Unconventional Gas—Transforming the Global Gas Industry

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Unconventional gas is changing the energy world. This energy revolution is just beginning so the full implications are still difficult to discern, but one thing is clear: the understanding of the natural gas resource base is shifting, with the result that the potential time horizon for future natural gas supply is being radically extended. The industry has traditionally thought of natural gas supply as lasting 60 years, based on the narrow metric of proven reserves divided by current production (or consumption). But today, recoverable reserves of unconventional gas—including both shale and coalbed methane [CBM]—are estimated conservatively at 250 years of current consumption.[1] This is at variance with the Malthusian assumptions that underlie much policy concern around other primary commodities. And it is not simply that the gas resource base has expanded; it has also become more widely distributed, with far-reaching implications for security of supply and geopolitics.

New conventional gas reserves are also continuing to be discovered, mainly in remote regions or deep water offshore—recently, notably, in East Africa and the Eastern Mediterranean. Exploration efforts targeting unconventional gas resources outside North America are also gradually revealing the scale of the potential for shale gas and CBM that will dramatically increase the total recoverable gas reserves.

AIMS

This paper argues that, although a new understanding of the international unconventional resource base is still being formed, the traditional conceptual model for the global gas industry no longer applies. We present four new conceptual models—one of which is likely to prevail—and survey developments and implications in the key emerging unconventional gas arenas.

CONTEXT

The US experience of explosive growth in shale gas production has already changed the market picture in that country. Since 2007 US natural gas production has grown by 20%, adding more than 10 billion cubic feet [Bcf] per day. Virtually all of this growth has come from development of shale reserves. Liquefied natural gas [LNG] imports, which had once been expected to provide a significant share of US gas supply by now, have declined to minimal levels. Instead the focus has switched to exports, and several LNG export projects are in the works. But shale gas is not unique to the United States.

IHS CERA is in the process of carrying out a series of studies on the potential for unconventional gas production around the world. Studies have been completed for the United States, Europe, Ukraine, China, and Indonesia. The results to date have indicated that the gas-in-place [GIP] figures for shale and CBM around the world are very large—and only a small percentage of this GIP needs to be technically recoverable for it to be of material significance. More importantly, our analysis suggests that significant volumes of unconventional gas are likely to be competitive relative to prevailing prices for gas that is traded internationally, by pipeline or LNG. As we continue our studies of unconventional gas potential, moving next to Latin America and then India, questions about the global implications of our findings are becoming more salient. How will a major upgrade in global gas resources affect the global gas market? How will the more diverse regional availability of

[1] International Energy Agency World Energy Outlook, 2010.

competitive gas change the gas market in certain key regions? And how will markets be affected if some countries or regions long assumed to be long-term importers of gas instead emerge as self-sufficient or even as exporters?

METHODS: CREATING FOUR MODELS FOR THE GLOBAL GAS INDUSTRY

The Traditional Model

The traditional conceptual framework for natural gas has broken down. That paradigm posited a predetermined increase in international trade, a trend that has been in place since the mid-1990s, as those countries with limited conventional gas resources increased imports from those countries richly endowed with conventional gas. The importing countries were expected to fall into two groups: first, developed economies (i.e., the United States, Japan, Europe, and South Korea) which would face high gas prices but which have the willingness and economic ability to pay; and second, the largest emerging economies (China, India, and possibly Brazil) together with an assortment of smaller developing economies which were seen as potential large importers but with a greater price sensitivity and therefore a greater level of uncertainty around their possible growth. On the other side of the equation were the exporters, assumed to be primarily Russia, the Middle East, Australia, North and West Africa, and certain Central Asian states.

