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1: Highlights

The 2016 IGU Wholesale Gas Price survey is the ninth to be undertaken in a series which began 10 years ago. The nine surveys have confirmed the significant changes in wholesale price formation mechanisms during a period of key developments and upheaval in the global gas market. The highlights of the 2016 survey are:

- Gas-on-gas competition (GOG) had the largest share of total world consumption at 45%, predominantly in North America, Europe, the Former Soviet Union and Latin America. The oil price escalation (OPE) share stood at 20%, and is predominantly Asia Pacific, Asia and Europe. The regulated categories – regulated cost of service (RCS), regulated social and political (RSP) and regulated below cost (RBC) – account in total for some 31%. RCS is mainly the Former Soviet Union, Asia and Africa, RSP mainly the Middle East, Former Soviet Union, Latin America and Asia Pacific and RBC the Former Soviet Union, Latin America and Africa.

- Cross border flows of gas account for some 28% of total world consumption. Pipeline imports are now over 57% GOG, with OPE at 35%, while OPE has 76% of LNG imports with GOG at 24%.

- Between 2015 and 2016, the GOG share was broadly unchanged, with an increase in the share in Europe being offset by declines in Asia and Asia Pacific, reflecting fewer pure spot LNG cargoes. The OPE share increased by 1.5 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 half 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 half 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 unchanged.
Since 2005, the GOG share has increased from 31% to 45%, at the expense of OPE which has declined from just over 24% to 20% in total, with the main change being in Europe where GOG increased from 15% in 2005 to 66% in 2016, with OPE declining from 78% to 30%. GOG also gained in Russia in 2009, in Latin America (Argentina especially) gradually through the period and in India in 2015 following the pricing reforms. The decline in OPE in Europe was partly offset by a move to OPE in intra-FSU trade and in 2015 in China when the pricing reforms were extended nationwide to all but the residential and fertilizer sectors.

Within the regulated sectors, RCS and RSP have gained at the expense of RBC – with key changes taking place in the Former Soviet Union, Middle East and Asia, with a more recent change in Africa (Egypt).

Overall, the regulated sectors share had fallen from 38% in 2005 to 31% in 2016, principally to GOG and, to a lesser extent, OPE. This has been one of the most significant changes recently, especially in China and India, with “market-based” pricing gaining at the expense of “regulated” pricing. Since 2009, when GOG in Russia increased at the expense of the regulated categories, there has been little significant change.

The changes in cross-border trade have been predominantly in pipeline imports with the GOG share rising from 23% to 57% between 2005 and 2016, all in Europe, at the expense of OPE. The share of LNG imports has been more stable in recent years, although GOG rose from 13% in 2005 to 32% in 2015, but over half this increase came between 2005 and 2007 as the spot LNG market grew, and then as trading markets such as the UK began importing LNG. The GOG share of LNG imports fell back again in 2016 to 24% as the rise in LNG trade was all in contracted volumes, linked to oil prices, and the growth was also outside the traded markets in Europe. The LNG world became more contracted in 2016.
Within Europe, GOG dominates in Northwest Europe\(^1\) with a 91% share in 2016, and has the largest shares at 58% in Central Europe\(^2\) and 46% in Scandinavia and the Baltics\(^3\). Elsewhere though, the GOG shares are smaller – some 32% in Mediterranean\(^4\) (principally in Italy), and is some 10% in Southeast Europe\(^5\). OPE dominates still in Mediterranean – Spain and Turkey, and has 32% share in Southeast Europe.

Asia, which is dominated by China and India, has seen significant change, initially from RSP to RCS in China in 2009 as prices were increased, and then a continuous rise in OPE, from around 25% in 2009 to 69% by 2016, as China imported pipeline gas from 2010 and the recent changes in domestic city-gate pricing. The GOG share increased sharply in 2015 to 14% as the pricing reforms in India were implemented, before declining slightly in 2016 as spot LNG imports declined.

In Asia Pacific, which is heavily LNG import dependent, there has been little change with OPE around 58% or so for the whole period, before rising to 64% in 2016 reflecting the changing mix in the LNG market. There was also little change in Africa, heavily dominated by RBC in the 70% to 80% range until the change to more RCS and GOG in Egypt and Nigeria, brought the share down to 50% and below in 2015 and 2016 respectively. The Middle East also has shown relative stability, apart from the major Iranian pricing changes in 2012, away from RBC to RSP, as prices were increased.

In the FSU there were early changes away from RBC to RCS in Russia, and the move to GOG in 2009 as independents competed with Gazprom in Russia, but apart from these there have been few significant changes. Latin America has experienced a gradual move to OPE and GOG (Argentina especially), with the regulated categories declining, over the period.

