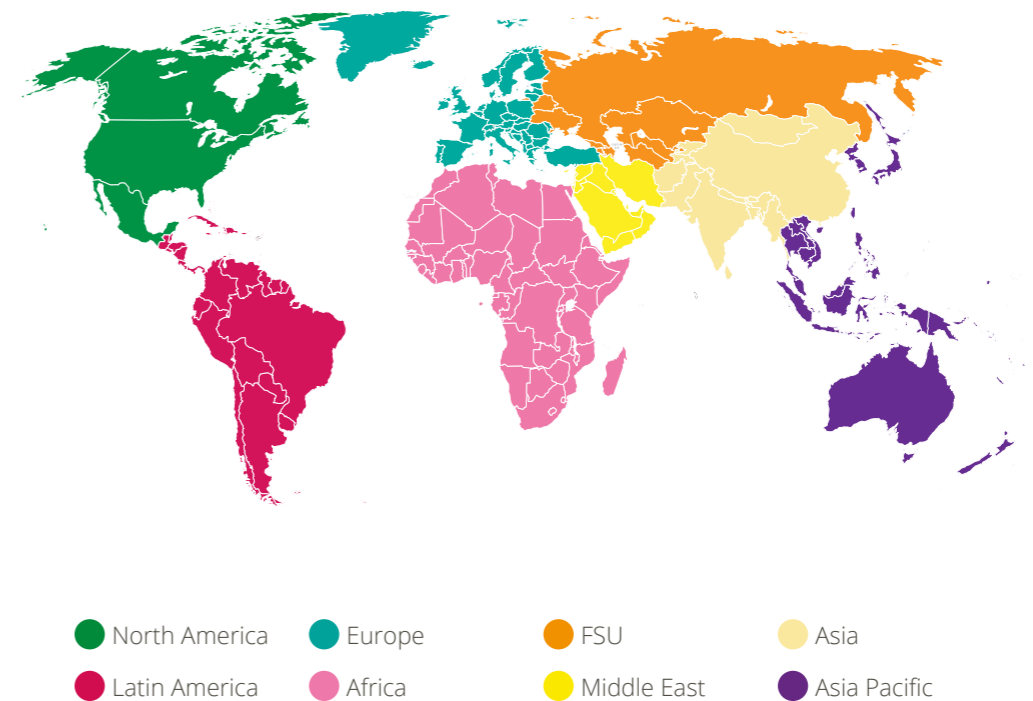


Figure A.1 IGU Regions

Data for each country were collected in a standard format. As an example, a data collection form for the UK is shown in the figure below. Individual country gas demand may be supplied from a combination of three sources – domestic production, pipeline imports and LNG imports (storage is ignored for the purpose of this analysis). For each of these three sources data was collected separately on what percentage of the wholesale price for that category is determined by each mechanism. In some countries, one single mechanism was found to cover all transactions and that mechanism, therefore, was allocated 100%. In many cases, however, several mechanisms were found to be operating, in which cases estimates were made of the percentages for each price mechanism. The only constraint is that the total for each source of gas – domestic production, pipeline imports and LNG imports – must add up to 100%.

Information was also collected on wholesale price levels. This covered the annual average price and the highest monthly average price and lowest monthly average price. All prices were converted to \$ per MMBTU. A comments section was included to identify and acknowledge the source of the information and any other useful information.

All data in the IGU study on gas volumes for consumption, production, imports and exports is taken from the IEA database, supplemented where necessary by any specific country and/or regional knowledge. It should be noted that 2017 volume data is still preliminary and may be adjusted once the final estimates are published later this year by the IEA. In addition previous years may also be revised. These revisions may lead to small changes in the percentages for each price category when country data is aggregated at both the regional and world level.



Figure A.2 Data Collection Form

COUNTRY	UNITED KINGDOM					
REGION	EUROPE					
VOLUMES 2017 BCM	CONSUMPTION	PRODUCTION	IMPORTS		EXPORTS	
			Pipeline	LNG	Pipeline	LNG
	79.6	42.6	39.5	7.2	11.2	0.0
WHOLESALE PRICE FORMATION	Domestic Production		Imports			
			Pipeline		LNG	
OIL PRICE ESCALATION	2.8%					
GAS-ON-GAS COMPETION	97.2%		100.0%		100.0%	
BILATERAL MONOPOLY						
NETBACK FROM FINAL PRODUCT						
REGULATION: COST OF SERVICE						
REGULATION: SOCIAL AND POLITICAL						
REGULATION: BELOW COST						
NO PRICE						
NOT KNOWN						
TOTAL	100.0%		100.0%		100.0%	
ESTIMATED 2016 WHOLESALE PRICE RANGE (\$/MMBTU)	Average		High		Low	
	\$5.73		\$7.05		\$4.68	

A.2 TYPES OF PRICE FORMATION MECHANISMS

In preparation for the initial 2005 survey, a series of discussions were held at the PGCB meetings²² on the definition of different types of price formation. It was decided to use for categorisation purposes the wholesale pricing mechanisms described in Box 3.

²² The Wholesale Gas Pricing Group began life as Sub Group 2 of PGCB and was chaired in the period leading up to the 2009 World Gas Conference by Runar Tjersland of Statoil and since 2009 by Mike Fulwood, formerly of Nexant, but now a Senior Research Fellow at the Oxford Institute for Energy Studies and a Fellow at the Center on Global Energy Policy at Columbia University. It is now part of the IGU's Strategy Committee and has been re-titled as the Gas Pricing Group.

**BOX 3: TYPES OF PRICE FORMATION MECHANISMS**

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 are spot LNG cargoes, 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. Usually 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.

A.3 ANALYSING THE RESULTS

In looking at the different price formation mechanisms, the results have generally been analysed from the perspective of the consuming country. Within each country gas consumption can come from one of three sources, ignoring withdrawals from (and injections into) storage – domestic production, imported by pipeline and imported by LNG. In many instances, as will be shown below, domestic production, which is not exported, is priced differently from gas available for export and also from imported gas whether by pipeline or LNG. Information was collected for these three categories separately for each country and, in addition, pipeline and LNG imports were aggregated to give total imports and adding total imports to domestic production gives total consumption. For each country, therefore, price formation could be considered in 5 different categories:

- Domestic production (consumed within the country, i.e. not exported)
- Pipeline imports
- LNG imports
- Total imports (pipeline plus LNG)
- Total consumption (domestic production plus total imports)

Each country was then considered to be part of one of the IGU regions, as described above, and the 5 categories reviewed for each region. Finally the IGU regions were aggregated to give the results for the World as a whole.

As well as collecting information on price formation mechanisms by country, information was also collected on wholesale price levels in each country. Comparisons of wholesale price levels, however, need to be treated with caution. As noted above, the wholesale price can cover different points in the gas chain – wellhead price, border price, hub price, city-gate price – so the comparison of price levels is not always a like for like comparison.

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