Part I

Introduction and context

1 Introduction to the study

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Natural gas is rapidly gaining importance in global energy markets. Prized for its relatively clean and efficient combustion, gas is becoming the fuel of choice for a wide array of uses, notably the generation of electric power. Natural gas is projected to be the fastest-growing major source of primary energy over the coming decades, with global consumption increasing nearly two-fold by 2030 (EIA 2004; IEA 2004). In the next few years, gas will surpass coal to become the world's second most important energy source; by 2050 gas could surpass oil to occupy the number one slot. Recent price increases do not fundamentally challenge the economic viability of this robust gas future.

There is plenty of gas to satisfy these visions of global gasification. The broadest measure of gas available totals about 350 trillion cubic meters (Tcm), or roughly 130 years at today's rate of consumption (USGS 2000). Even "proved reserves," a narrower measure of just the gas that has been detected and is commercial to develop using today's technology, suggest that scarcity is unlikely to impede a global shift to gas. The widely referenced *BP Statistical Review of World Energy* reports 176 Tcm of proved gas worldwide, or nearly 70 years at current production levels (BP 2004).

The geographical, financial and political barriers to gas development, however, will be harder to clear. A high proportion of the most prolific gas resources is concentrated in areas that are remote from the United States, Western Europe, China, Brazil, India, and other areas where demand growth is expected to be strongest. Admittedly, the technological hurdles to moving large volumes of gas over long distances are falling rapidly. Already today, one-quarter of world gas consumption is the result of international trade. Pipelines account for 78 percent of that

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trade; ocean-going tankers carrying liquefied natural gas (LNG) convey the rest (BP 2004). However, pipeline and LNG infrastructures are extremely costly to build and require long time horizons and a predictable economic and political context for investors to sink their capital and knowledge. The International Energy Agency's (IEA) comprehensive assessment of future investment in energy found that about 3 trillion dollars in investment will be needed to meet the growing demand for natural gas between now and 2030 (IEA 2003a). Most of the investment will be needed upstream – in exploration, production, and processing facilities – in increasingly remote areas where it has already proved difficult to do business. Two countries alone – Russia and Iran – account for nearly half the world's proven gas reserves (BP 2004).

The growing role for cross-border gas trade will force new political attention on the security of gas supplies. In the past, "energy security" has been debated almost exclusively in terms of oil markets; the shift to gas will force governments and consumers to ask similar questions of an increasingly vital gas supply. Emerging relationships between major gas suppliers and key end-use consuming countries will create new geopolitical considerations rising to the highest levels of economic and security policy.

This book focuses on the political, economic, and security dimensions of the global shift to gas. We look to history to explain why governments and investors have cleared the financial and political barriers for some international pipeline and LNG projects yet failed in many other ventures. And we look to the future – deploying a newly developed economic model of world gas trade – to examine how key political and technological factors may affect the evolution of a global gas market.

In this opening chapter, we offer a brief review of how gas rose to prominence and, at present, is becoming a globally traded commodity. Next, we introduce the two main elements of our study. We look historically at seven case studies that reveal how governments and firms have addressed the geopolitical issues surrounding major international gas trade projects. Then, we look to the future to examine how the business may unfold over the next three decades.

Throughout this book, our quarry is "geopolitics," which is a concept that bears explanation. For many analysts, geopolitics is the competitive zero-sum game played by nation-states in their pursuit of power and security. In this traditional view of international politics, prevalent especially during the Cold War, countries are primarily concerned about gains from trade, investment, and military action *relative* to other national competitors. Greater territory and resources for one party necessarily create a loss for others.

Our concept of geopolitics is broader. It is the influence of geographic, cultural, demographic, economic, and technological factors on the political discourse among international actors. In this definition, relative gains matter, but so do joint gains from possible cooperation. In so far as geography, technology, and political choices direct gas trade along one route at the expense of another, investment and revenues are diverted as well, with considerable political implications. Countries that commit to importing large volumes of gas place the security of their energy systems partly in the hands of others, which in turn gives both suppliers and users of gas a stake in the internal political stability of one another. This is what we mean by "geopolitics of gas" – not simply an endless jockeying for global position, but also the immensely political actions of governments, investors, and other key actors who decide which gas trade projects will be built, how the gains will be allocated, and how the risks of dependence on international gas trading will be managed.