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 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 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.

---

\(^1\) Belgium, Denmark, France, Germany, Ireland, Luxembourg, Netherlands, UK  
\(^2\) Austria, Czech Republic, Hungary, Poland, Slovakia, Switzerland  
\(^3\) Estonia, Finland, Latvia, Lithuania, Norway, Sweden  
\(^4\) Greece, Italy, Portugal, Spain, Turkey  
\(^5\) Bosnia, Bulgaria, Croatia, FYROM, Romania, Serbia, Slovenia
Average wholesale prices at the world level were $3.35 per MMBTU in 2016 which was the lowest level recorded in all the nine surveys. In 2016 prices were also more converged than in previous years, as “market” prices continued to decline, while “regulated” prices predominantly rose, outside the FSU where the currency weakness reduced the prices in dollar terms.
2: Introduction

2.1 BACKGROUND

The 2016 IGU Wholesale Gas Price survey is the ninth to be undertaken in a series which began 10 years ago, at the start of the 2006 to 2009 triennium culminating in the World Gas Conference in Buenos Aires. Prior to the 2016 survey, previous surveys were undertaken for the years 2005, 2007, 2009, 2010, 2012, 2013, 2014 and 2015. The nine 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 2016 survey responses were received for around 70 out of 110 countries, but these responses covered 90% of total world consumption. Data on the remaining countries, where responses were not received, was researched by Nexant 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 meetings6, 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.

2.3 REPORT LAYOUT

Section 3 of the report covers the results at the World level of the 2016 survey for the different categories – domestic production, pipeline imports, LNG imports, total imports and total consumption. A comparison of the results across all nine 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 2016 survey, by region, price formation mechanism and country, and then comparisons over all nine surveys.

Section 5 of the report looks at the individual regions (IGU definitions) results for the 2016 survey, comparisons across all nine 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.

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6 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 of Nexant. 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

<table>
<thead>
<tr>
<th>Price Formation Mechanism</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OIL PRICE ESCALATION (OPE)</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>GAS-ON-GAS COMPETITION (GOG)</strong></td>
<td>The price is determined by the interplay of supply and demand – gas-on-gas competition – and is traded over a variety of different periods (daily, monthly, annually or other periods). Trading takes place at physical hubs (e.g. Henry Hub) or notional hubs (e.g. NBP in the UK). There are likely to be developed futures markets (NYMEX or ICE). Not all gas is bought and sold on a short term fixed price basis and there will be longer term contracts but these will use gas price indices to determine the monthly price, for example, rather than competing fuel indices. Also included in this category is spot LNG, any pricing which is linked to hub or spot prices and also bilateral agreements in markets where there are multiple buyers and sellers.</td>
</tr>
<tr>
<td><strong>BILATERAL MONOPOLY (BIM)</strong></td>
<td>The price is determined by bilateral discussions and agreements between a large seller and a large buyer, with the price being fixed for a period of time – typically one year. There may be a written contract in place but often the arrangement is at the Government or state-owned company level. Typically there would be a single dominant buyer or seller on at least one side of the transaction, to distinguish this category from GOG, where there would be multiple buyers and sellers trading bilaterally.</td>
</tr>
<tr>
<td><strong>NETBACK FROM FINAL PRODUCT (NET)</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>REGULATION: COST OF SERVICE (RCS)</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>REGULATION: SOCIAL AND POLITICAL (RSP)</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>REGULATION: BELOW COST (RBC)</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>NO PRICE (NP)</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>NOT KNOWN (NK)</strong></td>
<td>No data or evidence.</td>
</tr>
</tbody>
</table>
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 2016 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 2016; 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 2016 SURVEY RESULTS

3.2.1 DOMESTIC PRODUCTION

Domestic production in 2016 accounted for some 72% of total world consumption – around 2,620 bcm.

![Figure 3.1 World Price Formation 2016 – Domestic Production](image)
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 44%, totalling some 1,160 bcm, with North America accounting for 832 bcm – almost three quarters 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 155 bcm. The balance is in Europe at 78 bcm – principally the Netherlands and UK, Asia Pacific at 28 bcm – Australia and New Zealand, Asia at 28 bcm – all India, and Latin America at 23 bcm – mainly Argentina and Colombia.

OPE has a relatively small share in domestic production at 9%, totalling some 231 bcm, with 138 bcm in Asia – China and Pakistan mainly, 59 bcm in Asia Pacific – mainly Thailand, with some in Australia, Philippines and Malaysia, 24 bcm in Latin America – Brazil and Colombia, 5 bcm in Europe – small amounts in a few countries, and 5 bcm in Africa, mainly Tunisia.

