The Pricing of Internationally Traded Gas

The Pricing of Gas in International Trade – An Historical Survey

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INTRODUCTION

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This is the first academic book in any language to be entirely devoted to the pricing of internationally traded gas. The majority of books on gas are notably silent on the issue of pricing.[1] Given the sizeable amount of research dealing with international oil prices, this is extremely surprising and would alone be sufficient justification for this work, but there are additional reasons for believing that such a volume is long overdue. First, the growing importance of natural gas in energy balances worldwide, which is partly a function of the expansion of international gas trade. Second the rise to prominence and importance of natural gas issues – and especially pricing issues – in energy and political relations between countries. The best known example of this was a dispute over gas pricing between Russia and Ukraine, which sparked the January 2009 crisis, when Europe lost around 20 per cent of its gas supplies for a period of two weeks. In North America, a surplus of gas in the early 2010s drove prices down to very low levels, creating the possibility of large-scale LNG exports and also a debate as to the impact of exports on domestic prices. In Europe and Asia, the main debate centres on the extent to which the price of imported gas should remain linked to oil products and crude oil (respectively).

This introduction focuses on some specific issues which have arisen during the preparation of the book, in relation to concepts and terminology, with the aim of explaining why natural gas pricing is such a difficult subject to research.

Defining Regions and Trade

All natural gas literature refers to trade within and between geographical regions, and this book is no exception. However, defining regions in relation to natural gas trade and pricing is analytically problematic.

1 Exceptions are Julius and Mashayekhi (1990), Chapter 10 which dealt mostly with domestic gas pricing; IEA (1998) which focused mainly on early liberalization experience; and ECT (2007), Chapter 4 which includes a major analysis of domestic and international pricing in Europe, North America, and for LNG.

Arguably North America – defined as the USA, Canada, and Mexico – is the best example of a coherent region in relation to pricing, possibly due to the very substantial physical inter-linkages between countries. From the early 1990s to the late 2000s, there was reasonable coherence in continental Europe, with the UK having a different price mechanism. But in the early 2010s, significant gas pricing differences have developed between different parts of the continent of Europe. It is doubtful whether South America can be considered as one gas region, or if it should be divided between the Southern Cone, Brazil and Bolivia, and Colombia and Venezuela. Moreover it is unclear whether the Caribbean should be considered part of North America, South America, or as a separate region, or as a region at all.

Similar problems are encountered elsewhere. The main reason we refer to the 'CIS region' is because the countries in this region used to be part of the Soviet Union. But Central Asia (Kazakhstan, Uzbekistan, and Turkmenistan), the Caucasus (Azerbaijan, Georgia, and Armenia), the western CIS (Ukraine, Belarus, and Moldova), and the Russian Federation could all be considered different gas regions, and some countries within those groupings sit uneasily together. The Middle East and North Africa tend to be spoken of as a single region, but in relation to gas, the differences between countries in the Gulf and the Maghreb are very substantial; although not perhaps as great as the differences between North and sub-Saharan Africa. But probably Asia is the most problematic gas region to define, with the established LNG markets – Japan, Korea, and Taiwan – having little in common with China, India, and the countries of south-east Asia (some of which have been LNG exporters but in the 2000s are becoming importers).

But without individual analysis of each country (and sometimes of regions within a country) there is no way to avoid regional generalizations, despite the fact that geographic, economic, or political shorthand may have little relevance to gas trade or pricing. Attention is drawn in the chapters to the differences between countries, and between groups of countries within regions, but readers should be aware of the analytical problems of approaching the subject in this way.

An extension to this problem is that even the concept of 'trade' is difficult to define in relation to gas. While this book treats all gas which crosses a border as 'internationally traded', there are important distinctions between bilateral pipeline trade between neighbouring countries, and trade involving a number of different states as buyers or transit countries. Nor can this be defined in terms of distance: Canadian gas travels very long distances to the USA, much further than Algerian gas to Spain and Italy. But should the former be deemed 'regional' and the latter 'international' (or inter-regional).[2] Likewise should Russian deliveries to Ukraine be considered regional, but its exports to EU countries international, and if so why? All LNG trade is generally classified as international, although North African deliveries to southern Europe travel a fraction of the distance involved in the majority of Atlantic and Pacific LNG trade, with the exception of Sakhalin exports to Japan which could reasonably be considered 'regional'. The conclusion is that geographical classifications of international gas trade are impressionistic rather than precise. But definitional problems notwithstanding, the regional approach still manages to capture the major issues in relation to the ongoing transition of natural gas from local to international or global energy commodity.

Long-term contracts

The focus of this book is *pricing* not contracts, but inevitably the role of long-term contracts is an integral part of the pricing story.[3] With OECD gas markets increasingly determined (or at least influenced) by hub/spot prices reflecting short-term market conditions, it is easy to lose sight of the fact that most international trade (outside North America and the UK) is still conducted on the basis of long-term contracts with complex price clauses.[4] The most important pricing elements of those clauses are: the base price (Po), the index (on the basis of which the base price is adjusted), the frequency of adjustment, the opportunities (if any) to reset the base price and/or the index, any other provisions such as minimum (floor) or maximum (ceiling) price levels. Related to pricing is the take-or-pay clause present in the majority of long-term contracts, which requires the buyer to pay for a specified minimum quantity of the annual contract quantity of gas at the contract price, whether or not that volume of gas has been taken. Long-term contracts – with a duration of 15–30 years – between exporters and importing national or regional utilities provided the basis for the establishment and initial decades of the gas industry's growth.[5]

2 The International Energy Agency's *World Energy Outlook* defines gas trade as 'regional' or 'inter-regional' using its own regional classifications. IEA (2011, 31–5).

3 Conversely, pricing is an integral – but not necessarily the most important – part of a long-term contract.

4 For an encyclopaedic source on long-term gas contracts see ESMAP (1993), which also contains many of the different pricing provisions.

5 Importing utilities traditionally had contracts with large industrial customers

Ownership structures and liberalization

In the majority of exporting countries, national producing/exporting companies were government-owned, but international oil and gas companies also played an important role.[6] In the majority of, but not all, importing countries, the national/regional/municipal utility buyers were owned by the corresponding level of government.[7] These utilities had a *de facto* (and in some cases a *de jure*) monopoly of the customers in their service areas (which in some cases meant the entire country) and consequently governments were responsible for the regulation and pricing of gas to different classes of customer. This determined the structure for the successful development of an industry which depended on very large fixed capital investments in production, pipeline networks, and LNG (liquefaction and regasification) terminals and ships. This structure, and the ownership of the industry, came to be questioned from the mid 1980s onwards, with the privatization of utilities, and the liberalization (de-monopolization) of energy markets, first in North America and Britain, and subsequently more widely in Europe and elsewhere.[8]

Government involvement and commercial risk

The ownership structure of the industry, the size of projects and

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(including power generators) and municipal distribution companies, although not usually of such long duration.

6 Soviet, Algerian, and (initially) Norwegian exporters were government-owned companies but IOCs played a significant role in Norway; in the Netherlands, IOCs (principally Shell and Exxon) were major producers and part owners of Gasunie with the Dutch state. Some of the LNG suppliers to Japan were state-owned companies but export projects in the USA, Abu Dhabi, and Brunei were owned and operated by IOCs. In North America, all gas was imported and exported by private companies with the exception of Pemex in Mexico, but heavily regulated by federal authorities in the USA and Canada.

7 But in North America investor-owned utilities were the norm although the industry was regulated by national (federal) and regional (state) authorities; in Japan, gas and electricity utilities were also privately owned, and in Germany regional utilities were mainly privately owned. In most of the rest of the industry utilities were government-owned until privatizations started in the 1980s.

8 Liberalization and competition happened first in North America, where the industry was already privately owned; Great Britain saw the first privatization of a large gas utility, which was then followed by market liberalization.

investment requirements, and political sensitivity of gas pricing in exporting and importing countries, meant that governments were often intimately involved in major international pricing decisions. In virtually every country governments reserved for themselves (or their regulatory authorities) the right to accept, change, or reject agreements arrived at in negotiations between the commercial parties. Thus, although in theory gas pricing should be decided by commercial parties, in reality most contractual and pricing decisions are at least approved (and in many cases decided) by energy ministers – if not prime ministers and presidents – in importing and exporting countries.

International contracts, which allowed gas industries to develop and expand beyond their indigenous resource base, needed to be long enough for investments to be recovered in exporting and importing countries, and to provide a guaranteed cash flow, thereby assisting the financing of these investments. The logic of the division of risk inherent in these contracts was that:

- the exporter assumed the price risk, in other words, the risk that the price, however determined, would be sufficient to remunerate the investment in production and transportation of gas to the border of the importing country;
- the importer assumed the volume risk (via the take-or-pay provision), namely, that sufficient market would be developed in order to honour the volume terms of the contract. But in countries where imported gas became a large share of total demand, domestic gas prices needed to have an increasingly close relationship to international prices.

In both cases, the implicit assumption was that transactions entered into by both parties (whether state or privately owned) were financially guaranteed by their governments; an assumption which, from the importing side, became increasingly questionable during the 2000s.

Confidentiality and lack of transparency

An important reason why no book on this subject has previously been attempted is the lack of publicly available information, and the reluctance of a relatively small group of international gas stakeholders to disclose such information. This is summed up by Peebles, a well-known industry practitioner who, having described numerous gas contracts in his 1980 study (Peebles, 1980), observed:

> Not unreasonably … contractual details, in particular pricing arrangements, are confidential matters as between buyers and sellers … The main exception to this generality is in the case of [LNG] projects directed at North America where full contractual details, including prices, have to be filed with the appropriate regulatory bodies and as such become matters of public record.[9]

It might reasonably be asked, since North Americans had no problems in disclosing relatively full details of gas contracts and prices governing volumes – mainly comprising Canadian exports to the USA, but subsequently pipeline trade with Mexico, and LNG exports and imports – which accounted for more than 50 per cent of global gas trade in 1970, and remained well over 10 per cent in 2009, why absolute confidentiality was considered normal practice elsewhere. Despite the plethora of trade journals and price reporting services, near-total lack of transparency of pricing and other commercial contractual terms, remains common practice in long-term international (and many domestic) gas contracts. Many long-term contracts have confidentiality clauses stating that none of the commercial details may be disclosed, although this has become decreasingly tenable during the 2000s as price reporting services expanded, via electronic media, making their quotations (irrespective of accuracy) available to a global audience. However, for this reason, the comprehensiveness of sources in many chapters is less than would be expected in an academic book.

Price Formation in International and Domestic Gas Pricing: classifications and terminology

This book is about international, not domestic, gas pricing. A work on pricing in domestic gas markets would run to several volumes. But domestic pricing has a significant impact on international pricing and vice versa, and for this reason plays an important part in the narrative of many chapters in this book. Looking around the world, there are clearly very different methods of pricing gas, and significant differences in terminology for describing them. The International Gas Union (IGU) created a Task Force which carried out four surveys over the period 2005–10 and developed a classification system for gas prices which is reproduced in Box 1. While the focus of, and terminology used in, this book are different, the IGU data are extremely valuable because they cover the entire gas world and provide a database by price formation mechanism and region using a consistent methodology.

9 Peebles (1980, 31 and 201).

Box 1: IGU Price Formation Classifications

Oil price escalation (OPE): price 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.*

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 longer). Trading takes place at physical hubs (for example Henry Hub in the USA) or notional hubs (such as NBP in the UK). If there are longer term contracts these will use gas price indices to determine the price. Spot LNG is also included in this category.**

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.

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.

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 its population.

No Price (NP): The gas produced is either flared, or provided free to the population and industry, possibly as a feedstock for chemical and fertilizer plants. The gas produced may be associated with oil and/or liquids and treated as a by-product.

Notes:
* referred to throughout this book as oil-linked or oil-indexed pricing
** referred to throughout this book as hub-based, spot or market pricing.

Source: IGU (2012, 7).

The first two categories – OPE and GOG – are referred to throughout this book as oil-linked or oil-indexed pricing; and hub-based, spot, or market pricing. These are the two main price formation mechanisms in international gas trade and dominate much of the discussion in this book. The other categories are mainly relevant for domestic gas pricing, but a few international contracts are still priced according to BIM and (in rare cases) RSP. There are some difficulties disentangling the RSP and RBC classifications because of lack of precise definition of, and empirical data on, costs.

Pricing and the subsidy issue

As noted above, the RBC (and potentially also the RSP) category in Box 1 raises the additional conceptual question of whether markets where domestic prices do not reflect international prices are subsidizing consumers. This book uses the term 'subsidy' to denote a situation in which the price paid by consumers does not cover the cost of production and delivery to their premises. However, other literature uses the term to denote prices which are below those in international trade.[10] Using gas domestically, when it could be could be exported, involves a major opportunity cost subsidy, equivalent to the difference between potential export revenues and actual revenues from domestic sales.[11] For importers, it involves governments or state-owned utility companies contributing the difference between the price which needs to be paid for imports, and the revenue which is received from domestic sales. The situation of the exporter is a choice of revenues foregone, which may not be an efficient use of resources, but is one which can be maintained over a long period of time.

Structure of the book

The book is comprised of 14 chapters. Chapter 1 deals with general analytical issues involved in gas pricing. This is followed by a historical chapter covering pricing developments up to the year 2000. Regional

10 For extended discussion of these issues see Chapters 1 and 6, and also Fattouh and El-Katiri (2012a) and (2012b).

11 In many gas exporting countries, gas is being used in the domestic energy market to substitute for oil which is being exported. In those countries, therefore, it can be argued that the correct comparison is not between domestic and exported prices but between export prices for gas and export prices for oil. For a specific discussion of this in an Egyptian context see Darbouche and Mabro (2011).

and national pricing is then dealt with in eight chapters covering: North America, Europe, CIS, Middle East and Africa, Latin America and the Caribbean, south-east Asia, India, and China, with a further chapter dealing with the future of Pacific LNG. These chapters cover pricing developments in the 2000s with a look forward to 2020, and they are followed by two thematic chapters, one on the Gas Exporting Countries Forum and the prospects for cartelization, and the other on the globalization of gas pricing and connections between the three major trading markets. Finally conclusions are offered as to whether the future of international gas pricing in the 2000s is likely to involve globalization, cartelization, or a continuation of regional pricing.