A Primer: From Local to Global Markets for Gas

Humans have been aware of the seepage of natural flammable gases from the earth for at least several thousand years. There is an early reference in ancient China to the use of gas for heating pans of brine water to produce salt. But gas was not used extensively as a fuel source until the nineteenth century.[1] While natural gas was used as early as 1821 to illuminate the town of Fredonia, New York, its widespread use in the United States awaited the rise of the petroleum industry, beginning with the Titusville, Pennsylvania, finds of 1859. Natural gas "associated" with oil was a nuisance for the Pennsylvania oilmen who vented and flared the hazardous byproduct. However, enterprising businessmen soon saw the possibility of transporting it by primitive pipes to nearby industrial centers. By 1890, Pittsburgh was the natural gas center of the United States, with the fuel being used for both industrial and domestic purposes. Natural gas gained an advantage for its high caloric content and for its relative cleanliness compared to coal – an environmental asset that remains a key strength for gas a century later. By 1900, natural gas was used extensively in the Appalachian region, but its broader use remained constrained by the technical difficulties associated with transporting natural gas over long distances.

[1] See Castaneda (1999) pp. 3–11 and Peebles (1980), pp. 5–17, for an early history of gas use.

BOX 1.1 WHAT IS NATURAL GAS?

Natural gas is a fossil fuel that contains a mix of hydrocarbon gases, mainly methane (CH_4), along with varying amounts of ethane (C_2H_6), propane (C_3H_8), and butane (C_4H_{10}). Carbon dioxide, oxygen, nitrogen, and hydrogen sulphide are also often present. Natural gas is "dry" when it is almost pure methane, absent the longer-chain hydrocarbons. It is considered "wet" when it contains other hydrocarbons in abundance. Those longer chain hydrocarbons can condense to form valuable light liquids (so-called natural gas liquids, or NGLs). "Sweet" gas possesses low levels of hydrogen sulphide compared to "sour" gas. Natural gas found in oil reservoirs is called "associated" gas. When it occurs alone it is called "non-associated gas." Colorless, odorless, and highly combustible, natural gas is used for fuel in electrical power generation, heating, and cooking. For more on the properties and specific conventions used in this volume, see Appendix: technical notes (p. 484).

Advances in welding, metallurgy, and compression technology in the late 1920s and early 1930s brightened the prospects for gas. A series of long-distance pipelines were laid from new gas fields in the American Southwest, most notably a 1,600 km (1,000 mile), 600 mm (24 inch) pipeline from the Texas Panhandle to Chicago. Natural gas was rapidly becoming a national industry – a trend accelerated by the heavy industrial demands of the Second World War, which saw natural gas consumption increase by over 50 percent in just four years. As part of the war effort, the federal government actively encouraged the construction of additional pipelines linking the Southwest to factories of Appalachia in the East (Castaneda 1999).

Natural gas use in the United States grew rapidly in the years following the Second World War, reflecting robust overall economic growth, continued expansion of the pipeline network, and broad-based technological advances in exploration, transportation, refining, and end-use by industries and households. In 1947, two pipelines built during the Second World War to carry oil from Texas to the Northeast – the so-called "Little Inch" and "Big Inch" – were converted to natural gas to service growing East Coast demand for natural gas. US production rose from 112 Bcm (4 Tcf) in 1945 to 627 Bcm (22 Tcf) in 1970; the national pipeline grid grew from just over 160,000 km (100,000 miles) in 1950 to roughly 400,000 km (250,000 miles) twenty years later. In many ways, the period 1945–1970 marked a "golden age" in gas use in the United States, with natural gas providing a third of total primary energy in the late 1960s and early 1970s, a proportion that has not been reached again to date (BP 2004). By the late 1960s, US policy-makers worried that gas was becoming scarce and began imposing controls on its usage and pricing, which weakened the incentive to look for new gas supplies. Only when US natural gas controls were lifted in 1978 did a boom in gas drilling yield large fresh supplies. Higher decontrolled prices curtailed consumption through the 1980s. More recently, strong demand growth has confronted stagnating US domestic production rates, driving US natural gas prices to unprecedented highs and calling into question the prospects for continued growth in gas consumption.