The regulated categories – RCS, RSP and RBC – in total account for 42% of domestic production, with RCS principally in the Former Soviet Union and Asia, RSP principally in the Middle East, Former Soviet Union, Asia Pacific and Latin America 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 2016 – Domestic Production**
3.2.2 PIPELINE IMPORTS

Pipeline imports in 2016 accounted for some 18% of total world consumption – around 650 bcm.

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

GOG is well over half of all pipeline imports, totalling some 372 bcm, with Europe at 248 bcm and North America the rest. 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 35% of all pipeline imports, totalling some 229 bcm, mostly in Europe with some 119 bcm – Turkey, Italy, Spain and Germany being the main contributors. Asia accounts for some 40 bcm – China, the Former Soviet Union for some 22 bcm – principally Ukraine and Russia, with 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 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.

---

7 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 2016 were almost 750 bcm so effectively 100 bcm was "re-exported" by pipeline.

8 There is a very small amount of RCS in Africa reflecting the regulated transportation tariff element of pipeline gas from Nigeria to Ghana. The BIM category also includes a small element of transportation tariffs, principally Bolivia to Brazil.
3.2.3 LNG IMPORTS

LNG imports in 2016 accounted for some 10% of total world consumption – around 350 bcm.

LNG imports are split 76% OPE and 24% GOG. The regional breakdown is shown in Figure 3.6 below.

OPE at some 266 bcm is mostly Asia Pacific – Japan, Korea and Taiwan, followed by Asia – China and India – and Europe – mainly Spain, Turkey, France and Italy.

GOG totals some 86 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 and Korea taking the largest shares – but also includes Argentina and Brazil.
3.2.4 TOTAL IMPORTS

Total imports in 2016 accounted for some 28% of total world consumption – around 1,000 bcm.

Total imports are the sum of pipeline and LNG imports and comprise the three categories of OPE (49%), GOG (46%) and BIM (5%).
The table below shows the regional and category breakdown in volume terms.

Table 3.1 World Price Formation 2016 – Total Imports

<table>
<thead>
<tr>
<th>REGION</th>
<th>OPE</th>
<th>GOG</th>
<th>BIM</th>
<th>TOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTH AMERICA</td>
<td>0.0</td>
<td>130.5</td>
<td>0.0</td>
<td>130.5</td>
</tr>
<tr>
<td>EUROPE</td>
<td>152.1</td>
<td>265.7</td>
<td>0.0</td>
<td>417.8</td>
</tr>
<tr>
<td>ASIA</td>
<td>91.4</td>
<td>12.1</td>
<td>0.0</td>
<td>103.5</td>
</tr>
<tr>
<td>ASIA PACIFIC</td>
<td>190.5</td>
<td>25.8</td>
<td>0.0</td>
<td>216.4</td>
</tr>
<tr>
<td>LATIN AMERICA</td>
<td>20.9</td>
<td>8.8</td>
<td>1.0</td>
<td>30.7</td>
</tr>
<tr>
<td>FSU</td>
<td>21.7</td>
<td>0.0</td>
<td>29.7</td>
<td>51.4</td>
</tr>
<tr>
<td>AFRICA</td>
<td>4.5</td>
<td>9.6</td>
<td>3.8</td>
<td>17.9</td>
</tr>
<tr>
<td>MIDDLE EAST</td>
<td>13.5</td>
<td>4.6</td>
<td>17.3</td>
<td>35.4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>494.6</td>
<td>457.2</td>
<td>51.7</td>
<td>1003.6</td>
</tr>
</tbody>
</table>
3.2.5 TOTAL CONSUMPTION

Total consumption in 2016 was around 3,624 bcm.

GOG has the largest share at 44%, totalling around 1,614 bcm, dominated by North America at 963 bcm, followed by Europe at some 344 bcm and the Former Soviet Union at 155 bcm. In all GOG can now be found in some 52 countries, in one form or another, and in all regions.

The OPE share at 20%, totals around 726 bcm and is predominantly Asia Pacific (250 bcm), Asia (229 bcm) and Europe (157 bcm). OPE is widespread being found in some 61 countries, including virtually every country in Europe, and in all regions except North America.

The regulated categories – RCS, RSP and RBC – account in total for some 31%, around 1,104 bcm:

- RCS totals some 354 bcm and is in 18 countries, mainly the Former Soviet Union (Russia) and Asia (China), followed by Africa (Egypt and Nigeria);

- RSP totals some 545 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 Asia Pacific – Indonesia and Malaysia, with some in Latin America – mainly Argentina;

- RBC totals some 205 bcm and is in 14 countries, mainly the Former Soviet Union – Kazakhstan, Turkmenistan and Uzbekistan, Africa – Egypt and Algeria – and Latin America – Venezuela.

