Box 3.2. Unconventional Natural Gas: A Game Changer?

Shale gas has emerged as a major new source of natural gas in the United States and could become a new source of supply elsewhere, with major implications for gas markets across the globe. This new energy source accounted for about half of total U.S. gas production in 2010 (Figure 3.2.1) and for three-quarters of global unconventional gas output (U.S. EIA, *International Energy Outlook*, 2010). This box discusses the potential and limitations of the recent "shale gas revolution."

Natural gas resources are classified as conventional or unconventional depending on the technology necessary for exploitation. Conventional gas is found either in easily accessible gas reservoirs or in oil wells. Unconventional natural gas resources include tight gas sands, coalbed methane, and shale gas, and these require more advanced extraction technology. Shale gas is natural gas trapped deep in sedimentary rock and diffused over a relatively large area. The existence of unconventional gas reservoirs has long been recognized. However, the technology to produce economically viable unconventional gas on a large scale emerged only in the past decade.[1]

The global resource base for unconventional gas, which includes gas reservoirs that have not yet been developed or found and which is more uncertain with regard to recoverability, is considerably larger and exceeds that of conventional natural gas (Table 3.2.1).[2] In terms of production share, unconventional gas amounted to 12 percent of 2008 total global natural gas production, and the International Energy Agency expects it to rise to 15 percent by 2030 (IEA, *World Energy Outlook*, 2009). Yet there are sufficient resources for much larger expansion. At current global production rates, today's worldwide proven reserves (conventional and unconventional) could sustain current production for 58 years (IEA, *World Energy Outlook*, 2009),[3] whereas the combined resources equal 250 years of current production.

Shale gas extraction has so far been confined to the United States, but there is growing interest in exploiting unconventional sources of gas across the globe. In fact, a number of countries have started

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[1]Unconventional gas extraction typically involves horizontal drilling and hydraulic fracturing (making fractures in the rock and injecting a fluid to increase permeability).

[2]About 380 trillion cubic meters (tcm) of unconventional resources are estimated to have highly likely recoverability (IEA, *World Energy Outlook*, 2010). The remaining recoverable conventional gas resources are estimated at 400 tcm.

[3]The Middle East and North Africa region has more than 40 percent of the world's proven gas reserves, with scope for new discoveries. The Islamic Republic of Iran, Qatar, and Russia hold about half of global proven gas reserves.

Table 3.2.1. Unconventional Natural Gas Resources, 2009

(Trillions of cubic meters)

	Tight Gas	Coalbed Methane	Shale Gas	Total
Middle East and North Africa	23	0	72	95
Sub-Saharan Africa	22	1	8	31
Former Soviet Union	25	112	18	155
Asia-Pacific	52	48	174	274
Central Asia and China	10	34	100	144
OECD[1] Pacific	20	13	65	98
South Asia	6	1	0	7
Other Asia-Pacific	16	0	9	25
North America	39	85	109	233
Latin America	37	1	60	98
Europe	12	7	15	34
Central and Eastern Europe	2	3	1	6
Western	10	4	14	28
World	210	254	456	920

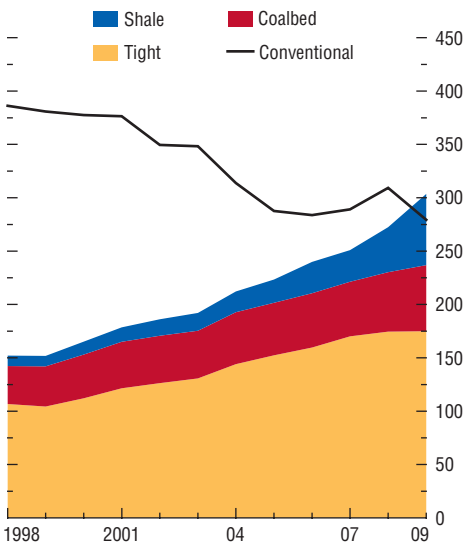
Source: International Energy Agency, *World Energy Outlook*, 2009.

[1]OECD = Organization for Economic Cooperation and Development.

Box 3.2 *(continued)*

Figure 3.2.1. U.S. Natural Gas Supply, 1998–2009

(Billions of cubic meters)



Sources: International Energy Agency; U.S. Energy Information Administration; and IMF staff calculations.

exploring potentially large shale gas resources, including Australia, Austria, Canada, China, Germany, Hungary, India, Poland, Saudi Arabia, and the United Kingdom.