Before 1950, the development of the natural gas industry was essentially a US phenomenon. In that year, the United States represented roughly 90 percent of the natural gas produced and consumed in the world (Darmstadter, Teitelbaum, and Polach 1971). Subsequent decades, however, saw other key industrial economies shift to gas as well. Natural gas offered a fuel source that was well suited to the rapidly growing energy needs of the industrialized world. Combustion of natural gas is consistent, easily manageable, and cleaner-burning than the key alternatives – coal and oil – making gas ideal for use in industrial boilers, refining, cooking, and space heating. New technologies that were needed to facilitate natural gas growth were developed and rapidly spread throughout the developed world (figure 1.1).

In Western Europe, Italy made the first move to gas with discoveries of natural gas in the Po Valley during the Second World War, developing the largest gas market in Western Europe by the mid-1960s. Later, discoveries in and around the North Sea would make that region the center of Western Europe's gas production. The 1959 discovery of the massive Groningen gas field in the Netherlands set the stage for rapid growth there, and also in neighboring Belgium, Germany, and France in the 1970s.[2] From the earliest years of Khrushchev's rule, the gas-rich Soviet Union (USSR) adopted an industrial strategy that mandated a shift to gas; with pipelines and economic integration, the USSR extended gasification to most Soviet satellite states in Eastern Europe from the late 1960s through the 1970s.

The impetus for increasing the role of gas in the energy supply was enhanced by the 1973 Arab oil embargo. The economies of Japan and Western Europe at the time ran mainly on imported oil. The shortages and spiking prices that resulted from the embargo sent many countries to diversify away from Middle East oil. Japan, in particular, adopted an aggressive policy to diversify its energy sources. Even prior to the oil crises, Japanese planners were looking to import natural gas to replace

[2] More detail on European gas markets can be found in chapter 3 and chapter 5 and the references therein.

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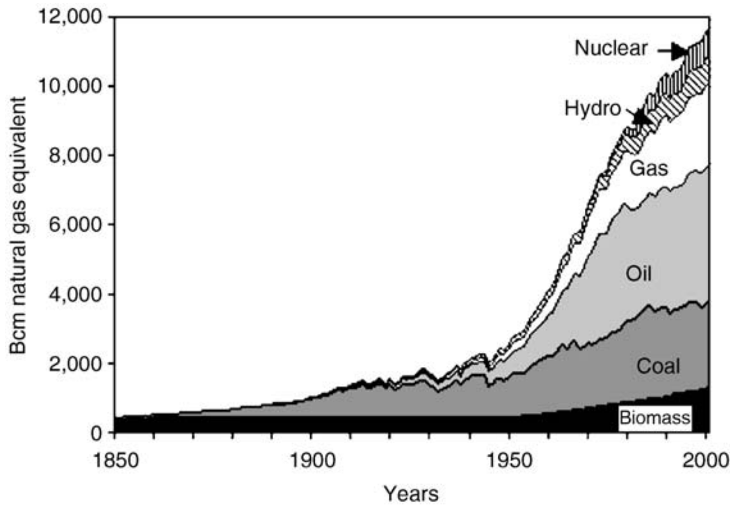

Figure 1.1. Global primary energy consumption, by fuel in Bcm natural gas equivalent.

Source: 1850–1990: IIASA–WEC (1998); for 1990–2001: IEA (2004b) and EIA (2005).

town gas – which was produced from imported coal. Increasingly mindful of the need for ecological protection, the Japanese government orchestrated investment in nuclear power and, especially, natural gas. By the end of the 1970s, Japan was the world's largest importer of LNG. It relied notably on supplies from Indonesia and Brunei (see chapter 4).

As gas consumption grew around the world, North America's share of global gas consumption fell from nearly 90% in 1950 to less than one-third in 2003. Rising consumption in the Former Soviet Union (FSU), Western Europe, and Asia (largely Japan and South Korea) through the 1970s, 1980s, and 1990s brought these regions on a par with the United States in terms of gas consumption. We show this evolution in figure 1.2.