The BIM share at 4% totals some 137 bcm and is in 24 countries, predominantly Middle East – Qatar, UAE and Israel, Former Soviet Union – Belarus, Asia Pacific – Indonesia, and Latin America – Trinidad.
The NET share at less than 1% totals some 17 bcm in just 2 countries – Egypt and Trinidad.

The NP share at 1% totals some 27 bcm in 10 countries, largely Norway, 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 2016 – Total Consumption

<table>
<thead>
<tr>
<th>REGION</th>
<th>OPE</th>
<th>GOG</th>
<th>BIM</th>
<th>NET</th>
<th>RCS</th>
<th>RSP</th>
<th>RBC</th>
<th>NP</th>
<th>NK</th>
<th>TOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTH AMERICA</td>
<td>0.0</td>
<td>962.8</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.7</td>
<td>0.0</td>
<td>967.5</td>
</tr>
<tr>
<td>EUROPE</td>
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<td>6.8</td>
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<td>26.5</td>
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</table>

### Figure 3.9 Regional Price Formation 2016 – Total Consumption
3.3 WORLD LEVEL COMPARISONS 2005 TO 2016

3.2.1 DOMESTIC PRODUCTION

The main changes in price formation over the nine surveys have been the general rise in GOG from 35% in 2005 to 44% in 2016. The share rose marginally in 2016, as the GOG share rose again in Europe, FSU and Latin America. The OPE category is not particularly large in terms of domestic production, but rose again in 2016 as the full year effect of China extended its pricing mechanism, linking city-gate prices to competing fuels for all sectors other than residential and fertilizers, came through. This resulted in a move away from RCS.

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 2016. A large part 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. There has also been an increase in GOG in Latin America as well, principally in 2009.

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.

3.3.2 PIPELINE IMPORTS

The main changes in the nine surveys from 2005 to 2016 are the continued rise in GOG from 23% in 2005 to 57% in 2016, which has been at the expense of the OPE category. However, the decline in OPE has been 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.
The rise in GOG at the expense of OPE has been entirely in the European market as the Northwest Europe countries began switching to GOG and more recently the Central Europe countries and, in 2014, Italy. In respect of pipeline imports into Europe GOG in 2016 has a 68% share compared to 32% 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 2016 – Pipeline Imports**

### 3.3.3 LNG IMPORTS

The main changes in the nine surveys from 2005 to 2016 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 2013 to 27% and in 2014 to 25%. In 2015 there was a recovery back to a 32% share, but in 2016 the share fell back to 24%.

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 a number of factors:
• The rise in LNG trade was largely built on new projects and contracts linked to oil prices;
• A decline in the volume of pure spot LNG cargoes; and
• The lack of growth in LNG imports in the traded markets in Europe.

Essentially, LNG trade became more contracted in 2016, which benefitted OPE, and the start-up of US LNG exports, effectively Henry Hub priced, only had a small effect.

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

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 2016. 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 16 percentage points and GOG gained a similar share, in large part due to pipeline imports in Europe.

Apart from the very small RCS on the Nigeria to Ghana pipeline
Since 2010 there have been very small quantities of RCS reflecting the regulated transportation tariff element of pipeline gas from Nigeria to Ghana. The BIM category also includes a small element of transportation tariffs, principally Bolivia to Brazil.
3.3.5 TOTAL CONSUMPTION

The figure below shows the changes in the price formation mechanisms over the nine surveys from 2005 to 2016.

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 less than 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 40.7%, 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 3 percentage points, based on the switch to GOG in Europe (and 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 0.5 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 Russia. RCS was down by 1.5 percentage points 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 up marginally, with the decline in Nigeria, being more than offset by rising consumption on Kazakhstan, Turkmenistan and Uzbekistan.

• Between 2014 and 2015, the GOG share increased by just under 2 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 under half a percentage point reflecting the changes in China, partly offset by moves to RSP 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 just over 0.5 percentage points, reflecting moves away in Bangladesh and partially in Egypt.

• Between 2015 and 2016, the GOG share was broadly unchanged, with an increase in the share in Europe being offset by declines in Asia and Asia Pacific, reflecting fewer pure spot LNG cargoes. The OPE share increased by 1.5 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 half 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 half 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 unchanged.
Overall over the 2005 to 2016 period, OPE has declined by 4.5 percentage points, GOG has risen by 13.5 percentage points, BIM has declined by 2 percentage points, RCS has risen by 9 percentage points, RSP risen by 3.5 percentage points and RBC declined by 19.5 percentage points.