This conceptual model implied a move toward globalisation of gas markets. North America, which had long been largely self-sufficient in natural gas, was expected to join the global market because of the depletion of its conventional resources. At the same time, emerging economies were enlarging the number of LNG-importing countries, which had previously been a fairly small, defined set of key Asian and European players. It was a small mental leap to surmise that growing LNG trade and diversity of imports could lead to a global marketplace for natural gas, and a move toward some form of global pricing, as exists for other primary commodities.[2]

Three factors have undermined the traditional model:

- First, unconventional gas has upended previous expectations about resource distribution and potential trade flows, with potential large-scale resources now located in what were previously seen as net importing regions. It is no longer obvious that international trade of gas will grow; instead there could be a reversal and a new trend of more self-sufficient local or regional markets. Market globalisation could turn to market localisation.
- Second, large conventional finds in the deepwater East Africa, the Eastern Mediterranean, and associated gas offshore Brazil have widened the potential source points for conventional gas exports.
- Third, gas shortages across much of the Middle East, which are spreading to North Africa as well, raise questions about the importance of the Middle East/North Africa region for exports.[3]

Alternative Models

What will replace the traditional model? How fundamentally will global and regional supply and demand balances shift? What are the implications for global trade, and especially for the future of LNG? We believe that four possible models can be considered for the future of the global gas business:

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[2] See Yergin, Daniel and Stoppard, Michael, "The Next Prize," *Foreign Affairs*, Vol. 82 No. 6 (2003).

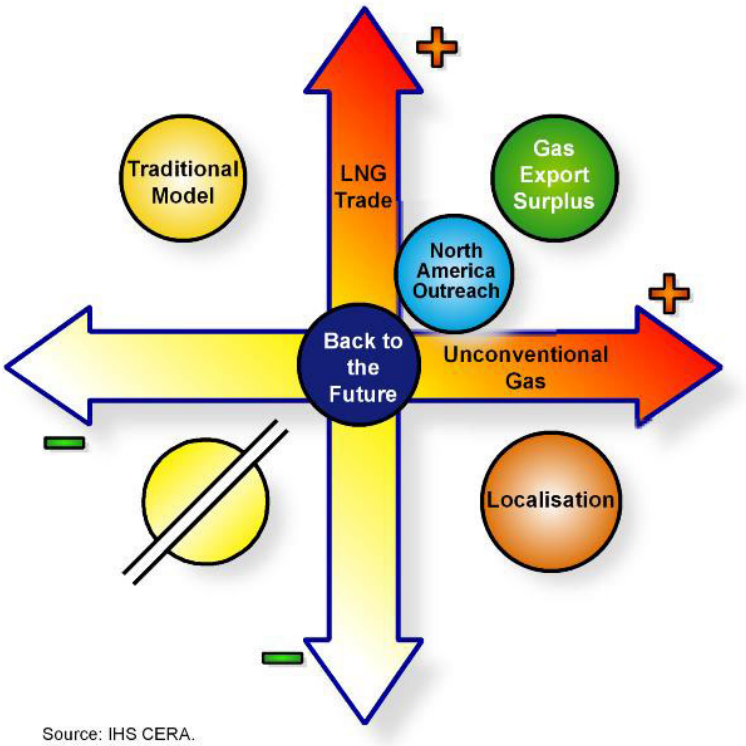
[3] See the IHS CERA Multiclient Study *Thirst for Growth: Outlook for Gas and Power in the Middle East and North Africa*, May 2012.

1. **Back to the Future.** In this model, North America reverts to its previous position of isolation from global gas trade, while the impact of unconventional gas development elsewhere in the world is significant but not revolutionary. For the LNG trade, this is a “business as usual” case as it returns to its traditional focus on Asia Pacific.
2. **North America Outreach.** In this model, the North American unconventional gas revolution continues to a point where the United States begins to export large quantities of LNG—while similarly revolutionary changes do not spread to the rest of the world. The global LNG business grows as a result, with its market structure evolving to accommodate this major new exporter.
3. **Localisation.** In this model, shale gas production increases, with the result that key emerging markets join North America to become largely self-sufficient in gas—globalisation of unconventional gas production techniques undercuts the globalisation of gas itself. The LNG industry begins to decline as a result.
4. **Gas Export Surplus.** In this model, exports of “unconventional LNG” boom not only in North America, but in other regions also. Of course, global exports must balance imports, meaning that this model is necessarily limited. However, it is helpful to think through the price and demand consequences of a world in which potential exports of gas significantly outweigh the global import requirement.