CHAPTER 2

THE PRICING OF GAS IN INTERNATIONAL TRADE – AN HISTORICAL SURVEY

Jonathan Stern

Introduction

This chapter is an historical survey of natural gas pricing in different regional markets from the 1970s to the early 2000s, which has the aim of providing some background to the chapters which follow, where the focus is primarily on the events of the 2000s and future developments. It begins with a statistical history of international gas trade over the past 40 years, which should enable readers to understand the location, evolution, and relative importance of different regional markets in relation to traded volumes of pipeline gas and LNG. This is followed by an account of the history of international gas pricing in the major trading regions, and a conclusion which attempts to identify some patterns of pricing in the evolution of gas trade.

International Gas Trade: a Statistical History

The first record of natural gas crossing an international boundary found by this author is for 1890, when Eugene Coste, a pioneer Canadian entrepreneur, began exports of gas to Buffalo (in New York state) from a well near Niagara Falls in Ontario. He expanded these exports to Detroit in 1895. There are no details of pricing, but it was clearly not under a long-term contract since, within a decade, reserves were nearing exhaustion and the Ontario government, anxious to retain the resource for domestic users, banned exports in 1901.[1] The USA was apparently exporting gas to Canada and Mexico in the 1930s, but data are difficult to locate and volumes were probably relatively small.[2]

European gas trade can be said to have started in 1946 with the export of Soviet gas to Poland. However, the international status of the trade is questionable, as the Stryii field was located in that part of the Ukraine which was formerly Polish territory and had only been incorporated into the USSR in that year.[3] The gas flowed through an existing pipeline, volumes did not exceed 0.35 bcm/year and nothing is known about the pricing arrangements.

The Canadian exports to the USA which began in 1950 can be considered the true start of international – or at least regional – gas trade. This illustrates the relatively short history of internationally traded gas in comparison to oil or coal. Global oil trade totalled 449 million tons (525 bcm) in 1960 rising to 1263 mt (1448 bcm) in 1970 – prices are transparently available back almost to the mid-nineteenth century.[4] Coal trade dates back to the nineteenth century and had grown to 132 mt (roughly 100 bcm) in 1960[5] By contrast, in 1960 internationally traded gas volumes were still only 5.3 bcm and it was not until the following decade that trade expanded significantly, reaching just over 45 bcm in 1970. Of this total, just over half was between North American countries, Europe accounted for just over a third, and Soviet imports from Iran and Afghanistan for 9 per cent.[6] The Japanese import of Alaskan LNG, which had only just begun in 1970, was the only trade in the Pacific and one of only three global LNG trades in that year, the other two being Algeria to France and the UK.

Table 2.1: Growth of internationally traded gas 1950–2010* (bcm)

	Total	*Pipeline*	*LNG*	*LNG % of total*
1950	0.8	0.8	-	-
1960	5.3	5.3	-	-
1970	45.7	43.0	2.7	5.9
1975	125.4	112.3	13.1	10.4
1980	200.9	169.6	31.3	15.6
1985	228.9	178.0	50.9	22.2
1990	307.4	235.3	72.1	23.4
1995	464.9	371.7	93.2	20.0
2000	630.5	492.8	137.7	21.8
2005	861.7	672.8	188.9	22.0
2009	907.0	664.6	242.4	26.7
2010	1015.1	718.9	296.3	29.2

* intra-CIS trade included post-1990

Sources: Table 51 in Cedigaz (2011, 125). Table 38 in Cedigaz (1996, 100).

Table 2.1 shows how international gas trade evolved in the sixty years between 1950 and 2010 with very significant, but uneven, growth over the decades. Broadly speaking there was a more than four-fold increase in gas trade in the 1970s, and a 50 per cent increase in the following decade; during the 1990s trade more than doubled and increased roughly 50 per cent in the 2000s. Pipeline gas trade followed a similar pattern but markedly levelled off in the second half of the 2000s. LNG increased to around 22 per cent of global gas trade in 1985 and retained that share until 2005, but volumes grew nearly 60 per cent in the five years up to 2010 and its share of global trade increased to nearly 30 per cent.[7]

Table 2.2 shows that in 2010, gas trade remained concentrated in four importing regions: North America, Europe, CIS, and Asia.[8] Less than 7 per cent of pipeline gas and LNG was imported by countries

Table 2.2: Growth of global gas imports by region 1970–2010 (bcm)

	Global Pipeline and LNG Imports					*Global LNG Imports Three Regions % World LNG*			
	North America	*Europe*	*CIS**	*Asia*	*Four Regions % Total Imports*	*Asia*	*Europe*	*North America*	*Total*
1970	23.2	16.1	3.6	0.98	100	37.5	62.5	-	100
1982	26.4	130.0	2.3	23.6	97.4	68.7	25.7	4.5	100
1990	43.8	199.5	1.5	51.9	95.5	72.0	24.6	3.4	100
1996	83.0	254.1	102.0	80.1	95.0	77.8	20.9	1.2	100
2000	114.4	309.4	89.5	101.2	97.5	71.5	24.0	4.5	100
2005	142.5	417.5	121.9	141.5	95.6	64.8	25.2	9.9	99.9
2010	144.3	463.7	136.2	201.5	93.2	60.0	29.4	7.0	96.4

* Soviet imports prior to 1990, subsequent years represent imports of all CIS countries. For regional definitions see Appendix 2.1.

Sources: Tables 52 and 56 Cedigaz (2011, pages 131 and 137); Tables 27 and 40 Cedigaz (1997, pages 87 and 101); Cedigaz 1992, Tables 21 and 22, 52–3; Cedigaz 1983, Tables 13 and 14, 32–3.

Table 2.3: Growth of global gas pipeline and LNG exports by region 1970–2010 (bcm)

	North America	*Latin America*	*Europe*	*CIS**	*Africa*	*Middle East*	*Asia/ Oceania*
1970	25.1	-	11.3	3.3	1.5	1.0	2.6
1982	24.6	5.1	61.5	31.2	10.7	2.9	2.3
1990	41.8	2.2	62.2	110.2	32.6	9.8	47.3
1996	84.1	2.4	89.8	225.5	41.9	12.8	72.7
2000	109.4	10.2	109.5	225.8	67.9	29.1	78.6
2005	125.5	32.8	165.6	285.1	93.3	58.4	101.2
2010	124.4	36.4	194.4	294.3	112.9	136.4	116.2

* Soviet Union prior to 1990; subsequent years include trade between CIS countries. For regional definitions see Appendix 2.1.

Sources: Table 52 Cedigaz (2011, 132); Tables 22 and 40 Cedigaz (1997, pages 87 and 101); Cedigaz 1992, Tables 21 and 22, 52–3; Cedigaz 1983, Tables 13 and 14, 32–3; Table 2.15 Stern (1980, 59); Stern 1985, Table 1.2, 24–5.

outside those regions, and less than 4 per cent of LNG was received by countries outside the USA, Europe, and Asia. Asia has dominated LNG imports, and Japanese and Korean imports have dominated Asia.

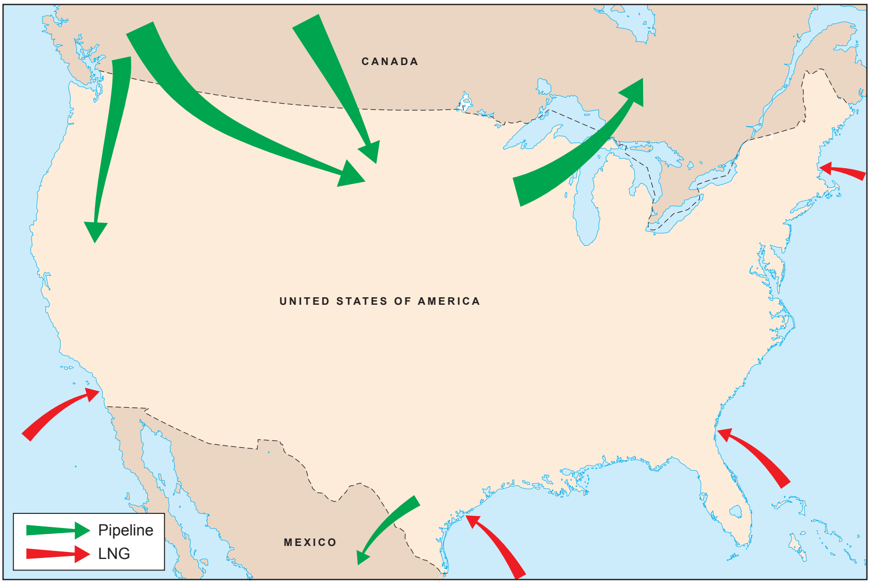
Global gas exports are less regionally concentrated than imports and have become increasingly so over the past 25 years (Table 2.3). In 1996, North America, Europe, CIS, and Asia still accounted for nearly 90 per cent of global gas exports, but by the end of the 2000s that figure had fallen below 70 per cent. During that 15 year period, exports from Middle East and African countries (mainly of LNG) had more than quadrupled to nearly 250 bcm, taking over the leadership position in LNG exports from south-east Asia.

This statistical introduction is completed by Table 2.4 which shows the ten largest gas exporters and importers over the period 1996–2010.

Table 2.4: Largest exporters and importers of gas 1996–2010 (bcm)

	1996	*2000*	*2005*	*2010*
Exporters:				
Canada	80.1	102.2	104.7	92.4
Norway	38.0	48.9	81.7	100.6
Netherlands	45.8	36.6	46.8	53.3
Russia	196.5	186.6	222.6	224.6
Turkmenistan	24.0	36.7	47.0	30.7
Algeria	40.7	61.4	65.3	55.8
Qatar	0	14.0	27.1	94.9
Indonesia	35.3	36.2	36.6	41.3
Malaysia	18.9	22.1	29.8	32.0
Australia	9.9	10.1	14.9	25.4
Total	489.1	554.8	676.2	724.0
As a % of global exports	92.4	88.0	78.7	71.3
Importers:				
USA	81.7	109.0	122.8	104.7
Germany	78.0	76.2	90.8	92.8
Italy	36.9	57.6	73.6	75.3
France	36.1	42.3	49.0	48.9
Spain	8.9	16.7	33.4	36.4
Turkey	8.0	14.3	27.0	36.7
UK	1.7	2.2	16.5	53.6
Ukraine	51.0	52.4	61.1	61.2
Japan	61.9	72.6	78.2	93.5
Korea	13.0	19.8	30.5	44.4
Total	388.8	463.1	582.9	578.9
As a % of global imports	73.5	73.4	67.8	57.0

Sources: Table 52 Cedigaz (2011, 131–2); Tables 27 and 40 Cedigaz (1997, 87 and 101).



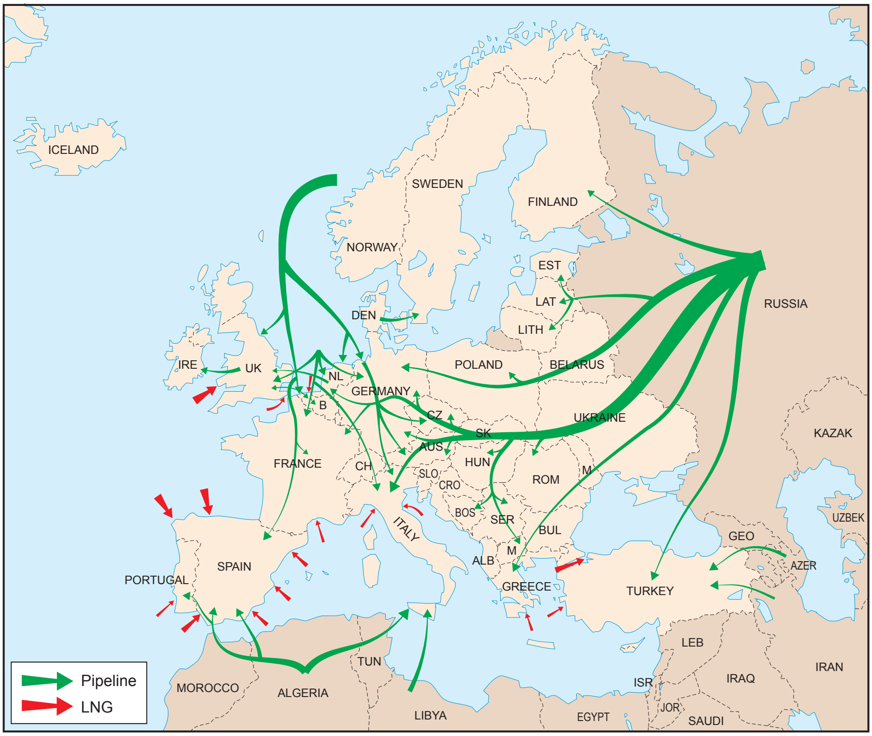
Map 2.1: Gas flows in North America, 2010

This is a somewhat skewed presentation reflecting a decision to focus on the position of countries in 2010. For example, US exports (or possibly re-exports) of gas to Canada would have placed it in the top 10 exporters for much of the historical period, but I have chosen to include Australia, as the latter is poised to become the largest LNG exporter in the world by 2020. Likewise, Russia was a larger importer of gas than the UK for many of the years in Table 2.4, but the UK – which was a net gas exporter for a brief period from 1998 to 2004 – became the seventh largest gas importer in 2010 and will probably move up the rankings in the 2010s. The global share of the 10 largest exporters has become somewhat less concentrated during this period, when it has fallen from more than 90 per cent in 1996 to just over 70 per cent of global exports in 2010, although this misses the dimension of regional concentration of gas exports. The share of the ten largest importers has also fallen, but less significantly, from nearly three quarters in 1996 to below 60 per cent in 2010.