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<tr>
<td>2013</td>
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<td>2014</td>
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<tr>
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<td>2016</td>
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<td>9.8%</td>
<td>15.0%</td>
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<td>0.7%</td>
<td>100.0%</td>
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The major overall changes, in the 2005 to 2016 period, have been the continuous move away from OPE to GOG in Europe, from RBC to RCS, RSP and GOG in Russia, from RSP to RCS and OPE in China and from RBC to RSP in Iran and from RBC to RCS in Egypt and Nigeria. GOG and OPE have also recently benefitted from pricing reforms in India and China respectively.

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 above compares the changes in the “market” and “regulated” categories over the eight surveys.

The total of “market” pricing rose from 62% in 2005 to 69% in 2016, mirrored by a decline in “regulated” pricing, from 38% in 2005 to 31% in 2016. 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; and

- The pricing reforms in India, which began in late 2014, moving pricing away from RSP to GOG.
3.4 ANALYSIS OF CHANGES IN GAS-ON-GAS COMPETITION

The rise in GOG from 31% of total world consumption in 2005 to 44.5% in 2016 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 and Argentina.

- **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 nine surveys into these 3 categories.

![Figure 3.16 Changes in GOG 2005 to 2016](image-url)
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 36.9% in 2016 – a rise of almost 7 percentage points. The Bilateral category has risen from 0.9% to 5.7% - a rise of 5 percentage points, while the Spot LNG category has risen from 0.2% to 1.8% - a rise of 2 percentage points. The total rise in GOG between 2005 and 2015 has been 13.2 percentage points.

Just 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. 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 recovered\(^{11}\), before declining again in 2016 as LNG trade became more contracted.

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\(^{11}\) 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.
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 2016 survey; and

• Comparisons across the nine 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 2016 SURVEY RESULTS

4.2.1 PRICE LEVELS BY PRICE FORMATION MECHANISM

The figure below shows a snapshot of wholesale prices for 2016 by price formation mechanism.12

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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 $5.93 per MMBTU, is almost double the $3.01 for the GOG category, which is only slightly above the RCS category. However, the price level in the GOG category is heavily influenced by the relatively low prices in 2016 in North America. If these were excluded then the balance of GOG prices would be much closer to the OPE levels.

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 $1.23 per MMBTU in 2016.

### 4.2.2 PRICE LEVELS BY REGION AND COUNTRY

The figure below shows a snapshot of wholesale prices for 2016 by IGU region.

![Wholesale Prices in 2016 by Region](image)

Wholesale prices can obviously vary significantly from year to year, but both Asia and Asia Pacific had average prices around $6.00. OPE is the primary pricing mechanism in both regions. Prices in Europe, which has the next largely share of OPE, were almost $1 lower than in the Asian regions. Prices in North America in 2016 were below the average for Latin America and even Africa. Prices have fallen back sharply in the Former Soviet Union, in $ terms, reflecting the continued currency weakness, especially for the rouble, to lower levels than in the Middle East.

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 2016.
The highest wholesale prices in 2016 were again found in the main LNG importing countries in Asia Pacific – South Korea, Japan and Taiwan – plus Singapore and China, where domestic prices have a larger weighting of OPE prices. These were followed by some Central European countries plus Israel and 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, Canada and Mexico, where prices are even below those in Egypt, Nigeria, Bangladesh 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. 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 2016

4.3.1 CHANGES IN WHOLESALE PRICES BY PRICE FORMATION MECHANISMS

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

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 in 2015 to $3.74 and in 2016 to $3.01. These changes were largely due to lower North America prices, but most countries with significant GOG saw prices fall in 2016. In contrast OPE prices rose significantly from $5.50 per MMBTU in 2005 to over $10.00 in 2012, as oil prices increased, remaining at that level through 2014, before declining to around $8.00 in 2015 and $6.00 in 2016, following the oil price fall. 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.
4.3.2 CHANGES IN WHOLESALE PRICES BY REGION

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

At the world level, on average, wholesale prices have rose between 2005 and 2013 from around $4.48 per MMBTU to $5.60. This rise was across all regions except 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.
Prices have also converged since 2013, with regulated prices rising and market prices falling. The figure below shows standard deviation of wholesale prices by country and region between 2005 and 2016.

Further analysis on price convergence is being undertaken by the Gas Pricing Group and the results will be published in a separate report later in the year.
5. Regional Level Results

5.1 INTRODUCTION

This section covers the regional level results for the eight IGU regions and for each region the results of the 2016 survey are discussed, followed by a comparison of the results of the nine surveys undertaken from 2005 to 2016.

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.