Figure 1 illustrates how the four models fall on a matrix of unconventional gas production and global LNG trade. The quadrant of low unconventional gas production and little LNG trade is not credible as a model.

Figure 1

Four Models for the Global Gas Business



Source: IHS CERA.
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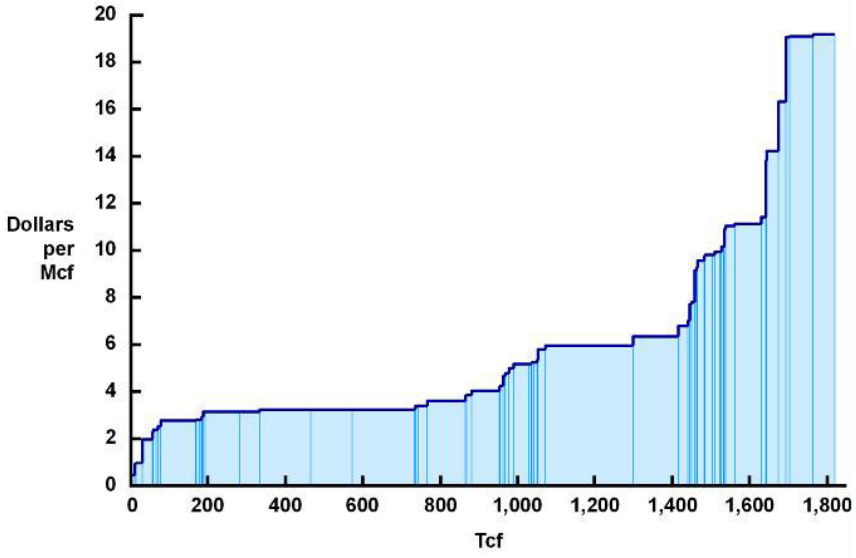
North America—Self-Sufficient or Exporter?

The transformation of the North American gas market by the production of shale gas in the past five years creates two possible outcomes for North America—the market remains isolated as today as in Model 1, "Back to the Future"; or the market is tied into the rest of the world via LNG exports from the Unites States and Canada as in Model 2, "North America Outreach." Some perspective on the development of shale and its production costs in North America can provide context for exploring these two options.

Two years ago, IHS CERA released an in-depth assessment of the unconventional gas resource base in 17 emerging shale and tight sands gas plays in the US Lower 48 and Canada.[4] The study indicated that these 17 plays contained more than 1,800 trillion cubic feet [Tcf] of recoverable gas resource—almost all of it in eight shale gas plays. Together with conventional gas resources there is more than 3,300 Tcf of recoverable gas in North America—more than 100 years' supply at current rates of consumption. Moreover, IHS CERA estimates that fully half of this resource base can be produced for a full-cycle cost of $4 per thousand cubic feet [Mcf] or less, in 2010 dollars (see Figure 2). This finding is highly significant in that it suggests that the North American natural gas resource base has become highly supply-elastic thanks to unconventional gas technology. Large increments of demand can be added to the market without requiring a large price increase to elicit the required supply response. Such an extensive low-cost resource base suggests that the Henry Hub natural gas price is likely to remain low for a long time.

Figure 2

Breakeven Henry Hub Price for Natural Gas Resources



Source: IHS CERA.
Note: Includes proved, possible, and potential resources.
Mcf = thousand cubic feet.
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[4] See the IHS CERA Multiclient Study *Cream of the Crop: Performance Analytics for North American Resource Plays*, February 2010.

Over the past two years, unconventional gas supply has burgeoned in North America, far outstripping demand growth and filling storage facilities to record levels. As of April 2012, this had caused prices to plummet below $2.50 per Mcf. Producers are moving their operations to wet gas plays and oil plays, but these plays also produce natural gas, and total gas production has not yet begun to decline—as it must to achieve market balance until or unless exports of gas from North American start up. Over the long term, once the market has come back into balance, domestic supply is expected to continue to increase, with virtually all of the growth coming from shale gas resources (see Figure 3).