These are the important countries and regions, having participated in international gas trade over the past several decades, on which this chapter will principally focus. For this reason, the chapter concentrates on the pricing of gas in regions which have accounted for the majority of global trade: North America, Europe, the (Soviet Union now) CIS, and Asia, with only a minor focus elsewhere. The rest of this chapter

Map 2.2: Gas flows in Latin America and the Caribbean, 2010

NOTE TO MAPS 2.1–2.6: These maps show the main gas movements (imports and exports) in 2010 which are shown in Tables 2.2 and 2.3. They are schematic and should be taken as illustrations rather than accurate geographical or numerical representations.

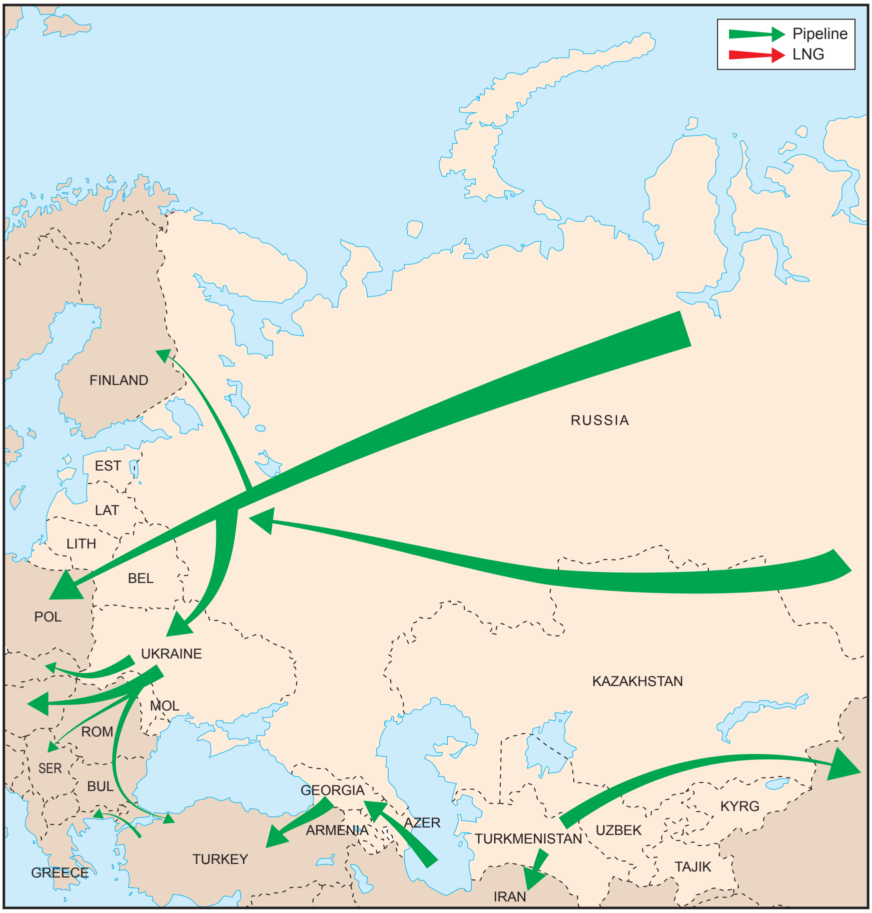


Map 2.3: Gas flows in Europe, 2010

pulls together the main historical gas pricing practices in different regions for the period up to the late 1990s/early 2000s, providing a general backdrop to the subject, and allowing other chapters to focus on regional and national pricing over the past decade in greater detail. Its main focus is on the principles of price formation, rather than the level of prices.

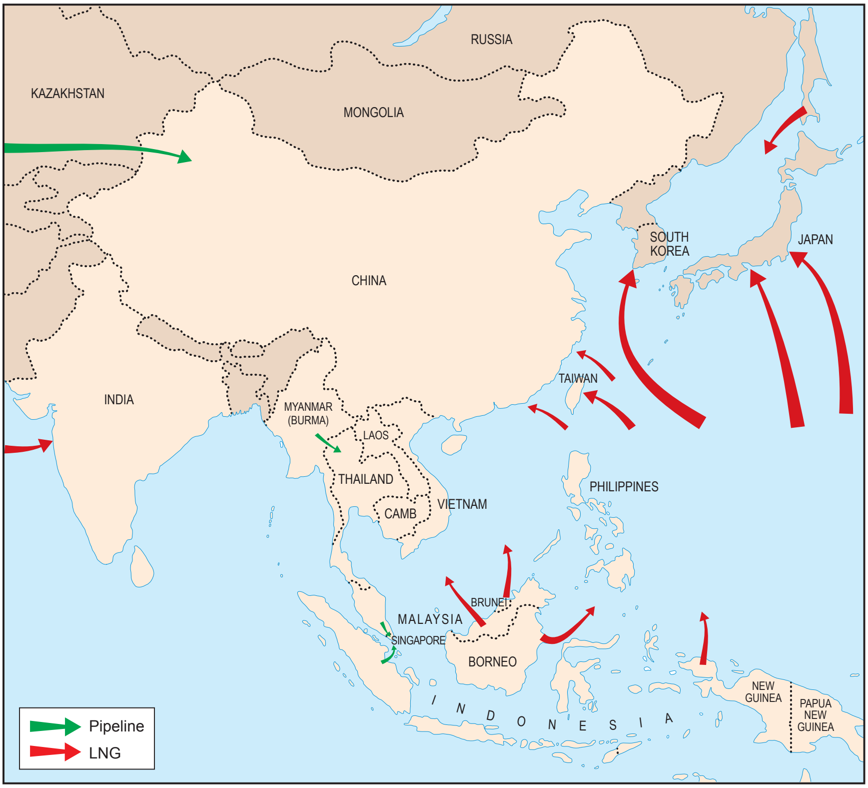
Pricing in North American Gas Trade

In a global natural gas context, the USA and Canada are unusual in that private companies dominate their industries, and while they have strong ties to each other, their markets developed – and remain – relatively isolated from the rest of the world. Private ownership meant that these markets developed the concept of regulation – both state and Federal – from their very earliest beginnings, whereas elsewhere in the world 'government policy' was the major determinant of domestic and international gas development.[9] New York founded the first utility



Map 2.4: Gas flows in Russia and Eurasia, 2010

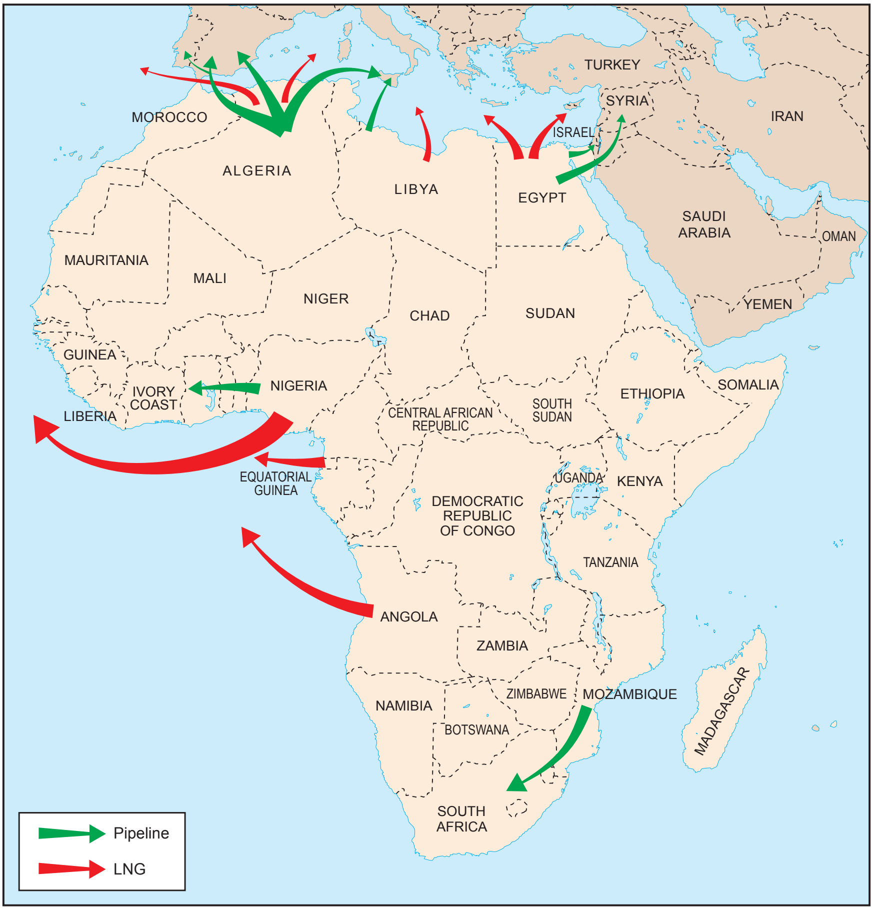
commission in 1907, with administrative and judicial roles; by 1920 thirty five states had followed suit to ensure that prices – known in North America as 'rates' – being charged by gas companies throughout the chain were 'just and reasonable'.[10] That phrase, which is notoriously difficult to define in terms of dollars and cents, resonates throughout the history of North American gas, including cross border trade. In 1930, the US (Federal Power Commission which in 1977 became the) Federal Energy Regulatory Commission (FERC) was established to regulate interstate energy commerce, which includes international trade (such as pipeline imports from Canada and Mexico, and LNG); its Canadian counterpart the National Energy Board (NEB) was created in 1959.



Map 2.5: Gas flows in Asia, 2010

The fact that US imports from Canada still accounted for more than 10 per cent of global gas trade in 2010 and have been by far the largest bilateral transfer of gas between two countries for the past 50 years, means that its pricing has a special place in the history of international gas trade. Despite the fact that prices have been 'deregulated' and set by market forces for most of the past 25 years, the regulated history of US–Canadian gas trade is important, as it provides historical precedents for many international gas price regimes in other regions.

In the mid to late 1950s, Canadian gas exports were priced at $0.22/MMBtu which the Canadian National Energy Board (NEB) considered a 'distress price' and had difficulty considering as 'just and reasonable in relation to the public interest.'[11] However, since the Peace River gas fields and the Westcoast pipeline, which also served Canadian customers, would not have been economic without the Pacific Northwest gas market in Seattle, the Canadian side had no option other than to accept the price, as without the US market it would not have been possible to



Map 2.6: Gas flows in Africa, 2010

attract the finance needed to develop production and transportation. But there was an additional problem: the export price was significantly below the C$0.32/MMBtu price at which gas was sold in the nearby market of Vancouver. Renegotiation between the companies in the mid-1960s raised the export price to C$0.27/MMBtu, but this was not approved by either the US or Canadian regulators. The NEB then set out three tests for the determination of a just and reasonable export price:

- It must recover its appropriate share of the cost incurred;
- It should, under normal circumstances, not be less than the price to Canadians for similar deliveries in the same area;
- It should not result in prices in the US market area materially less than the least cost alternative for energy from indigenous sources.

Prices increased in stages, and in 1977 the NEB developed the concept of 'substitution value', designed to reflect the cost to Canadians of oil purchased on the world market, adjusted for transportation. This raised prices to US$2.16 and then in stages to $4.94/MMBtu in 1981 (Table 2.5).

Table 2.5: Regulated Canadian gas export prices 1972–85 ($/MMBtu)[12]

	Year	*Canadian $*	*US$*
Average	1972		0.30
Average	1973		0.34
Average	1974		0.54
January	1975	1.00	
August	1975	1.40	
November	1975	1.60	
September	1976	1.80	
January	1977	1.94	
September	1977	2.32	2.16
May	1978	2.66	2.30
August	1979	3.28	2.80
November	1979	4.08	3.45
February	1980	5.17	4.47
April	1981	5.88	4.94
April	1983	5.50	4.40
July	1983		4.40 and 3.40 for volumes above 50% of ACQ (Volume Related Incentive Price)
November	1984		Negotiated market pricing subject to Toronto wholesale price floor
November	1985		Negotiated market pricing subject to adjacent zone price floor

Sources: Table 4.4 (Winberg, 101); Table 8.2 (Gibson and Willrich, 217).

Substitution value was crystallized in 1980 into the Duncan–Lalonde formula (named after the Secretaries of Energy of the day) expressed thus:[13]

$$X_1/5.796 - X_2 + X_3 = P$$

Where: X_1 was the f.o.b. price of Canadian oil imports,
5.796 was the conversion factor from dollars per barrel to dollars per MMbtu,
X_2 was the transportation adjustment factor,
X_3 was the weighted average transportation cost of exporting the gas to the USA
P was the price of the gas in US$/MMBtu

The Duncan–Lalonde formula thus created an oil-related price for Canadian gas exports to the USA.