5.2 NORTH AMERICA

5.2.1 NORTH AMERICA 2016 SURVEY RESULTS

North America consumption in 2016 was some 27% of total world consumption – around 968 bcm.

Figure 5.1 North America Price Formation 2016

GOG clearly dominates the North American market with fully liquid trading markets in the USA and Canada and the wholesale price in Mexico being referenced to prices in the USA. The small amount of NP is in Mexico where Pemex uses the gas in the refinery process and for enhanced oil recovery.
5.2.2 NORTH AMERICA COMPARISON 2005 TO 2016

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 5.2 North America Price Formation 2005 to 2016

5.3 EUROPE

5.3.1 EUROPE 2016 SURVEY RESULTS

European consumption in 2016 was some 14% of total world consumption – around 523 bcm.

Figure 5.3 Europe Price Formation 2016
GOG remains the largest share in Europe, standing at 66%, totalling around 344 bcm. Some 78 bcm is domestic production, mainly Netherlands and UK, with some 249 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 17 bcm, over half of which are into the UK, with the remaining quantities being largely spot cargoes into the more traditional LNG importing countries.

OPE is now down to 30%, totalling around 152 bcm, and is predominantly pipeline imports (119 bcm) into almost every European country, apart from the UK, Netherlands, Denmark, Croatia, Sweden, Austria and Ireland, followed by LNG imports (28 bcm) into Spain, France, Italy, Turkey, Portugal, Poland and Greece, with domestic production (5 bcm) in a variety of countries.

RCS accounts for some 11 bcm and is domestic production in Romania, while RSP also accounts for some 8 bcm and is also domestic production in Poland, Hungary and Croatia.

5.3.2 EUROPE COMPARISON 2005 TO 2016

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 66% in 2016 – when OPE had declined to 30%. The other largely regulated categories – domestic production in Poland, Hungary and Romania – remained at similar levels.

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 pricing formulas where 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 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.

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.
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 Europe\textsuperscript{13} 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 9% OPE and 91% GOG in 2016, as a result of increased hub trading and contract renegotiations, as noted above.

\textsuperscript{13} Belgium, Denmark, France, Germany, Ireland, Luxembourg, Netherlands, UK
Central Europe\textsuperscript{14} has also, more recently, seen significant changes. Apart from the 15\% or so of RSP, in Hungary and Poland, OPE has declined from 85\% in 2005 to 28\% in 2016, while GOG has increased from almost zero in 2005 to 58\% in 2016, principally reflecting increased imports of spot gas, often from Germany, and contract renegotiations.

There has been much less change in other areas of Europe such as the Mediterranean\textsuperscript{15}, where OPE has only declined from 100\% in 2005 to a low of 63\% in 2015, before recovering to 68\% in 2016, reflecting the change in Turkey, and GOG rising from nothing to around 32\%. 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. The change in the Algerian contract into Italy came too late in 2016 to affect the results.

\textsuperscript{14} Austria, Czech Republic, Hungary, Poland, Slovakia, Switzerland
\textsuperscript{15} Greece, Italy, Portugal, Spain, Turkey
In Southeast Europe a very small amount of GOG is shown, from 2014 on, in Croatia but in no other country. 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.

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**Figure 5.8 Southeast Europe Price Formation 2005 to 2016**

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**Figure 5.9 Scandinavia and Baltics Price Formation 2005 to 2016**

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16 Bosnia, Bulgaria, Croatia, FYROM, Romania, Serbia, Slovenia
In Scandinavia and Baltics, 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.

5.4 ASIA

5.4.1 ASIA 2016 SURVEY RESULTS

Asian consumption in 2016 was some 9% of total world consumption – around 334 bcm.

OPE at 69% totals some 229 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 domestic production in Pakistan where the regulator sets gas wellhead prices but linked to the oil price.

GOG at 12%, some 40 bcm, is mainly domestic production in India, reflecting the mainly hub linked pricing formula, and spot LNG imports into India, China and Pakistan.

RCS accounts for some 18%, totalling around 61 bcm of domestic production, mostly in China with around 20 bcm in Bangladesh.

The small amount of BIM at 1% - 3.5 bcm – is in Bangladesh.

17 Estonia, Finland, Latvia, Lithuania, Norway, Sweden
5.4.2 ASIA COMPARISON 2005 TO 2016

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 69% over the nine 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 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. 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 already includes spot LNG in India, China and Pakistan, but these declined in 2016, reducing the GOG percentage to 12%.

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.
5.5 ASIA PACIFIC

5.5.1 ASIA PACIFIC 2016 SURVEY RESULTS

Asia Pacific consumption in 2016 was some 11% of total world consumption – around 389 bcm.