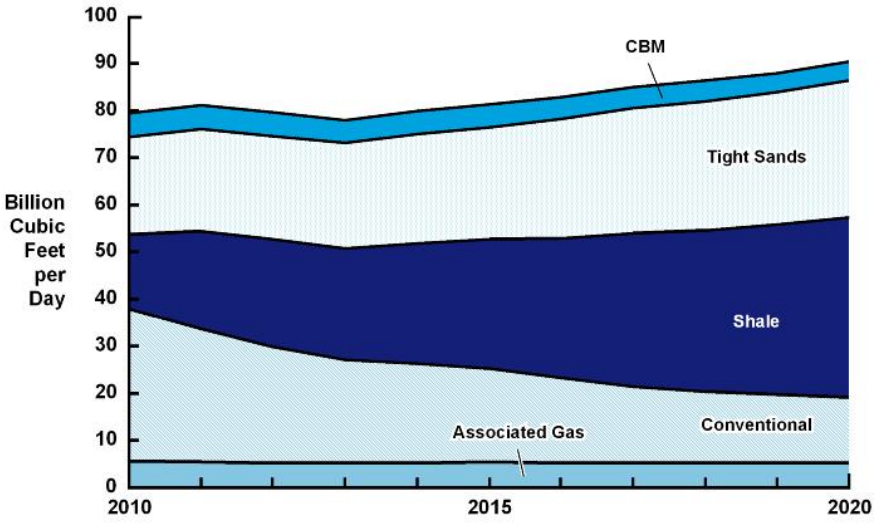
Even over the long term, the North American natural gas market is, for the first time, demand constrained rather than supply constrained, and the search for new markets and demand growth is well under way. Although some incremental demand is expected to come from vehicles, chemicals, and other industrial demand, by far the greatest demand growth is expected to come from the power sector as gas-fired generation increases its market share, replaces coal plant retirements, and backs up intermittent generation from wind and solar plants (see Figure 4).

Model 1: Back to the Future

In this model, this low-cost and large resource base would allow North America to meet its demand requirements for the long term, and indeed would help drive a trend of locating industries in the United States where gas is an important input or feedstock; e.g., fertilisers, chemicals, or even steel production. A recent study by IHS Global Insight concluded that the shale gas revolution in the United States has created 600,000 direct, indirect, and induced jobs. President Barack Obama cited this number in his most recent State of the Union address, noting that the shale industry provides employment for a large number of people, and has encouraged government to take a supportive stance toward the industry.[5]

Figure 3

North American Natural Gas Productive Capacity Outlook by Type



Source: IHS CERA.
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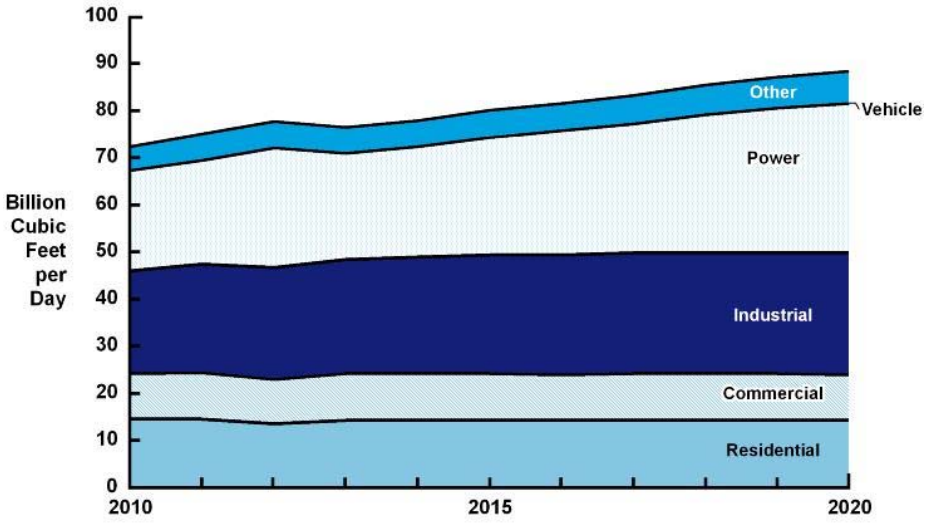
[5] See the IHS Global Insight Study *The Economic and Employment Contributions of Shale Gas in the United States*, December 2011.