In the early 1980s US gas demand fell (mainly due to a slowdown in economic activity) and production increased. The combined effect of this was to create a gas surplus, which meant that the Canadian prices could not increase further (without becoming disconnected from oil prices) and export volumes fell. This was the period which saw the unfolding of US deregulation following the 1978 Natural Gas Policy Act (NGPA) which had provided for the unravelling of the ferociously complicated regulated wellhead pricing structure in stages up to 1985.[14] As prices were deregulated a surplus of gas developed (known as the 'gas bubble which turned into a sausage'), and with it a spot market based on Henry Hub prices.[15] In 1984–5, FERC Orders 380 and 436 relieved buyers of their obligations to take high price gas on long-term contracts and these were followed by Order 636 (in 1992) which required pipeline companies to move their networks to full non-discriminatory open access. During 1980–83, Canada moved to 'volume-related incentive pricing' (VRIP) in order to recover volume sales and thereafter progressively moved towards market pricing as this unfolded in the USA.[16]

While Canada has always been the largest exporter of North American natural gas, it is not widely known that Mexico also began to export small volumes in the late 1950s and continued to do so in a somewhat sporadic fashion, with long breaks (often of several years) and rarely exceeding 1 bcm/year (with the exception of 1980–83 when exports were in the range of 2–3 bcm/year).[17] The price in the original 1957 contract, which involved a volume of 1–2 bcm/year, had been \$0.14/MMBtu escalating at \$0.002/MMBtu per year, and there was determination not to allow gas to be exported so cheaply in the future. With the initiative to build a major gas export pipeline (the 'Gasoducto') from Mexico to the USA in the late 1970s, the issue of price came to the fore and briefly threatened to provoke a major diplomatic incident between the countries.[18]

The Gasoducto started construction before a price had been agreed, so that by the time it became clear that price would be a problem, investment had already been sunk. After much high-level negotiating, involving the US Energy Secretary, the Director General of Pemex, and the Mexican President, the following price formula was agreed:[19]

$$P = P_0 \times F/F_0$$

Where: P was the price of the gas in \$/MMBtu,
P_0 was the base price on 1 January 1980 of \$3.625/MMBtu,
F was the arithmetic mean of the following crude oil prices:

Arabian light 34, Saharan blend 44, Forties 36.6, Tia Juana 26, Isthmus 34,

F_0 was the value of F on 1 January 1980 = \$27.444/bbl.

This was the Mexican counterpart of the Canadian Duncan–Lalonde formula equating gas prices to rough equivalence with crude oil. However, because of Canadian price increases, agreement was reached between the USA and Mexico in 1980 that competitive pricing should be applied to all imports; in practice this meant parity with Canadian gas prices during 1980–84. But as Canadian prices began to fall, this created problems for Pemex – both because of its growing domestic gas market and because the formula yielded a price at which the US market, already in surplus, no longer needed Mexican gas. Deliveries were suspended in November 1984, and no Mexican gas was exported to the USA until December 1993; exports never regained the levels of the early 1980s, and Mexican imports of US gas increased substantially in the 1990s and 2000s.[20]

In addition to Canadian and Mexican gas, from the early 1970s onwards the USA began to import (as well as export) LNG.[21] A study published by this author in 1985, listed 22 LNG import projects at various stages of operation, suspension, negotiation, and discussion with exporters in: Africa (Algeria and Nigeria), Asia (Indonesia and Malaysia), North America (Canadian Arctic Islands and Alaska), South America (Argentina, Colombia, Ecuador, Venezuela), Trinidad, Norway, Iran, Australia, and the USSR.[22] Of these projects, only the Distrigas peak shaving contract for imports of Algerian gas at the terminal in Everett Massachusetts has operated (with interruptions of only a few years in the 1980s) since 1971. Imports were received under the contracts with El Paso and Panhandle (Trunkline) projects for 2–3 years in the period 1978–80 and 1982–3 respectively. The three terminals built in the 1970s at Cove point, Elba Island, and Lake Charles to receive these (and other) imports then closed, reopening only when market conditions changed.[23]

The main reason for the failure of most of the early LNG projects was pricing. Similar to the Mexican situation, as the US gas market deregulated, all LNG import projects ceased operating, with the exception of Distrigas, as the US government and regulatory authorities refused to approve imports at prices higher than market levels.[24] The price in the Distrigas project was set to be competitive with US domestic gas prices. Small volumes (0.59–0.96 bcm/year) and flexible offtake provisions allowed both sides the option to vary deliveries with market conditions.[25] In 1988, after deliveries had been suspended for three years, the Distrigas contract was amended, creating a minimum f.o.b. price and a reference price, with obligations for the buyer to take a stated number of cargoes at the reference price, which converted to options to take if the price fell below the stated minimum level; recognizing that in a competitive deregulated market it would be impossible for the buyer to take gas above the market price.[26] All of the other projects involved much larger volumes at oil-linked prices, reflecting the Algerian hard-line pricing position in the late 1970s and early 1980s that gas prices should reflect parity with crude oil prices on an f.o.b. basis (see below); this would have brought the price in the El Paso contract up to around $8.00/MMBtu in 1980 (see below Table 2.7).[27]

Table 2.6: US pipeline gas and LNG import prices 1982–92 ($US/MMBtu)

FROM:	*Canada (Mexico*)*	*Algeria (LNG) c.i.f.***	
		*Panhandle****	*Distrigas*
1982	4.87	3.92	5.47
1983	4.51	3.51–3.87	5.15
1984	4.08		4.47
1985	3.18		4.33
1986	2.51		
1987	2.14		
1988	2.00		2.00–3.50****
1989	2.04		1.9–2.2
1990	2.03	1.78	1.78
1991	2.06	1.76	2.29
1992	1.96	1.73	2.43

* equal prices due to MFN agreement;
** prices quoted are for average of four quarters and may not be representative due to different numbers of cargoes being delivered (including none in some quarters)
*** trade terminated in 1983, restarted in 1989;
**** six cargoes only

Source: Cedigaz for respective years

The USA was the first country in the world, followed closely by Canada because of the inter-linkage of the two markets, to move to spot pricing at a hub (generally known as 'market pricing') by removing regulation of upstream pricing and liberalizing access to pipelines. This created a surplus of gas which could not support the much higher oil-linked prices which had been agreed with exporting countries. Once market pricing had been established – on the basis of Henry Hub spot and (after 1990) NYMEX futures prices – it was not commercially feasible for any supplies, domestic or imported, to be delivered on any other price basis, and this was the reason why Mexican and (with one exception) LNG imports at crude oil-related prices collapsed. In the Mexican case, the decision was taken that gas was more valuable domestically; in the case of Algerian LNG, the projects (again with one exception) were all deemed unprofitable at market prices. Canadian gas imports, which (as discussed above) for a brief period 1977–81 had also been oil-related, were adjusted to market price levels without significant difficulty.

North American gas deregulation led to more than a decade of low, market-related prices in the $2–3/MMBtu range, which finished at the end of the 1990s. From then until the mid-2000s, US gas prices fluctuated wildly, exceeding $12/MMBtu in early 2006 and again in early 2008, until the unconventional (principally shale) gas era, ushered in a period of lower prices which during 2011–12 were in the range of $2–3/MMBtu.[28]

South America

Gas trade in South America has a long history of trading relatively small volumes of pipeline gas: Bolivia started exporting gas to Argentina in May 1972 under a 20 year contract (which was extended to 1999, by which time Bolivian exports to Brazil had begun), but because Argentina subsequently discovered domestic gas reserves, volumes never exceeded 2.5 bcm/year.[29] During 1978–84, at the same time as Argentina's own gas production and demand was expanding, Bolivian gas prices (which were linked to oil prices) increased fourfold from around $1.10/MMBtu to 4.25/MMBtu, which meant that the gas was no longer competitive. This led to a renegotiation of prices in 1984, with the base price falling by 20 per cent and the actual price paid based on a 70:30 ratio of the new price formula to the previous formula, with 80 per cent paid in convertible currency and 20 per cent in goods. In this way the price was reduced from $4.25/MMBtu in 1984 to just over $1.50/MMBtu in 1992.[30] Chapter 7 takes up the extremely complex story of pipeline gas and LNG trade in South America and the Caribbean in the 2000s.

International Gas Pricing in Europe

OECD Europe

The discovery of a giant gas field at Groningen in the Netherlands in

1959 launched the large-scale use of natural gas in the north-western part of continental Europe, not just in the Netherlands but, with substantial exports of Dutch gas, also in neighbouring countries. All other large-scale European gas imports from (the Soviet Union now) Russia, Algeria, and Norway which followed in subsequent decades, were strongly influenced by the commercial, specifically the pricing, framework created for Dutch gas exports.

As with so many other issues in relation to gas, there is confusion about terminology in respect of the pricing of Dutch exports. Variously known as: the Groningen principle, replacement value principle, market value principle, and netback market value approach, the origins can be traced back to the Dutch Minister of Economics J.W. de Pous in the early 1960s.[31] The market value principle (shown in terms of a formula in Figure 2.1) is described as follows:[32]

> ...the price paid by the gas company to the foreign or domestic gas producer at the border or the beach is negotiated on the basis of the weighted average value of the gas in competition with other fuels adjusted to allow for transportation and storage costs from the beach or the border and any taxes on gas. There are in principle three different average netback market values. These correspond to existing gas users, new gas users (such as greenfield industrial plants) and to existing oil users with no dual firing capability (the market value of the latter being the lowest because of the high capital cost of fuel switching). The beach/border base price that is ultimately negotiated will correspond to a level between the highest and the lowest of the three values, weighted across the different end-user customer categories. The base price is usually indexed to oil product prices (usually heating oil and/or heavy fuel oil) or simply to crude oil (on the implicit assumption that the ratio of crude to product prices will remain broadly constant). This is to ensure that effective prices over the life of the contract remain broadly in line with market values.

The netback market value concept remained the dominant form of pricing in European long-term contracts in the 2000s, although by the end of the decade it was coming under increasing stress (see Chapter 4). Yet when it was created, the only significant criticism came from Odell who, from the start of the Dutch gas era, argued that the cost base of the industry was low and this method was designed to ensure high profits for a comparatively small number of market players (including the Dutch State).[33] Nearly four decades later this view was endorsed by a more official source:[34]

> … the market value approach enabled Shell, Exxon and the Dutch government to obtain much higher revenues than by pricing based on the low production costs of gas from the Groningen field. It also made sure

The Netback Market Value Concept

The netback market value of gas to a specific customer at the beach or border is defined as follows:

Netback =		Delivered price of the cheapest alternative fuel to the customer (including any taxes) adjusted for any differences in efficiency or in the cost of meeting environmental standards/limits;
	minus	Cost of transporting gas from the beach or border to the customer;
	minus	Cost of storing gas to meet the customer's seasonal or daily demand fluctuations;
	minus	Any gas taxes.

The weighted average netback value of all customer categories is used as the basis for the negotiation of bulk prices at the beach or border.

Figure 2.1: The netback market value concept

Source: IEA (1998, 32).

that the growing use of gas did not abruptly jeopardize the past marketing success for oil products.

This latter point is crucial for understanding the commercial rationale of netback (market) pricing in north-west Europe. In almost every country, gas was replacing oil products, fuel oil, and gasoil (which were being supplied by the same companies involved in domestic gas production and export). Therefore if those products were to be replaced by gas, the latter needed to be priced high enough to recompense them for the loss of oil markets, but low enough to persuade customers to switch to gas, and maintained at a level to prevent those same customers from switching back to oil products. The price of gas was therefore based on those products, with typical shares of gasoil and fuel oil of 50:50 or 60:40 respectively.

To introduce gas into new markets, companies throughout the gas chain needed to build highly capital-intensive infrastructure, principally large diameter pipelines (offshore and onshore), and large distribution networks in order to bring gas to individual customers. They therefore needed to enter into long-term contracts which would oblige all parties to have legal obligations to take or pay for the gas at defined prices until investments had been amortized.[35] The duration of most of these contracts was 15–25 years. Throughout that period, the majority of contracts allowed for a review of prices – a 'price reopener' – only every three years. The principal rationale for a review was to examine a claim by either side as to whether there had been 'changed economic circumstances beyond the control of the parties to the contract', which would justify changing either the base price (the Po) or the indexation formula (principally the gasoil/fuel oil ratio) or both. Failure of the parties to agree a new price level following a review, would trigger an arbitration clause in the contract which (as we shall see in Chapter 4) became much more common in the 2000s and 2010s, but was relatively rare in the first several decades of European gas trade.

A particular feature of the Dutch contracts, especially before many European countries had developed storage capacity, was a relatively high daily and annual flexibility in order to cover seasonal (in other words, temperature related) changes in demand. This was possible because (with the exception of Italy and Switzerland) Dutch gas was travelling only short distances to export markets. For this reason, the contracts contained a capacity charge, in addition to the commodity (gas) charge, which reflected the high levels of daily and seasonal flexibility which Dutch gas was able to provide.[36] All other contracts (Norwegian, Russian, and Algerian) contained a 'take-or-pay' clause which required the buyer to take or (in the event of inability to take) then to pay for a minimum volume of gas, usually 85 per cent of an annual contract quantity, which had to be taken within the gas year.[37] In contrast to Dutch gas, these exporters were delivering through much longer pipelines and needed a high load factor (in other words, high capacity utilization) to ensure a cash flow for the producer/exporter which would enable the latter to borrow money to finance the development of the fields, pipelines, and LNG terminals necessary to produce and deliver the gas.

This system of long-term contracts ensured that no competitive gas could reach markets and hence prevented gas-to-gas competition.[38] The success of the Dutch pricing model demonstrated that substantial profits could be made by selling gas in OECD Europe, and encouraged other producers – including those outside Europe with much higher production and transportation costs compared with Dutch resources – to develop gas for export to Europe.

An alternative price basis to oil products, extensively discussed and included mainly in Algerian gas contracts, was to index gas prices to those of crude oil. As shown in Table 2.7, Algerian gas pricing went through a number of stages which, until the 1990s, had little in common with other exporters. Prices in the early Algerian export contracts eschewed oil indexation because oil prices had declined during the 1960s and investment in pipelines and export facilities meant that construction materials, such as steel, were regarded as a more appropriate index.[39] But Algerian price policy grew steadily more hawkish after the

Table 2.7: Main pricing provisions in Algerian long-term gas contracts, 1960s–90s

	1960s	*Mid-1970s*	*First half 1980s*	*2nd half 1980s*	*First half 1990s*	
Export Market	LNG UK/USA	LNG USA/ Europe	LNG Europe	LNG Europe	LNG USA	Pipeline gas Europe
Base price	$0.305/MMBtu*	$1.3/MMBtu	4.8/MMBtu	$2.3/MMBtu	Market-related	$1.9/MMBtu
Indexation	15–20% to steel product prices and wages	Full indexation to gasoil and fuel oil prices	Full indexation to basket of (official) crude oil prices	Full indexation to basket of crude oil prices (netback values)	Netback f.o.b. price equal to 63% of the sales price	Full indexation to gasoil and fuel oil prices
Floor price	None	$1.30**	None	$1.30***	None	$1.00***

Source: Table 7.7 (Aissoui 2001, 190).