A Global Business: Pipelines and LNG

In tandem with the shift to gas came international trade. In large measure, trade by pipeline was an extension of the same basic pipeline technologies pioneered early in the twentieth century. Improved steel and, especially, compressors made larger and lengthier pipelines both

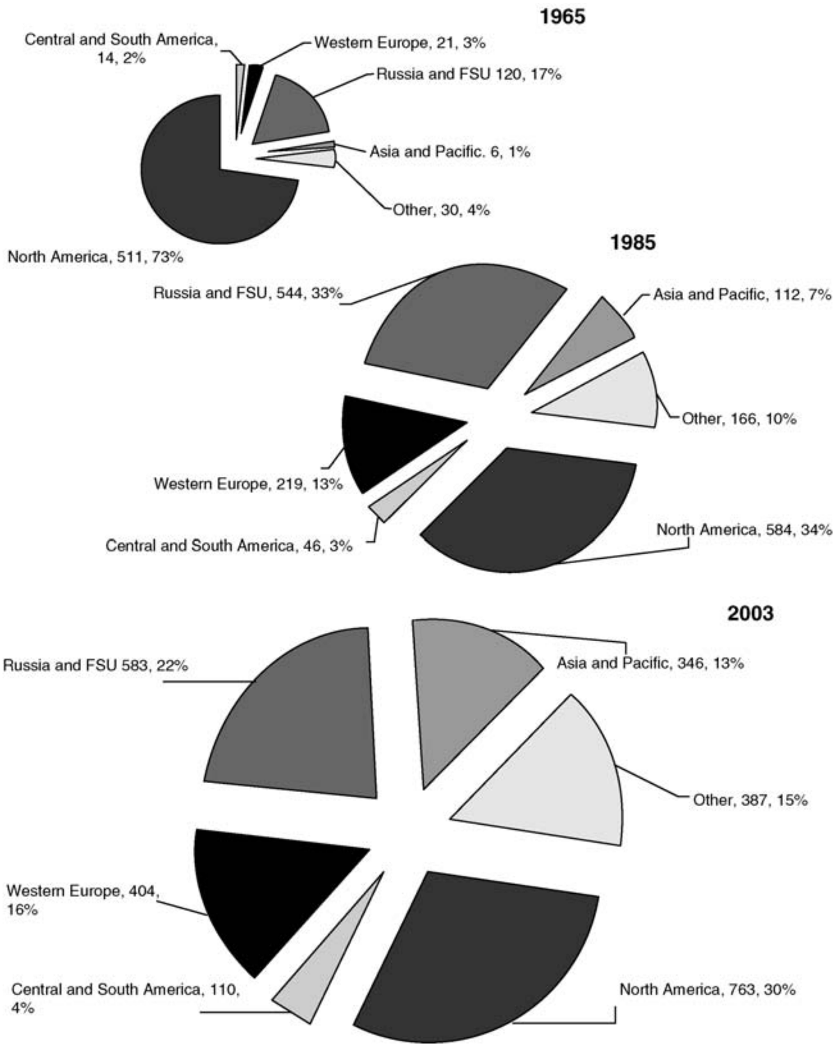

Figure 1.2. Worldwide consumption of natural gas, 1965, 1985, 2003. Pie charts are proportional in size to total consumption. Statistics indicate total consumption in Bcm and share of total.

Source: BP (2004).

technically and economically viable. By the early 1980s, major pipelines linked Canada to the United States, the Soviet Union to Eastern and Central Europe, Norway and the Netherlands to other Western European countries, and Algeria under the Mediterranean to Italy.

Pipelines, nonetheless, imposed severe limitations on the trade in gas. By nature, pipelines are economic for trade over relatively small (though growing) distances, and thus markets made through pipes were regional in nature. These pipeline links created two key large markets – North America and Europe – and many other smaller networks in Latin America, Southeast Asia, and the Middle East (IEA 2004; L'Hagert *et al.* 2004). Denser interconnections and longer pipelines expanded the scope of these regional gas markets, but the emergence of a truly global gas business is taking place only as the development of significant and economical ocean shipping technology – LNG – promotes economical gas trading over very long distances and a flexible business model that encourages arbitrage between these dense pipeline regions.