Figure 4

North American Natural Gas Demand Outlook



Source: Energy Information Administration, IHS CERA.
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The concept that low-cost gas could be a catalyst for a rebound of the US industrial base would lead in this model to a strong focus on maintaining gas use within North America and opposing exports. LNG exports require federal political approval. Such a reluctance to encourage gas exports would result in a gas market model much like what has existed in the past, with North America as an island—a market that is isolated from the rest of the world, which today remains connected by the LNG business.

This model would most likely result in large price differentials among markets. US industrial use would only be encouraged if US gas prices were to remain relatively low. In this model, the impact of unconventional gas development in the rest of the world would be significant but not revolutionary, with the LNG industry continuing to be a mainly Asian-focused business, given modest demand growth expectations for Europe. Constraints on the export of LNG from the United States might support the preservation of oil-indexed gas pricing in Europe and the Asia Pacific region.

Model 2: North America Outreach

The vast low-cost gas resource in the United States has already incited many investors to consider exporting LNG to other parts of the world as the industry eyes higher-priced markets in Europe and Asia as another outlet for growing domestic supply. Export applications for some 105 million tons per annum [mtpa] of LNG had been filed with the US Department of Energy [DOE] as of February 2012. These projects have been opposed by those who fear that implementation of these projects would increase domestic gas prices to the detriment of gas consumers, including industrial users; and under the relevant legislation, the DOE has the duty to consider the public interest in assessing such applications.

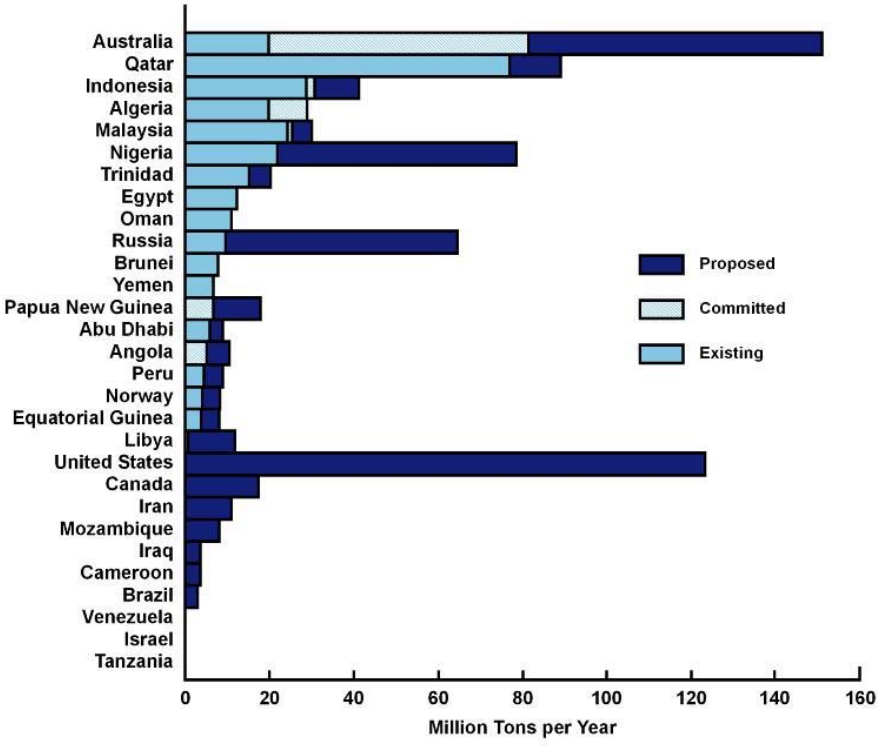
However, a separate piece of legislation states that any export of gas, including LNG, to countries with which the United States has a free trade agreement [FTA] should be automatically deemed to be consistent with the public interest, and therefore approved. The

United States currently has FTAs in place with 16 countries, including potential LNG importer South Korea. Permission for export to non-FTA countries is not so easily obtained, however, and the Secretary of Energy Steven Chu has announced that no further permits will be forthcoming until the department makes a final determination that such exports will be in the public interest.