* base price agreed between Sonatrach and El Paso in 1969; other base prices are indicative and may vary from contract to contract.
** indexed to a basket of currencies
*** not indexed

substantial oil price increases in the 1970s and 80s, and its insistence on parity pricing with crude oil on a netback basis led to a hiatus in gas trade. This period, known as the 'Gas Battle', led to abandonment of virtually all LNG exports to the USA and a far less rapid build-up in exports to Europe than had been foreseen.[40] The collapse in crude oil prices in 1986 caused a significant rethink in Algerian gas pricing, because indexation would have yielded a negative price in many cases, with both existing and new contracts coming much more into line with conventional European netback pricing based on oil products.[41] Spain is an exception, where LNG contracts were originally based on oil products and were changed to Brent crude oil indexation in the late 1990s (to reflect competition with Asian markets); pricing of pipeline gas through the GME is based on oil products.

Crude oil parity pricing in European gas trade in the late 1970s and early 1980s was almost entirely focused on Algeria with one exception: the contracts for Norwegian Statfjord exports to continental European countries, concluded at the beginning of 1981, featured a formula which included 50 per cent OPEC and North Sea crude oil prices and 50 per cent heavy and light fuel oil prices.[42] However, the crude oil elements of this were swept away by the Troll contracts which, because of their very substantial volumes, set a new benchmark for European international price levels. Statfjord gas prices were subsequently harmonized with the much larger Troll volumes indexed 50–60 per cent to gasoil and the balance to heavy fuel oil prices and a base price consistent with the flexibility offered.[43] A completely different price mechanism was included in the Norwegian gas sale to the Dutch power generation conglomerate SEP in 1988. This was a 25-year contract with a relatively high base price – reflecting the capital costs of the coal-fired power plants with which the gas would compete – but indexed to coal prices.[44] However, this did not turn out to be a success for the buyer and was never repeated elsewhere.

The UK: from cost-related to NBP pricing

In contrast to the oil-related price mechanisms used in OECD Europe from the 1970s, were various forms of cost pricing used in the UK.[45] From the start of production on the UK Continental Shelf (UKCS) in the 1960s until the market was opened up to competition, including greater international trade, in the late 1990s, the UK market's only significant international exposure was to Norwegian pipeline gas (and much smaller volumes of Algerian LNG). Throughout the negotiations between the state-owned (Gas Council later known as the) British Gas

Corporation (BGC) and the UK Continental Shelf (UKCS) gas producers, the main pricing principle was referred to in the public domain as a 'cost price, a cost-plus price or a cost-related price'.[46] However, in his official history of North Sea oil and gas Kemp traces, from its earliest beginnings in the 1960s, the internal debate and negotiation between the government, Gas Council, and producers, showing how this swung between cost and market-related pricing.[47] In the event, the critical issue proved to be indexation, with the dominant indices in the contracts being changes in costs, rather than competing fuels. Another key difference, in contrast with continental Europe, was that BGC contracts with UKCS producers had no price review or other reopener clauses.

When it came to negotiating an import price from the Norwegian sector of the Frigg field, BGC agreed to pay a slightly higher base price than for UKCS (including UK sector Frigg) gas, but crucially it was indexed to competing fuels both in the UK and low sulphur fuel oil in Rotterdam.[48] The repercussions of the Norwegian Frigg contract were enormous as it contributed around 25 per cent of the UK's gas supply for the first half of the 1980s. In 1978/9 the average price paid by BGC for all of its gas was 4.3 pence per therm (p/th) while Norwegian Frigg cost 12p/th.[49] This led to embittered complaint from a generation of UKCS producers that BGC had discriminated against them in order to secure large volumes of Norwegian gas, with the effect of maintaining its negotiating leverage. The Frigg contract undoubtedly contributed to the subsequent rejection by the government of the Norwegian Sleipner import contract which, coming in 1984 (two years prior to the privatization of BGC) marked the beginning of the government-enforced liberalization of the gas market and gas trade.[50] Not until the mid-2000s, when it became clear that the UKCS production was in serious decline and imports were set to increase substantially, were companies allowed to sign new long-term import contracts with a term of 10 years.[51]

Starting with the privatization of British Gas in 1986, government and regulatory authorities made maximum efforts to promote gas to gas competition and market-related pricing both domestically and in continental Europe.[52] Domestically, the creation of the National Balancing Point (NBP) virtual hub, with a transparent and widely quoted price reference, accelerated the development of a traded market in Britain.[53] Internationally, the government-inspired Interconnector pipeline (IUK) to Belgium opened in 1998, creating a physical, and hence a commercial (price), bi-directional connection between the UK and the continent of Europe for the first time.[54] The IUK exposed north-western continental European countries to pricing and trading influences from the UK market, which eventually led to similar hub development on the other side of the Channel.[55] However, the opposite was also true for the British market where stakeholders who had expected to be 'exporting' market pricing to the continent of Europe, found themselves 'importing' continental European oil-linked pricing. Nevertheless, just as in the case of Henry Hub in North America, the creation of a virtual hub and a traded market meant that all gas – whether domestic or imported – was commercially required to be sold or purchased at NBP prices.[56]

Soviet and CIS Gas Pricing

Although the Soviet Union ceased to exist more than 20 years ago, the country played an extremely important role in both the history of natural gas trade and gas pricing. In 1991, the last year of the country's existence, exports were more than 105 bcm – slightly less than one-third of global gas trade, and the Soviet Union exported twice as much gas as the next largest exporter (Canada).[57] The history of Soviet gas exports to Europe during the cold war period has to be considered in two parts: West European countries; and the socialist countries – members of the Council for Mutual Economic Assistance (CMEA).[58] The CMEA member countries accounted for nearly 37 bcm in 1991, more than 10 per cent of global gas trade in that year. Following the break-up of the Soviet Union and the CMEA, not only were a completely new set of pricing arrangements required between the Russian Federation and the former CMEA member countries, but also between the former Soviet republics which (excluding the Baltic countries) had become members of the Commonwealth of Independent States (CIS).

Soviet gas pricing in Western Europe: from barter trade to independent marketing

While Soviet gas exports were priced similarly to Dutch netback market pricing, but (as noted above) with a high level of take-or-pay instead of a capacity charge, barter trade played an important part in the early exports of gas from the USSR. During the early 1970s, the cost of Soviet imports from large-diameter pipeline and compressor stations (needed to transport the gas to Western Europe) far exceeded earnings from gas exports, and only in the early 1980s did net earnings become positive.[59] However the barter element was not direct, with the loans for pipe and equipment supplied by individual European countries (Germany, France, and Italy) being underpinned by the revenues from long-term contracts for gas supplied to those countries.[60]

In the early 1980s, this same barter element became a major international issue, as the US Reagan Administration attempted to prevent the expansion of Soviet exports to Europe by restricting exports of all materials with US components; efforts which ultimately ended in failure.[61] At that time, the state monopoly gas exporter Soyuzgazexport was being courted by its Algerian counterpart to support the latter's drive for crude oil parity export prices (see above). The response was a polite agreement on the principle, but regret that 'market conditions did not allow for its introduction', and the Soviets continued to price their gas against oil products.[62]

In comparison to the problems of former Socialist countries in Europe (see below), the break-up of the Soviet Union did not create substantial problems for exports to West European countries. Netback market pricing had been established and continued, with the only major change being the name of the Russian counterparty – from Soyuzgazexport to (Gazexport and then to) Gazprom Export. However, change was not completely absent, with the start of an initiative to market gas directly to customers in joint ventures, rather than simply selling gas at the borders of European countries. This began in 1990, prior to the end of the Soviet era, with the German company Wintershall (a subsidiary of BASF) forging two major joint ventures (WIEH and Wingas) which, over the following 20 years built pipelines and storage facilities, marketing Russian gas in a variety of (mainly south-east) European countries in addition to Germany.[63] Following on from the Wintershall example, Gazprom then created a number of joint ventures in countries where it sold gas. It also purchased equity (through the privatization) of gas companies in the Baltic countries (well before they became EU member states in the late 2000s) and elsewhere.[64]

The creation of the WIEH and Wingas joint ventures can be seen as the very early beginnings of competition in European gas markets. While it was pipeline to pipeline, rather than gas to gas, competition (since all of the gas was Russian) it placed a squeeze on the considerable margins being made by midstream incumbents in Europe (particularly Ruhrgas), and showed that customers were interested in obtaining alternative gas supplies at lower prices than their traditional suppliers were offering.[65]

One final observation relating to the history of Soviet and Russian gas pricing. Much will be said in the rest of this book about the development of spot gas sales and pricing, but even in the Soviet era we saw the very beginning of this form of gas commerce with sales outside long-term contracts. These sales were referred to as 'summer gas' because of the season in which they took place, priced below long-term contract levels, utilizing spare pipeline capacity during the period of low demand, and providing importing utilities with lower cost gas to fill their storages in preparation for winter.

Soviet–CMEA gas pricing and its aftermath

Soviet oil and gas exports to CMEA members were priced according to the 'Bucharest formula' which stated that the price should be equivalent to an arithmetic average of 'world market prices' which was relatively straightforward in the case of oil, but for gas in practical terms it meant the price of Soviet exports to Western Europe. However, straightforward calculation was complicated by the barter trade element of Soviet gas exports to Europe, and similarly within the CMEA where European members made direct investments in Soviet gas development at the Yamburg field and in the Orenburg gas pipeline bringing gas to their countries.[66] The formula itself changed significantly in 1975. Before that date, the price was calculated as an average of prices for each of the five years of the preceding five year plan period, which was then fixed for the following five year period. After 1975, the formula changed to an average of the preceding five years and therefore changed each year; this was also known as the 'sliding price' or 'Moscow formula'.[67]

During this period, much commentary from both sides was devoted to determining 'who was subsidizing whom', with the Soviet side claiming that European CMEA countries were receiving huge subsidies in comparison to prices being paid by West European countries, and CMEA countries claiming that they were being forced to invest hard currency in Soviet gas projects, as well as paying prices equivalent to those on world markets (albeit in transferable rubles). The work of Balkay and Sipos, using detailed statistics on oil and gas prices charged for Soviet oil and gas to Hungary, and unit pricing values for all CMEA countries, suggests that from the early 1970s to the mid-1980s, gas was relatively cheap in comparison to oil; a result which would be expected from a formula where price adjustments contain a significant lag in a period of rapidly rising world oil (and therefore European gas) prices.[68] However, for the purposes of this historical survey, the main point is that even in the world of Soviet central planning, all gas export prices (eventually) led back to oil via a formula based on (West European) oil product pricing.

The break-up of the Soviet Union and the CMEA created huge problems for the countries in Europe which were faced with moving rapidly to oil product-linked West European prices. In fact, the Yamburg and Orenburg agreements, despite having been judged as a type of exploitation and forced investment by importing countries, proved to be an extremely useful bridge to netback market prices. These were intergovernmental agreements which guaranteed deliveries of gas under soft currency or barter arrangements until the late 1990s. Even so, during the period 1990–94 deliveries of Russian gas to Central and Eastern Europe fell by 20 per cent, reflecting both economic transition in those countries and price increases.[69] Even by 2010, Russian exports of gas to the former socialist countries of Europe had not returned to 1990 levels. However, during the 1990s, all of these countries moved to traditional netback pricing arrangements as their Soviet era agreements expired, and they increasingly sought (with limited success) to diversify away from Russian gas supplies.

CIS gas pricing in the post-Soviet era

Any difficulties in the gas pricing transition for former CMEA countries paled into insignificance compared with arrangements between former Soviet republics, where movements of gas had been an internal resource transfer overseen by Gosplan.[70] Although the significance of the Soviet break-up went largely unrecognized at that time, inter-republic trade in gas in 1992 was around 100 bcm, which added an additional 30 per cent to global gas trade in that year.[71] Trade between the former republics declined in the early 1990s before recovering later in the decade, but never fell below 70 bcm/year.[72]

CIS gas pricing issues can be divided into four groups of countries: Baltics, Caucasus, Central Asia, and western CIS. The Baltic countries constitute an entirely separate group given their refusal to join the Commonwealth of Independent States (CIS) in 1992 and their determination to adopt a European (rather than a Russian) political and economic orientation, resulting in membership of NATO in 2004 and the European Union in 2007. Rejection of CIS membership meant that Estonia, Latvia, and Lithuania were required to pay Russia for their gas in hard currency at prices which were somewhere between CIS and European levels.[73] The predictable consequence was that, even by 1991, import volumes roughly halved to around 5 bcm/year, and significant debts were incurred (although not remotely on the scale of other former republics) which were not repaid until the late 1990s.[74]

Little is known about the commercial arrangements for Caucasus countries (Azerbaijan, Georgia, and Armenia) because in the immediate post-Soviet period supplies were taken over by Itera – a company which conducted large-scale barter trade for (mainly Central Asian) gas supplies – before being taken back by Gazprom in the 2000s, but in any case volumes were relatively small.[75]

Disentangling the pricing elements of major intra-CIS gas trade flows between:

- Central Asian countries which traded gas amongst themselves with exports of (mainly Turkmen) gas to Russia, Caucasus, and Western CIS countries;
- Russia as an exporter to western CIS countries, and importer and transit country for Central Asian gas;
- Western CIS countries – Ukraine, Belarus, and Moldova – as importers of Russian and Central Asian gas and transit countries for exports to Europe.

is a herculean task because of barter trade of non-energy goods for gas supplies, barter of gas supplies for transit services, the division (and therefore separate pricing) of gas supplies between Gazprom and Itera, and non-payment and treatment of debts for gas deliveries. The rest of this section contains some details of post-Soviet pricing up to the early 2000s, leaving Chapter 5 to deal with more recent events.