OPE at 64% totals some 250 bcm, with LNG imports – predominantly in Japan, Korea and Taiwan, but also now including Indonesia, Singapore, Thailand and Malaysia – accounting for 169 bcm. Pipeline imports are some 22 bcm into Singapore, Thailand and Malaysia, while domestic production is 60 bcm – mostly Thailand but also Australia and the Philippines.

GOG at 14% totals some 54 bcm, of which 26 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 5% totals some 17 bcm, comprising part of domestic production in Indonesia and domestic production in Japan.

RSP at 16% totals some 63 bcm and is domestic production in Malaysia and Indonesia. NP at 1% or 4 bcm is domestic production in Brunei and PNG consumed in the energy industry.
5.5.2 ASIA PACIFIC COMPARISON 2005 TO 2016

There have been only minor changes in price formation mechanisms in Asia Pacific since 2005. GOG has risen from 11% to 14%, while OPE has increased marginally and RSP down from 23% to 16%. Changes have not been 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 reflects the relatively sluggish growth in consumption in Indonesia and particularly Malaysia. The gradual decline in RCS reflects the changing pricing in Vietnam towards OPE.

Figure 5.13 Asia Pacific Price Formation 2005 to 2016
5.6 LATIN AMERICA

5.6.1 LATIN AMERICA 2016 SURVEY RESULTS

Latin America consumption in 2016 was some 5% of total world consumption – around 170 bcm.

Figure 5.14 Latin America Price Formation 2016

OPE at 26% totals some 45 bcm, mainly domestic production in Brazil and Colombia, pipeline imports into Brazil, Argentina and Venezuela 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, Chile, 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 the transportation element of the imports into Brazil from Bolivia. NET at 8% totals some 13 bcm and is the balance of domestic production in Trinidad used as a feedstock in petrochemicals.

RSP at 21% totals some 35 bcm and comprises domestic production in Argentina, Peru, Ecuador and Bolivia. RBC at 16% totals some 28 bcm and is domestic production in Venezuela, while RCS at 5% totals some 9 bcm and is domestic production in Argentina, Brazil and Colombia. NP at less than 1% or 1 bcm is Cuban domestic production.
5.6.2 LATIN AMERICA COMPARISON 2005 TO 2016

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 21% and a rise in RBC from 0% to 17% - the latter all in Venezuela. The rise in GOG in part is due to rising spot LNG imports in Argentina, Brazil and Chile, 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 5.15 Latin America Price Formation 2005 to 2016
5.7 FORMER SOVIET UNION

5.7.1 FORMER SOVIET UNION 2016 SURVEY RESULTS

Former Soviet Union consumption in 2016 was some 17% of total world consumption – around 620 bcm.

Figure 5.16 Former Soviet Union Price Formation 2016

RCS at 38% is the largest share, totalling some 235 bcm and is almost all the major proportion of domestic production in Russia together with most of the domestic production in Azerbaijan. RBC at 17% or 103 bcm is domestic production in Kazakhstan, Turkmenistan, Uzbekistan and a small amount in Azerbaijan, while RSP at 11% or 70 bcm is a proportion of Russia domestic production (sold to the population) and Ukraine domestic production.

GOG at 25% totals some 155 bcm and is all domestic production to the eligible large customer market in Russia.

OPE at 3% or 22 bcm is all pipeline imports into Ukraine and 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.

5.7.2 FORMER SOVIET UNION COMPARISON 2005 TO 2016

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.
5.8 AFRICA

5.8.1 AFRICA 2016 SURVEY RESULTS

African consumption in 2016 was some 4% of total world consumption – around 132 bcm.

RBC at 48% or some 64 bcm, has the largest share and is domestic production in Egypt, Algeria and Libya.

RCS at 24% or some 31 bcm is domestic production in Egypt, Nigeria and South Africa plus part of pipeline imports from Nigeria to Ghana, Benin and Togo.

RSP at 2% or some 3 bcm is domestic production in Equatorial Guinea, Gabon, Morocco and Tanzania.
OPE at 7% or some 9 bcm comprises part of the pipeline imports into Tunisia and Morocco from Algeria, from Nigeria to Ghana, Benin and Togo, as well as domestic production in Tunisia and part of Ivory Coast and Tanzania.

GOG at 12% or some 15 bcm is part of domestic production in Nigeria (sales to the non-power sector) and spot LNG imports into Egypt.

BIM at 4% 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.

NET at 3% or some 4 bcm is domestic production in Egypt in fertilizer plants.

NP at less than 1% is Angola.

5.8.2 AFRICA COMPARISON 2005 TO 2016

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. The region remains dominated, however, by RBC, with gas prices largely subsidised.