In some countries assessing the commercial viability of reserves and developing the resource base could take up to a decade. There are a number of technical and political challenges: shale gas recovery requires large drilling areas that in some cases may cross borders, affect a large number of residents, and ultimately draw opposition on environmental grounds because of the risk of groundwater contamination with fracture fluids. For example, Europe, with high population density and many national borders, could face difficulties in regulating exploitation permits. Nevertheless, some eastern European countries, particularly Poland, are actively exploring their potential. China is targeting shale gas production of 30 billion cubic meters a year, which is about half the country's 2009 natural gas consumption.

Long-term marginal costs and the role of shale gas in the energy mix are difficult to project. Shale gas production is characterized by high initial production rates followed by a rapid decline.[4] The market price therefore needs to cover relatively high operating costs (when compared with conventional natural gas production) and provide for fast investment amortization. A Massachusetts Institute of Technology study (MIT, 2010) estimates that the breakeven price for the exploitation of shale gas is in the range of $4 to $8 per million cubic feet (at constant 2007 prices). So far, the U.S. benchmark (Henry Hub) natural gas spot price has fluctuated within this breakeven range, even though it remains well below precrisis levels. As a result, production has continued to grow rapidly despite concerns about the impact of current low prices.

The rapid increase in shale gas supply partly explains the recent decoupling of natural gas prices from oil prices in the United States. If prices per unit of energy were the same, the price of natural gas would be one-sixth the oil price per barrel. Figure 3.2.2 shows that this parity held broadly in the U.S. spot market until late 2005. Since then, gas has become cheaper than oil, suggesting that arbitrage remains limited given that gas and oil are not good substitutes in many applications—transportation being a prime example.

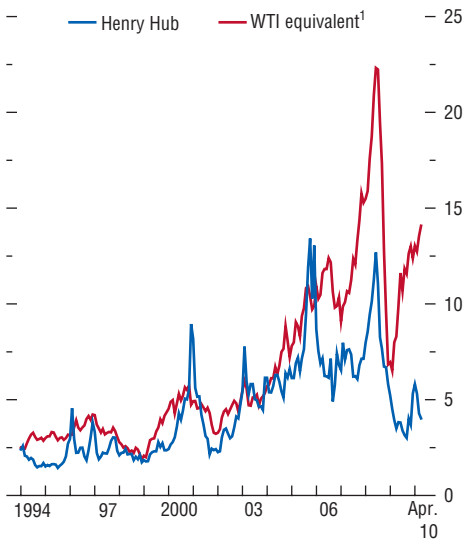
Increased shale gas supply in the United States has led to a redirection of liquefied natural gas (LNG) supplies to other markets, notably Europe and Asia, which has raised questions about traditional contract pricing arrangements. In Europe and Asia, gas prices remained indexed to oil prices in long-term contracts (Table 3.2.2), but the combination of increased U.S. shale gas production and increased LNG supply and distribution capacity outside North America could lead to a decoupling of oil and gas prices as in the United States. This pressure on contract arrangements

[4]The average decline rate (weighted by production) of the Barnett shale horizontal wells is 39 percent in the second year and 50 percent in the third year relative to the first year (IEA, *World Energy Outlook*, 2009).

Box 3.2 *(continued)*

Figure 3.2.2. U.S. Natural Gas versus Oil Spot Prices

(U.S. dollars per million British thermal units)



Source: Dow Jones & Company.
[1]WTI = West Texas Intermediate.

Table 3.2.2. Composition of Wholesale Gas Transactions: United States and Europe, 2007

(Percent)

	Spot Market Prices	Oil-Indexed Prices	Other
North America	98.7	0	1.3
Europe	22	72.2	5.8

Source: International Energy Agency, *World Energy Outlook* (2009).

has led to the emergence of spot price markets similar to those in the United States. Greater LNG transportation capacity has also facilitated price arbitrage between markets.

In conclusion, shale gas has the potential to change prospects for natural gas as a source of primary energy, but it remains difficult to predict the extent to which this potential can be realized. Lower relative prices for gas will probably lead to a greater market share of natural gas in total primary energy, with the power sector likely the main beneficiary. But large-scale shale gas production will have to start outside the United States for this energy source to realize its full potential.