In the immediate aftermath of the Soviet break-up, Russia and other exporting countries demanded payment in hard currency at 'world market prices'. However, since there was very little hard currency available at any price, let alone whatever 'world market prices' were intended to be, the result was barter trade, growing indebtedness, mutual accusations of non-delivery, and non-payment leading to periodic interruptions of deliveries. From an international legal perspective, post-Soviet countries signed bilateral intergovernmental agreements which provided a framework within which contractual terms, including pricing, could be decided usually on an annual basis. This is the major example of the 'bilateral monopoly' pricing which features as a separate category in the IGU classifications (see Introduction). In Central Asia, Turkmen export prices to CIS countries (and Iran) in the late 1990s were \$36–40/mcm (or roughly \$1/MMBtu) but only 40 per cent of that price was paid in cash with the rest barter. Turkmen prices increased to \$44–60/mcm by the mid-2000s when the barter element disappeared, and thereafter prices increased significantly, with a form of European netback market prices arriving at the end of the decade.[76] Uzbekistan charged similar prices for exports to other Central Asian countries in the first half of the 2000s.[77]

The most significant single intra-CIS transfer of gas during the

1990s was the 1998 Agreement between Gazprom and Ukraine for delivery of 52 bcm/year of Russian gas at a price of $50/mcm (around $1.45/MMBtu), which was a considerable reduction from the 1997 price of $80/mcm (which had caused a huge build-up of debt). Around 30 bcm out of the 52 bcm was contracted to be delivered in exchange (in other words, as barter) for transit of Russian gas to Europe, which was reflected in a reduction of the transit tariff charged by Ukraine from $1.75/mcm/100km to $1.01–1.09/mcm/100km.[78] In 2001, the price for gas supplied in excess of transit volumes increased to $80/mcm providing a significant incentive not to purchase such supplies, particularly given the availability of lower priced Turkmen gas, so that in reality prices remained at $50/mcm until the mid-2000s.[79]

The pricing of Russian gas to the other two western CIS countries was substantially different, albeit that the sales and transit volumes were significantly smaller, particularly in the case of Moldova. Little is known about Russia–Belarus prices in the 1990s, but in 2002 Belarus was still only paying Gazprom $17–18/mcm ($0.5/MMBtu) roughly equivalent to Russian domestic prices in that year, although it increased to $30/mcm in 2003.[80] When Gazprom demanded an increase to $50/mcm in 2004, Belarusian disagreement gave rise to an interruption of supplies.[81] Moldova had a completely different price relationship with Russia, paying the highest price of any CIS country at $80/mcm starting in 1996, but also charging the highest transit tariff of $2.5/mcm/100km. While payment for a part of the price was deferred until 2004, Moldova was the first of the Western CIS countries to see prices increase very substantially in the second part of the 2000s.[82]

Soviet imports from Iran and Afghanistan and discussions with Asian countries

Before concluding this account of Soviet and post-Soviet gas pricing, it is worth recalling the long-forgotten Soviet imports of gas from Iran and Afghanistan. During the 1970s these imports were substantial, reaching a high of 10 per cent of global internationally traded gas in that year. Indeed as a result of these imports, the Soviet Union only became a net gas exporter in 1974. All of these deliveries were bartered for Soviet delivery of goods and services to the exporting countries. Iranian exports to the Soviet Union through the IGAT 1 pipeline terminated in 1981, shortly after the Islamic Revolution. They resumed under a 15 year contract in 1990 reaching 3 bcm in 1991 but were then suspended following the break-up of the USSR.[83] Somewhat surprisingly Afghan exports continued after the Soviet invasion of 1980, albeit at much lower levels than the 1970s, until 1988.[84]

While Russian LNG exports to Asia became a reality in the 2000s, and pipeline exports to China and Korea are subject to ongoing discussions, it is mostly not known that these projects have long histories. In the case of Sakhalin exports, first discussions date back to the mid-1960s, and the first discussions of exports to China and Korea to the early 1990s.[85] With pricing being one of the major problems in the Russia–China gas relationship, it is to be hoped that a large-scale trading relationship can be established in less than the 45 years it has taken from first discussions to first deliveries of Sakhalin gas.[86]

Middle East and North African Gas Pricing

Recent developments in these regions are considered in Chapter 6, but some historical aspects of the subject are worth considering here, although two of the first trades in the Middle East region, from Iraq to Kuwait, and between countries in the lower Gulf region, ceased some years ago. The longest running gas trade in the lower Gulf was between Sharjah and the Emirates of Dubai, Ras al Khaimah, and Fujairah which began in 1986 and ran for 20 years until volumes began to decrease, finally ceasing in 2010 by which time they had been replaced by Qatari exports from the Dolphin project.[87] Iraqi exports to Kuwait, although on a relatively modest scale, ended in 1990 at the time of the Iraqi invasion.[88] These trades are reported to have been conducted at prices which, in the cases of Iraq–Kuwait and Sharjah–Dubai, remained low ($1.10/MMBtu and $1.25/MMBtu respectively) by international standards, but which were consistent with domestic gas pricing in the region at the time (and still are see Chapter 6). By contrast the price in the Sharjah–Northern Emirates trade was $3.00/MMBtu which was far above domestic prices (and about twice the subsequent price of Dolphin pipeline gas) although for relatively small volumes.[89]

In North Africa, the only early gas trade was linked to the pipeline export of Algerian gas to Italy via Tunisia. When the Trans-Mediterranean pipeline was commissioned Tunisia, itself a gas producer, first took its transit fee in kind and then negotiated additional supplies of gas from Algeria at a price indexed to a basket of crude oils.[90] By contrast Morocco, the transit country for the GME pipeline to Spain, only began to import gas from Algeria in the mid-2000s, using part of its transit fee, nearly a decade after gas flows through the pipeline commenced.[91]

Pacific LNG Pricing: from Fixed Prices to JCC[92]

As noted above, the first LNG was imported into Japan from Alaska in 1969. With no pipeline to take the gas to North American markets, LNG was the only option to commercialize Alaskan gas, and the fact that the fuel was new to Japan meant that neither buyers in Tokyo, nor the US oil companies which were selling the gas, had any significant experience of negotiating commercial gas terms. Perhaps reflecting these factors, Alaskan gas was sold at a delivered (c.i.f.) price of $0.52/MMBtu which was set for a 15 year period with no indexation and no inflation adjustment.[93] The only 'price reopener' was in a clause which stated:[94]

> If in the future another Liquefied Natural Gas project is placed into operation to supply Japan with natural gas from foreign gas sources, such as Alaska, Canada, Australia and the Middle East under similar conditions … Sellers will hold a discussion with Buyers concerning the price as herein set forth, and shall endeavour to find a solution satisfactory to all parties concerned.

In terms of expectations in the late 1960s, it is significant that the most favoured country clause does not mention Brunei or Indonesia – countries which became exporters less than a decade after Alaska, but rather Australia which did not become an exporter until 20 years after the start of the contract, and Canada where exports are yet to start.

The price in Japan's second LNG import contract, with Brunei, which began operations in 1972, was lower than the Alaskan contract at $0.486/MMBtu delivered (DES) to the Tokyo and Osaka regasification terminals; again there was no indexation or inflation adjustment or any price reopener provision in the contract.[95] But there was a take-or-pay provision which was extremely low in the first five to six years of the contract, but 97 per cent thereafter.

Table 2.8 shows that, despite the original contractual provisions, these 'fixed' prices did not last long. The impact of the huge 1973–4 increase in crude oil prices accounted for the progressive increase in LNG prices. However, it is surprising that from 1969–74, LNG prices exceeded crude oil parity on a calorific value basis (Figure 2.2). Only after 1975 did LNG begin to move in step with crude oil prices, and around 1980 most contracts moved to reflect the price of various crude oils imported in Japan. In the 1987 Amendment to the contract between Marathon and Tokyo Electric/Tokyo Gas, the price is indexed to the average of the top 20 crude oils imported into Japan in the previous year, with an adjustment to keep the gas competitive with the price of other LNG imports.[96]

Table 2.8: Japanese LNG prices (MMBtu) 1969–87, c.i.f. Japan

Fiscal Year	*Alaska*	*Brunei*	*Abu Dhabi*	*Indonesia*	*Malaysia*	*Average*	*Crude Oil*
1969	0.52					0.52	0.30
1970	0.52					0.52	0.31
1971	0.52					0.52	0.39
1972	0.57	0.49				0.55	0.43
1973	0.56	0.79				0.69	0.80
1974	0.87	1.44				1.30	1.94
1975	1.35	2.03				1.87	2.03
1976	1.73	1.92				1.89	2.14
1977	1.99	2.07	2.01	2.52		2.12	2.31
1978	2.15	2.20	2.21	2.78		2.40	2.34
1979	2.62	2.63	3.07	4.07		3.33	3.89
1980	5.56	5.59	5.95	5.45		5.55	5.60
1981	5.97	5.95	6.64	5.81		5.86	6.23
1982	5.79	5.78	6.17	5.62	5.58	5.73	5.84
1983	4.90	4.91	5.19	4.84	5.04	4.97	5.19
1984	4.87	4.80	5.17	4.76	5.00	4.84	4.95
1985	4.74	4.69	4.81	5.05	4.79	4.92	4.73
1986	3.13	3.26	3.89	3.46	3.29	3.41	2.70
1987	3.20	3.26	3.41	3.65	3.32	3.45	3.01

Source: Andy Flower

Given the (largely successful) struggle of European importers against crude oil parity pricing of gas in the 1980s noted above, an obvious question is why Japanese importers – apparently with little resistance – accepted this form of pricing. The answer lies in the fact that, in the 1970s and 80s (and still, but to a much smaller extent, in the 2010s), Japanese electricity utilities burned a great deal of crude oil (directly without further refining) in their power stations.[97] Moreover, Japanese electric utilities – principally Tokyo (TEPCO), but also Kansai and Chubu Electric – dominated early imports of LNG. Demand from city gas companies, led by Tokyo Gas and Osaka Gas, accounted for 30 per cent of Japanese imports and this LNG replaced naphtha and LPG. Although Japanese city gas demand has expanded very substantially since the 1970s, power companies still dominate Japanese LNG imports. With LNG able to directly replace crude oil in Japanese power stations, and as crude oil exporters (and OPEC members) such as Abu Dhabi and Indonesia became major exporters, the logic of linking LNG prices to those of crude oil was rational, with the latter providing an 'official' price benchmark to which LNG could be linked.

The history of the post-1980 evolution of Japanese LNG prices, concentrating on the 2000s and the development of 'S-curves', can be found in Chapter 11. The rest of this section will focus on the development of the Japan Customs Cleared crude oil price mechanism; often referred to as the 'Japan crude cocktail' (or JCC). As noted above, the practice of using a crude oil-related price for LNG imports into Japan dates back to the mid-1970s but the term 'JCC' is of a more recent vintage. As noted above, and shown in Figure 2.2, around 1980, prices in LNG import contracts began to shift towards an average of crude oils imported into Japan, although LNG exporters (at least initially) favoured their own crude blend – Murban in the case of Abu Dhabi, Minas in the case of Indonesia.[98]

There are two parts to the story of JCC: the concept itself, and the derivation of 'the slope' – the adjustment of the LNG import price to the movements of crude oil prices. As far as the concept is concerned, an important development is believed to have occurred in 1979 during the negotiation of the Malaysian LNG contract between Petronas and TEPCO/Tokyo Gas (which was eventually signed in 1983). The Malaysian side did not wish to use the index of Indonesian crude oil prices which had been adopted in the contracts with Pertamina, and sought its own crude oil formula. The initial agreement settled on a price at a significant premium to crude oil prices, but before deliveries started this was renegotiated to a formula to apply for the first four years of deliveries. Fifty per cent of this formula was linked to the average

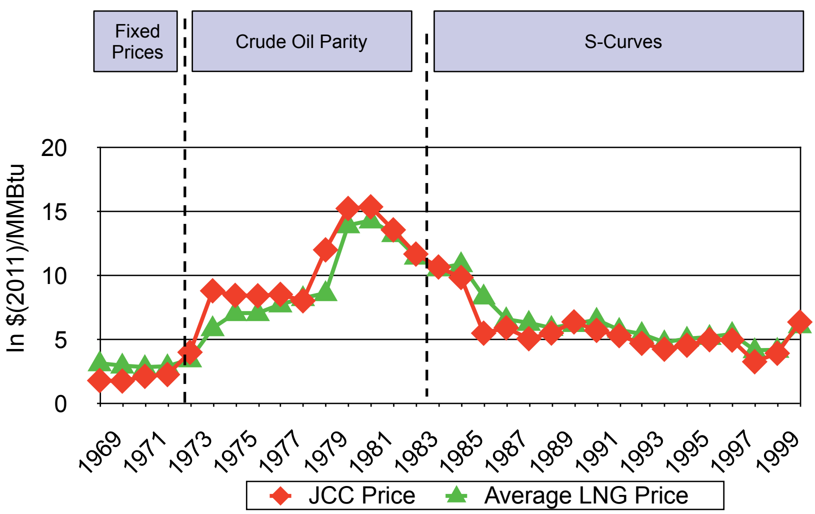


Figure 2.2: Crude oil prices and average Japanese LNG prices 1969-2000 (in real 2011$)

Source: Andy Flower

price of crude oil (including condensate) imported into Japan – which the Malaysians referred to as a 'cocktail' (hence JCC) – and 50 per cent to the official Malaysian Government Selling Price (OGSP) for crude oil. In this way, the formula took account of the markets of both sides in the negotiation. Starting in 1988, the Japanese Ministry of Finance began to publish monthly statistics of Japanese customs cleared crude oil prices in its so-called 'yellow book', a practice which continues today on its website.[99] The Malaysian contract did not use the term 'JCC', nor did the Australian North West Shelf (NWS) contract, signed in 1985, which was 100 per cent linked to the weighted average landed price at Japan of all crude oil imported into Japan.[100] However, by the early 2000s, the term JCC was beginning to feature in contracts.