Figure 5.19 Africa Price Formation 2005 to 2016
5.9 MIDDLE EAST

5.9.1 MIDDLE EAST 2016 SURVEY RESULTS

Middle East consumption in 2016 was some 14% of total world consumption – around 489 bcm.

RSP at 75% or 366 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 15% or 74 bcm is partly pipeline imports from Qatar to UAE and Oman and domestic production in Qatar and Israel.

OPE at 3% or 14 bcm is largely pipeline imports into Iran from Turkmenistan, plus some LNG imports into UAE, Jordan and Kuwait.

GOG at 2% or 11 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 2% or 7 bcm is largely gas used in enhanced oil recovery and refineries in Kuwait and Yemen.
5.9.2 MIDDLE EAST COMPARISON 2005 TO 2016

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.

Figure 5.21 Middle East Price Formation 2005 to 2016
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, and 2016 is the second. In the 2016 survey responses were received for around 70 out of 110 countries, but these responses covered 90% of total world consumption. Data on the remaining countries, where responses were not received, was researched by Nexant 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.
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 2016 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

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>UNITED KINGDOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>REGION</td>
<td>EUROPE</td>
</tr>
<tr>
<td>VOLUMES 2016 BCM</td>
<td>CONSUMPTION</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>76.8</td>
</tr>
<tr>
<td>WHOLESALE PRICE FORMATION</td>
<td>Domestic Production</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>OIL PRICE ESCALATION</td>
<td>3.5%</td>
</tr>
<tr>
<td>GAS-ON-GAS COMPETITION</td>
<td>96.4%</td>
</tr>
<tr>
<td>BILATERAL MONOPOLY</td>
<td></td>
</tr>
<tr>
<td>NETBACK FROM FINAL PRODUCT</td>
<td></td>
</tr>
<tr>
<td>REGULATION: COST OF SERVICE</td>
<td></td>
</tr>
<tr>
<td>REGULATION: SOCIAL AND POLITICAL</td>
<td></td>
</tr>
<tr>
<td>REGULATION: BELOW COST</td>
<td></td>
</tr>
<tr>
<td>NO PRICE</td>
<td></td>
</tr>
<tr>
<td>NOT KNOWN</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.0%</td>
</tr>
<tr>
<td>ESTIMATED 2016 WHOLESALe PRICE RANGE ($/MMBTU)</td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td>$4.64</td>
</tr>
</tbody>
</table>
A.2 TYPES OF PRICE FORMATION MECHANISMS

In preparation for the initial 2005 survey, a series of discussions were held at the PGCB meetings\(^{18}\) 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.

<table>
<thead>
<tr>
<th>BOX 1: TYPES OF PRICE FORMATION MECHANISMS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OIL PRICE ESCALATION (OPE)</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>GAS-ON-GAS COMPETITION (GOG)</strong></td>
</tr>
<tr>
<td>The price is determined by the interplay of supply and demand – gas-on-gas competition – and is traded over a variety of different periods (daily, monthly, annually or other periods). Trading takes place at physical hubs (e.g. Henry Hub) or notional hubs (e.g. NBP in the UK). There are likely to be developed futures markets (NYMEX or ICE). Not all gas is bought and sold on a short term fixed price basis and there will be longer term contracts but these will use gas price indices to determine the monthly price, for example, rather than competing fuel indices. Also included in this category is spot LNG, any pricing which is linked to hub or spot prices and also bilateral agreements in markets where there are multiple buyers and sellers.</td>
</tr>
<tr>
<td><strong>BILATERAL MONOPOLY (BIM)</strong></td>
</tr>
<tr>
<td>The price is determined by bilateral discussions and agreements between a large seller and a large buyer, with the price being fixed for a period of time – typically one year. There may be a written contract in place but often the arrangement is at the Government or state-owned company level. Typically there would be a single dominant buyer or seller on at least one side of the transaction, to distinguish this category from GOG, where there would be multiple buyers and sellers trading bilaterally.</td>
</tr>
<tr>
<td><strong>NETBACK FROM FINAL PRODUCT (NET)</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>REGULATION: COST OF SERVICE (RCS)</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>REGULATION: SOCIAL AND POLITICAL (RSP)</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>REGULATION: BELOW COST (RBC)</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>NO PRICE (NP)</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>NOT KNOWN (NK)</strong></td>
</tr>
<tr>
<td>No data or evidence.</td>
</tr>
</tbody>
</table>

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\(^{18}\) The Wholesale Gas Pricing Group is 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 of Nexant. It is now part of the IGU’s Strategy Committee and has been re-titled as the Gas Pricing Group.
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.