BOX 1.2 WHAT IS LNG?

LNG is natural gas reduced to a liquid state by cooling it to about minus 260° Fahrenheit (–160° Centigrade). This cryogenic process reduces natural gas's volume by a factor of roughly 600:1. The reduced volume of gas in its liquid state makes transport by ship economically feasible, especially over long distances for which pipelines are increasingly costly to build and operate. (On smaller scales, the LNG process is also used to store gas to meet short-term local needs during periods of peak demand.) LNG is manufactured at liquefaction units or "trains," where heat is removed from natural gas by using a refrigerant. Before LNG can be used as a fuel it must be returned to a gaseous state. This occurs at regasification plants, where LNG is heated before delivery into a pipeline system. All regasification plants today are located onshore, but difficulties with siting have led to numerous proposals for offshore facilities or technologies that would allow regasification on tankers.

LNG took hold in international markets relatively slowly, due largely to the unwieldy and costly technologies associated with producing, storing, and shipping it. The first patent for liquefying natural gas was granted in 1914, and the early applications of LNG technology were for storage. No shipping technologies existed at the time. In the 1940s, there were attempts to use stored LNG during periods of high demand in both the United States and Soviet Union – so-called "peak-shaving," when the pipeline network was inadequate to meet all the demand of final users. These projects were less than successful. Indeed, the first commercial LNG plant in the world – in Cleveland, Ohio – was shut down following a 1944 explosion that killed 128 people (Peebles 1980). Today, much safer LNG storage schemes are widely used for peak shaving.

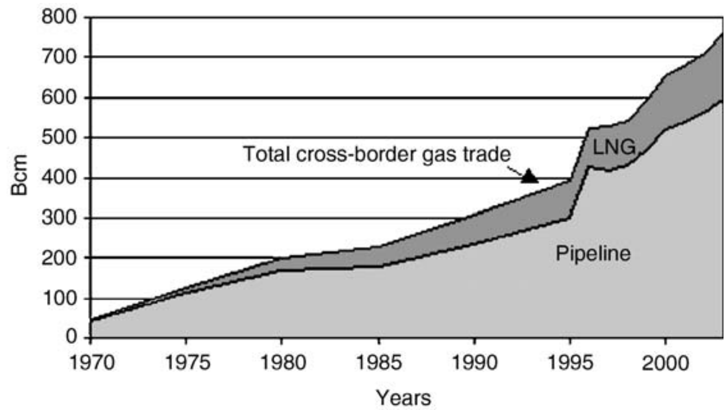

Figure 1.3. World trade in natural gas, 1970–2004. Since the early 1970s gas markets have become increasingly international, with cross-border trade by pipeline and LNG. The share of LNG in imported gas is rising, and the share of imported gas in total gas consumption is also rising. In 2000, for example, 27% of all gas consumed was imported; while in 1970 that fraction was only 4%. 1996 is the first year with reliable data on gas trade within the FSU and the former East Bloc countries. Previously "intra-country" pipeline movements thus became counted as "traded gas."

Source: CEDIGAZ (2000); IEA (2003); BP (2004).

In the late 1950s and early 1960s the technology for shipping LNG was developed and the world's first major LNG export plant opened in Arzew, Algeria, in 1964, exporting gas to buyers in France and the United Kingdom. By 1972, LNG plants were up and running in the United States (Alaska), Brunei, and Libya, with a second plant added in Algeria at Skikda. Rising concern about oil security following the oil crises of the 1970s then set the stage for a boom in new LNG capacity, heralded by major projects in Abu Dhabi (1977) and Indonesia (1977), both delivering LNG to Japan. Algeria and Indonesia emerged as the dominant LNG suppliers, each with nearly 20 million tons per annum (mtpa) of export capacity. New entrants came into the market over the next two decades, including Malaysia (1983), Australia (1989), Qatar (1996), Nigeria (1999), Trinidad & Tobago (1999), and Oman (2000). Today, LNG accounts for about one-quarter of the international trade in gas (see figure 1.3).