The derivation of 'the slope' – the adjustment of the LNG import price to the movement of crude oil prices – is equally important and is described by Andy Flower in the only accessible source for this important historical development.[101] Over the history of LNG in Asia the most commonly used factor is 0.1485, frequently referred to as a slope of 14.85 per cent (see Appendix 2.2). This figure dates back to one of the first major long-term LNG contracts negotiated for supply to Asian markets – the contract for 8 mtpa (10.4 bcm/year) between Indonesia's oil and gas company, Pertamina, and Japan's Western buyers consortium (Chubu Electric, Kansai Electric, Kyushu Electric, Osaka Gas, Toho Gas, and Nippon Steel) which was finalized in 1973.

The price formula results in a premium over crude oil parity at low oil prices but the premium erodes as the oil price increases (Figure 2.3). The LNG price falls to crude oil parity at around $26/bbl. In 1973, crude oil prices above $20/bbl, let alone the $100/bbl of 2011 and early 2012, could hardly be imagined in a world where a more than doubling of the price to $6/bbl in 1973 had caused the first 'oil shock'. However, the pricing formula introduced the principle of buyers being prepared to pay a premium price for their LNG at low oil prices as a way of ensuring that the safety and reliability of LNG supply was not compromised by sellers having to cut costs. The declining premium as the oil price increased helped the buyers when margins were likely to be squeezed in their downstream markets by high raw material costs. This principle has been evident in LNG pricing since 1973, for example, in the introduction of S-curves into Asian price formulae in the late 1980s and again since the late 2000s.

Oil price linkage was adopted by all the projects supplying Japan (the only LNG buyer in Asia until 1986 when Korea started importing) but the 0.1485 factor remained unique to Indonesian LNG until the collapse of oil prices in late 1985/early 1986. In many cases, non-Indonesian

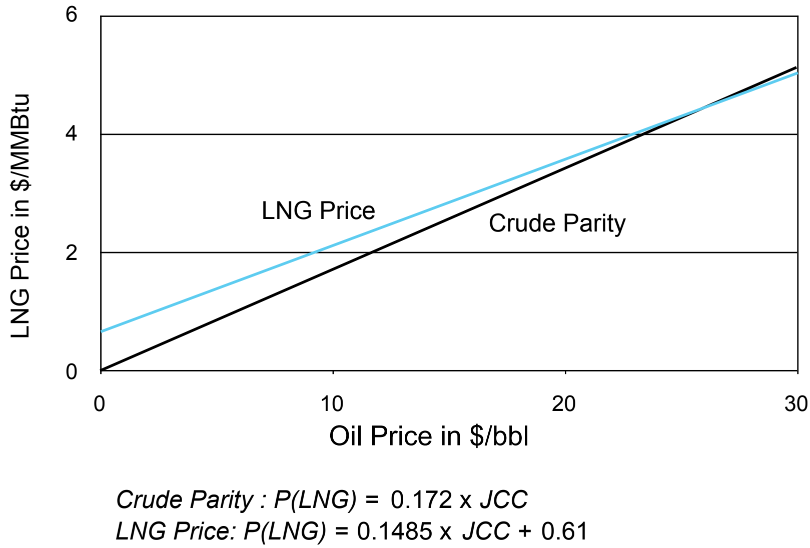


Figure 2.3: Indonesian LNG price in 1973 and crude oil parity

Source: Andy Flower

projects had been using crude oil parity pricing based on the OGSP of crude oil. As producers stopped selling crude oil at OGSP prices in the late 1980s and adopted much lower market prices, LNG sellers and buyers needed to find a new approach to pricing that worked for both parties in a low oil price environment.

By the time other Pacific Basin importers – South Korea in 1986 and Taiwan in 1990 – started to import from Indonesia, Japan had already been importing LNG for 15–20 years. In 1990, Japan imported nearly 52 bcm of LNG and was the overwhelmingly dominant force in global trade, accounting for more than 70 per cent of total imports.[102] These importers therefore had little alternative but to accept a crude oil pricing mechanism similar to that currently operating in Japanese contracts, and this has continued up to the present (see Chapter 11).

The only pipeline gas trade in Asia prior to 2000 was the Malaysian export to Singapore, which commenced in 1992. The pricing terms of this trade are discussed in Chapter 8.

LNG Spot Trading: an Emerging Phenomenon in the 1990s

Thus far the discussion of LNG pricing in both the Pacific and elsewhere has been in the framework of long-term contracts. But spot

LNG sales (sales outside existing long-term contracts) started to appear at the end of the 1980s. The initial spot trades were either commissioning cargoes for trades where contracts had not yet commenced, or opportunistic sales by exporters with spare capacity due to a hiatus or cancellation of existing long-term contracts. The first reference found by this author to spot sales of LNG is in 1989, when three cargoes were shipped to Japan from Algeria, followed by two further shipments in 1990. These sales appeared to be at prices substantially below Japanese contract prices.[103] However, global LNG spot trade did not reach 10 bcm/year until 1999, becoming substantially larger in the 2000s.[104]

Summary and Conclusions: International Gas Pricing from the 1960s to the Early 2000s

Large-scale international gas trade started only in the 1950s, much later than its major fossil fuel competitors, oil and coal, and until the 1970s was mainly regional and dominated by exports of Canadian gas to the USA. In the 1970s, gas began to be traded more actively in Europe still on a regional basis. With the arrival of Soviet gas and Algerian LNG in Europe, trading became increasingly international, a major global development being the start of Japanese LNG imports. Even by 2010, four regions: North America, Europe, CIS, and Asia accounted for 93 per cent of all international pipeline and 96 per cent of LNG imports, with virtually no gas traded in Africa, little in South America or in Asia aside from the major LNG importers. However, in the two decades leading up to the early 2000s, which are the focus of this chapter, gas trade expanded substantially from an essentially regional phenomenon – of pipeline connections between adjacent countries – to an international business; volumes crossing borders tripled, and LNG exceeded 20 per cent of total gas trade.

During this period gas imports, particularly those of significant volumes, were mostly sourced from and delivered to OECD countries. This was due to a number of factors: these countries had established gas markets (even if originally based on manufactured gas); the relatively large size and potential for expansion of their markets made construction of substantial infrastructure commercially viable; and crucially their domestic prices were not subsidized (in other words, prices paid by the end consumer covered the cost of production and delivery).[105] In many, if not most, countries outside the OECD these conditions – aside for the potential for major expansion – were not present. In post-Soviet CIS, established markets were huge but so were the subsidies in the pricing structure inherited from the Soviet Union. Nevertheless an immense production and transportation infrastructure had already been established in most countries, albeit under a different economic system, which then embarked on a transition to a market economy which is still underway.

The pricing of internationally traded gas has always been problematic from an analytical standpoint. Confusion over economic principles (see Chapter 1) has not been helped by the confidentiality of the business (see Introduction) which, outside North America, has prevented all but the commercial parties themselves from obtaining any information about prices, or by the constant intervention of governments and regulatory authorities into commercial negotiations. The early pricing arrangements in North America started from a regulated 'cost plus' basis, but evolved into oil-linked prices in the 1970s, and by the mid-1980s to market pricing based on Henry Hub/NYMEX spot and future prices.

Continental European import prices were based on and indexed (largely) to oil products (fuel oil and gasoil) and remained so, although with changes in the share of the products, throughout the period. The UK priced on a different basis using cost-related pricing for domestic gas, but with oil-related prices for the sole significant import contract from Norway. In the late 1990s, the British market was liberalized, and pricing moved to a spot basis at the NBP virtual hub.

Soviet gas exports to Western Europe initially had a large element of barter trade (with pipe and compressors being imported using gas export revenues) and investment in Soviet gas projects guaranteed reduced prices in soft currency and barter for European CMEA members. The post-cold war era saw the end of these arrangements for Russian exports to Europe, but the start of large-scale barter trade between (former Soviet now) CIS countries, particularly gas for transit services involving Russia, Central Asia, and Western CIS countries – a practice which continued until the mid-2000s.

Japanese LNG imports began with fixed-price contracts (at a premium to crude oil prices), but moved to reflect the crude oil prices of the LNG exporting country. By the early 2000s, they had moved to an average of crude oils imported into Japan, with Japan crude cocktail (JCC) becoming a common benchmark for LNG importers in the Pacific.

For the majority of importing and exporting countries the choice of oil prices against which to price gas was logical, in that all gas importers were also using oil in their energy balances – a growing share of which was imported. Gas imports were in most (although not all) cases replacing crude oil and oil products in energy balances; a process which also created a logical commercial relationship. Most of the early gas exporters were also crude oil exporters who thus also saw a logical linkage, leading to the claim that gas should be priced at parity with crude oil. An additional strong argument for both parties was that the price of crude oil and oil products was set by mechanisms which – even though they could not be said to be a product of supply and demand as understood by economists – could not be influenced by gas exporters or importers; in other words an independent price reference which could not be manipulated.

Problems began to emerge with this pricing logic, starting in the 1980s in North America, and gradually spreading to other countries in the 1990s and 2000s. Gas was increasingly successful in replacing oil in stationary energy sectors, and increasing oil prices confirmed the wisdom of switching to gas for all end-users with access to a network. At this stage of market penetration, gas was no longer replacing oil products in energy balances; it had established a large share in stationary energy sectors and was expanding that share. In both North America and Europe, oil had retreated into the transportation sector and specialist petrochemical uses. The original rationale for price linkage – that end-users could switch between oil products and gas – began to break down. In many countries, new environmental regulations increasingly prohibited large-scale use of oil products for use in industry and power generation. These developments were followed by a drive towards liberalization and competition – known in North America as 'deregulation' – where a combination of government policy and regulation, together with a surplus of gas supply, moved prices away from linkage to oil, and created gas-to-gas competition, with market prices formed at (virtual and physical) hubs. However, outside North America and Britain[106] these developments were ignored by the majority of both gas exporters and importers, who were content with a pricing system which guaranteed them high and rising financial returns in a period where – with only a few exceptions (particularly the mid-1980s and late 1990s) – oil prices had continued to increase.

This historical survey of pricing suggests that international gas pricing could be said to have followed an 'evolutionary path' of three stages: cost-related (or regulated in some other way), to oil-related, and finally to market-related (hub-based) pricing. This is persuasive in relation to North America and the UK but, by 2000, was by no means an established trend elsewhere.[107] The key development for industries which moved to hub-based pricing was the liberalization (de-monopolization) of the industry, in particular access to networks, and the introduction of gas-to-gas competition. However, these markets also had a significant number (and in the case of North America thousands) of stakeholders, particularly in the production of gas, which made competition more feasible. The other shared development was that once a spot and futures pricing system based at hubs – Henry Hub in the USA, NBP in the UK – became the price benchmark of the industry, this applied to all gas sold in the region, including imported gas. In other words, aside from long-term 'legacy' contracts which may need to be allowed to run their course, once markets liberalized, it became impossible for any new gas supply, from whatever source, to be sold on any basis other than hub pricing.

But in moving to market pricing, traditional long-term contracts in North America and the UK were terminated, partly because their terms reflected the monopoly power of incumbents which had disappeared in a competitive market, and partly because of a need to move from the rigid structures of these contracts to the flexibility of spot pricing and trading. However, both North America and the UK were largely self-sufficient in gas and liberalization initially created substantial supply surpluses. In countries which did not have substantial domestic gas production, governments and utilities viewed security of supply through a lens of long-term import contracts, and were reluctant to introduce policies which might jeopardize the contractual and pricing status quo.

In 2000, prior to the global surge in LNG trade, and with spot trade only just beginning to make an appearance, there was no discussion of globalization of gas markets. The Gas Exporting Countries Forum had not yet come into existence and therefore there was little consideration of the possibility of organized cartelization. Up to the end of the twentieth century therefore, gas was a world of regional markets with regional prices. But much was to change in the 2000s; events during that decade and the future of pricing in the 2010s are examined in the following chapters, and in the Conclusions.

Appendix 2.1: Cedigaz regional definitions

Australia includes the overseas territories.

OECD comprises Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, USA.

OPEC comprises Algeria, Angola, Ecuador, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, Venezuela.

Africa comprises Algeria, Angola/Cabinda, Benin, Cameroon, Congo, Egypt, Ethiopia, Eritrea, Gabon, Ghana, Ivory Coast, Kenya, Libya, Morocco, Mozambique, Namibia, Nigeria, Senegal, South Africa, Sudan, Tanzania, Tunisia, United Republic of Congo, Zambia, Zimbabwe.

Asia/Oceania comprises Afghanistan, Australia, Bangladesh, Brunei, China, India, Indonesia, Japan, Malaysia, Myanmar, New Zealand, Pakistan, Papua New Guinea, Philippines, Singapore, South Korea, Taiwan, Thailand, Vietnam.

CIS comprises Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan.

Europe comprises Albania, Austria, Belgium, Bosnia & Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Macedonia (FYROM), Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom.

Latin America comprises Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, El Salvador, Ecuador, Guatemala, Haiti, Honduras, Jamaica, former Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay, Venezuela.

Middle East comprises Abu Dhabi, Bahrain, Dubai, Fujairah, Iran, Iraq, Israel, Jordan, Kuwait, Oman, Qatar, Ras al-Khaimah, Saudi Arabia, Sharjah, Syria, Yemen.

North America comprises Canada, Dominican Republic, Mexico, Puerto Rico, USA.

United Arab Emirates comprises Abu Dhabi, Dubai, Sharjah, Ajman, Umm al-Quwain, Ras al-Khaimah and Fujairah

Source: Cedigaz 2010, Appendix 2, 182.

Appendix 2.2: The Origin of the 14.85 per cent Slope in Asian LNG Pricing[108]

The pricing formula in most long-term LNG Sales and Purchase Agreements (SPAs) in Asian markets can be reduced to the simple linear form:

$$P(LNG) = A \times P(CrudeOil) + B$$

Where:

$P(LNG)$ is the price of LNG in \$/MMBtu
$P(CrudeOil)$ is the price of crude oil in \$/bbl
A and B are constants negotiated by the buyer and seller.

The constant A is usually referred to as the 'slope' and in long-term contracts currently in operation ranges from 0.05 to 0.183. The two sides agreed some basic parameters to determine the price of the LNG under the c.i.f. contract which came into operation in 1977:

- The price would be made up of an f.o.b. (free on board) element plus the actual cost of transportation of the LNG from Indonesia to Japan. The buyers, seller, and the shipping company (the ships were chartered to Pertamina on a long-term basis) were to meet each year to agree the total cost of the shipping and to assess how that translated into a cost per MMBtu of LNG transported;
- The base f.o.b. price would be \$0.99/MMBtu which would apply at an oil price of \$6/bbl;
- The f.o.b. price would escalate 90 per cent with the oil price and 10 per cent with inflation;
- Rather than using actual US inflation it was agreed that the rate would be assumed to be 3 per cent per annum.

Applying these parameters, the pricing formula was:

$$P(LNG) = \frac{0.9 \times 0.99 \times P(CrudeOil)}{6} + 0.1 \times 0.99 \times (1.03)^n + FR$$

Where:

n is the number of years with $n = 0$ in 1973
FR is the freight rate (transport cost).

The oil-related element of the price: $\frac{0.9 \times 0.99 \times P(CrudeOil)}{6}$

simplifies to: $0.1485 \times P(CrudeOil)$

So the factor 0.1485 came from a set of assumptions, rather than from a figure that was the outcome of a typical price negotiation in which each side proposes a price and then the two sides enter in discussions which generally result in an agreement somewhere around the mid-point of the proposals by the buyer and the seller.

The freight rate was around \$0.50/MMBtu in 1977 when deliveries started and remained at around that level until the price formula was renegotiated in 2000. The inflation element in the f.o.b. price was \$0.11 in 1977, which meant that the LNG price when deliveries commenced was:

$$P(LNG) = 0.1485 \times P(CrudeOil) + 0.61$$

The way in which the LNG price using this formula moves with the oil price is shown in Figure 2.3, which also shows, for comparison, the crude oil parity price, that is, the price of LNG if 1Btu delivered to the market was the same price as 1Btu of crude oil. The conversion has been made by multiplying the crude oil price by 0.172, on the basis that the average barrel of crude oil produces 5.8MMBtu of heat when burnt, and 1 divided by 5.8 is 0.172

By 1986, the Indonesian price was:

$$P(LNG) = 0.1485 \times P(CrudeOil) + 0.645$$

Other projects proceeded to use this formula as a basis for new prices, with a slope of 14.85 per cent or a slope close to that level. The main difference between projects was in the size of the second constant, with the outcome ranging from 0.65 to 0.80. Price renegotiations in the 1990s generally focused on the second constant, with the slope remaining unchanged at, or close to, 14.85 per cent.

Notes

1 Canadian Centre for Energy Information (2004, 21).
2 Ratner et al. (2011, 5).
3 Peebles (1980, 168).
4 BP (1960, 11), BP (1970, 10), BP (2011, 16).
5 IEA (2003b, 21).
6 The North American figure is the total of exports of gas from Canada and Mexico to the USA; Canada and Mexico also imported a total of

0.7 bcm in that year from the USA.

7 The share of LNG in Table 2.1 declines in the 1990s because of the increase in international trade due to break-up of the USSR.

8 The definition of these regions can be found in Appendix 2.1.

9 It was not until the late 1980s that the term 'regulation' became commonly used in relation to gas industries outside North America. Even the terms 'state' ('provincial' in Canada) and 'federal' regulation are confusing if applied to most other countries where policy and regulation are either 'regional' or 'national' (state). And the term 'deregulation' which was commonly used in North America in the 1980s to denote abolition of regulation which had built up over the previous decades, was – completely inappropriately – applied to other countries which were creating both new regulation and regulatory authorities.

10 Herbert (1992, 42).

11 Much of this section is taken from Chapter 10 Winberg (1987).

12 All prices in this section are in nominal dollars i.e. money of the day.

13 Stern (1985, 55).

14 A detailed history of this period of US gas deregulation can be found in Chapter 5 of Tussing and Barlow (1984).

15 This is what Foss (2011, 28–38), refers to as the 'glubbausage'.

16 Stern (1985, 34–7)

17 Table 1.1, 24–5 in Stern (1985), for 1950–83. EIA for 1979–2011.

18 Much of this discussion is taken from Chapter 3 of Stern (1985).

19 Stern (1985, 89).

20 EIA.

21 US LNG exports to Japan are dealt with in the section on Asia below. This section deals only with large-scale LNG trade by ship; the USA has also exported small volumes of LNG to Canada and Mexico by truck. Ratner et al, (2011, 7).

22 Table 4.1, Stern (1985, 109–15).

23 Lake Charles was opened in 1982, closed in 1983, and reopened in 1989; Elba Island reopened in 2011, and Cove Point in 2003.

24 Table 2.6 shows that the Panhandle project continued to operate but cargoes were very limited.

25 Cedigaz (1991, 63).

26 Cedigaz (1991, 150–1) shows the minimum prices levels for 1989–91 and the formulae for calculating the reference price. The same source (147 and 149) has similar information on the Sonatrach–Panhandle contract which never resumed deliveries in 1989 following a break of 6 years, other than a limited numbers of cargoes.

27 Stern (1985, 74–9). Aissoui (2001, 188–94).

28 Foss (2007) and (2011), and Chapter 3.

29 IEA (2003a, 135).

30 Mares (2006, 174–5).

31 Taken from the famous 'nota de Pous' which set out the principle in a

Ministerial document in 1962. Correlje el al. (2003, 68); ECT (2007, 100).
32 IEA (1998, 32).
33 Odell (1969). For an in-depth history of the origins of Dutch gas pricing see Correlje et al. (2003, 30–48).
34 ECT (2007, 147).
35 As far as distribution networks were concerned, the task was most often that of converting from town gas (manufactured from coal or naphtha) to natural gas, rather than building a new network.
36 ECT (2007, 152).
37 In many European contracts the 'gas year' i.e. the year to which the annual contract quantity refers, runs from 1 October–30 September, to reflect the winter period in the northern hemisphere.
38 Correlje et al. (2003, 70).
39 Aissoui (1999, 38) recalls that during 1961–9 middle distillate prices declined by 18%.
40 Stern (1984, 73–87); Aissoui (1999, 42–6).
41 ECT (2007, 161–3).
42 ECT (2007, 160). To be strictly accurate, gas from fields other than Statfjord was also involved. One reason for the very high price was fierce competition between British and continental European buyers for the gas. Stern (1984, 18–21).
43 ECT (2007, 160–1). This reflected conditions in the Dutch contracts.
44 'SEPrise! Norwegian, Dutch Coast Raid Gets Green Flag', *Gas Matters*, 20 September 1988, 1-7.
45 The relevance of this was that for much of this period the UK was the largest gas market in Europe.
46 Dam (1976, 75).
47 Kemp (2011a, Chapter 4, especially 140–235).
48 The actual price formula can be found in Ibid, 287.
49 Ibid, 291.
50 For a complete account of the negotiations on Sleipner see Kemp (2011b, 32–50).
51 Table 3.2, Wright (2006, 72).
52 For the history of these developments see Chapters 3 and 4 Wright (2006).
53 Heather (2010).
54 Futyan (2006). This was not the first gas pipeline connection between the UK and continental Europe; that connection had been established with the export of Markham field gas to the Netherlands in 1992.
55 See Heather (2010), Heather (2012), and Chapter 4.
56 In many cases this required the termination of existing long-term contracts, or renegotiation of their price terms. However, in some cases 'legacy contracts' continued to run well into the 2000s with unchanged price terms, reflecting the lack of reopeners in the contracts.
57 Table 31, Cedigaz (1993, 80).
58 Hungary, Czechoslovakia, German Democratic Republic (East Germany),

Poland, Romania, Bulgaria. CMEA was also known as Comecon.
59 Stern (1980, 99).
60 For details see Stent (1982).
61 For details see Chapter 6, Jentleson (1986).
62 Stern (1984, 57).
63 For details see Stern (2005, 111–14).
64 Ibid, Table 3.2,113; Grigas (2012).
65 IEA (1998, 34); Lohmann (2006, 134–7).
66 Balkay and Sipos (1986, 157–9).
67 Ibid.
68 Balkay and Sipos (1986, 160–1). Table 3.2 Stern (1980, 82).
69 Stern (2005, 110 and 114–7).
70 The main central planning authority in the Soviet Union.
71 Derived from the net export figure from Table 3 in IEA (1995, 175) and Table 34 in Cedigaz (1993, 83). It took many years before major international statistical sources began to record trade between the former Soviet republics as part of international gas trade.
72 For details of intra-CIS gas trade in the 1990s see Chapter 2, especially Tables 2.1 and 2.2 in Stern (2005, 68–9).
73 Grigas (2012).
74 Table 3.3 Stern (2005, 126–7); Table 5 Stern (1999, 156).
75 Table 2.2 Stern 2005, 69 and 82–6).
76 Pirani (2009, 292–3). The Iranian price was 100% cash.
77 Table 11.10 Zhukov (2009, 373).
78 Yafimava (2011, 153–4). In the event, no gas was delivered in excess of the volumes bartered for transit.
79 Ibid,154–61.
80 Industrial prices in Russian Zone 5 in 2002 were 550 rubles/mcm, roughly equivalent to $18/mcm. Table 1.15 Stern (2005, 45).
81 For the full story of the Russia–Belarus gas relationship, including how prices were related to Gazprom's purchase of the Beltransgaz network, see Chapter 7 in Yafimava (2011).
82 For the full story of the Russia–Moldova gas relationship, including the distinction between Moldova and Transdniestria, see Chapter 8 in Yafimava (2011).
83 Adibi and Fesharaki (2011, 288–9). Only in 2006 did Iran restart its gas trade with the former Soviet Union in a swap deal by which Tehran supplies gas to the Azeri enclave of Nakhichevan and receives 110% of those volumes from Azerbaijan (see Bowden 2009, 225). Following that, the long-awaited completion of the Iran–Armenia pipeline allowed gas exports to start in 2010, in exchange for deliveries of power to Iran.
84 Tables 19 and 21 in Cedigaz (1990, 36 and 38).
85 For a history of the Sakhalin projects see Stern and Bradshaw (2008); for a history of pipeline gas to China see Chapter 7 in Paik (1995).
86 See Chapter 5 and Henderson (2011).

87 Dargin and Flower (2011, 449–50). It is arguable whether this meets the definition of 'trade' (see introduction) given that it was between parties which comprised the United Arab Emirates.
88 Yacoub and Rutledge (2011, 242).
89 Table 48 in Cedigaz (1993, 120). Prices are quoted for the year 1986; The Iraqi price was $1.00/MMBtu f.o.b. plus $0.1/MMBtu for transportation. For a survey of domestic pricing policy in this region see Fattouh and Stern (2011, 537–41) which shows (Table 15.4) that domestic gas prices in UAE in the mid to late 2000s were still only $1–1.05/MMBtu. See also Chapter 6.
90 Otman and Darbouche (2011, 96–102).
91 Ibid, 111–22.
92 The assistance of Andy Flower in providing information contained in this section is gratefully acknowledged.
93 Jones (1998, 52).
94 Section 9.1(b) of the contract.
95 DES stands for 'delivered ex ship' in contrast to c.i.f. which is a price inclusive of cost, insurance, and freight; the only difference between the prices is the location at which ownership of the gas is transferred to the importer.
96 Cedigaz (1991, 148–9). Marathon had a 30% share of the volumes in the Alaska contract (and Phillips Petroleum the other 70%).
97 This practice has continued into the 2010s but increasingly only to cope with emergency power shortfalls, for example in the wake of the March 2011 Fukushima nuclear accident.
98 Cedigaz (1991, 148).
99 Trade Statistics of Japan, Ministry of Finance, www.customs.go.jp/toukei/info/index_e.htm
100 The contract uses similar wording to the Malaysian contract to describe how the average price of Japanese imported crude is determined. 'The prices and quantities of imported crude oil and the exchange rates to be used in the determination of the weighted average price mentioned above shall be based on the statistics in "Japan Exports and Imports Monthly" edited by the Customs Bureau of the Ministry of Finance, and published by Japan Tariff Association'.
101 Most of the rest of this section is taken from Flower (2011); the arithmetic basis for the figures is explained in Appendix 2.2.
102 Table 32 in Cedigaz (1991, 109).
103 Table 30 in Cedigaz (1990, 61); Table 30 in Cedigaz (1991, 70–2). The average price of the 1989 cargoes was $2.71/MMBtu and the 1990 cargoes $2.76/MMBtu compared with the average Japanese import price of $3.26/MMBtu in 1989 and $3.60/MMBtu in 1990.
104 For details see Chapters 11 and 14, especially Table 14.3.
105 This refers to the RBC, RCS, and NP price categories in Box 1 of the Introduction.

106 Liberalization of utility industries also proceeded in Australia and New Zealand, but these developments had little impact elsewhere.
107 But in fact, the period of oil-linked pricing was relatively short in North America, and only existed in relation to the main pipeline gas import project (as opposed to domestic gas pricing) in the UK.
108 This appendix is an abridged version of Flower (2011, 5–9).

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