In light of the abundance of low-cost natural gas in the US resource base, as well as the costs of liquefaction, shipping, and regasification, it is not clear whether LNG exports would necessarily lead to a permanent increase in domestic US gas prices. The price effect would likely depend on the volume and timing of LNG export projects. The volumes of LNG exports could be very significant as a percentage of global LNG trade. Figure 5 shows the capacity of LNG by country for existing, committed, and proposed projects. The figure for the United States includes many projects that are nothing more than an application for an export permit. However, if permits were forthcoming, based on the relative low cost of feedstock gas and US construction, the United States could quickly become one of the three leading exporting countries alongside Australia and Qatar. The US Energy Information Administration [EIA] has already conducted a study examining the potential impact of 12 Bcf per day of exports, a volume greater than for any country today.[6]

Figure 5

Global Liquefaction Capacity
(existing, under construction, and proposed)



Source: IHS CERA.
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[6] US EIA, *Effects of Increased Natural Gas Exports on Domestic Energy Markets*, January 2012. http://www.eia.gov/analysis/requests/fe/.

Model 3: Localisation

Reviews of shale gas and CBM geological potential are under way at present in several countries that have prospects for large gas demand growth. Some of these markets are already importing LNG on a long-term contract basis, and are major target markets for LNG projects currently under development.

China is the leading example of this case. Growth in Chinese gas demand has in recent years been curbed by a lack of gas supply, and in general Chinese state companies have been aggressive in pushing forward new import pipeline projects (from Central Asia and Myanmar) as well as new LNG regasification projects, while signing new long-term gas supply agreements.

However, it is highly possible, and perhaps even probable, that China's endowment of unconventional gas resources will allow it to pursue a policy also based on domestic shale gas and CBM. If successful over several years, this would reduce the requirements for imported gas, whether in the form of LNG or by pipeline.

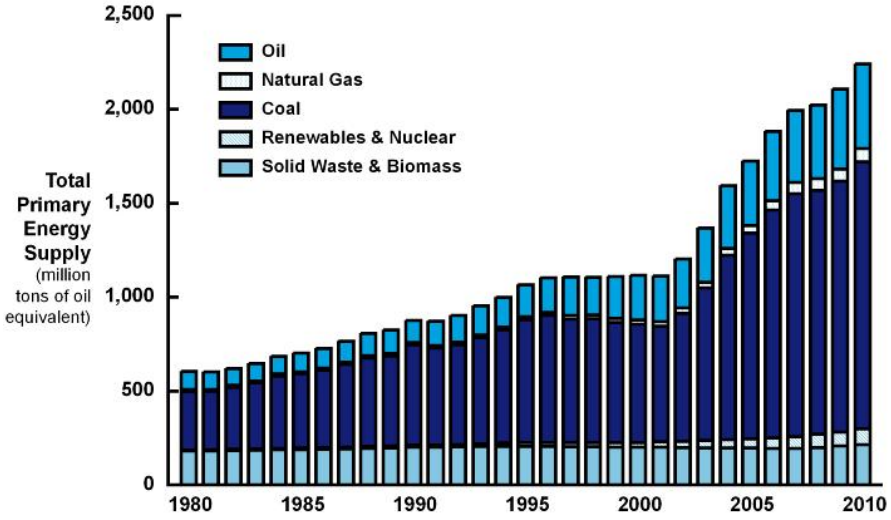
China's Future—Gas, Not Coal?

China's consumption of natural gas has doubled over the past five years, and IHS CERA projects that demand will quintuple over the next two decades. This changes the fuel's role in the economy.

Natural gas has historically been a niche fuel in China, accounting for less than 4% of primary energy supply even after recent rapid growth. Last year, China consumed 130 billion cubic meters [Bcm] of gas, roughly one-fifth of US consumption—despite China's having a population four times larger (see Figure 6).

Figure 6

China's Primary Energy Supply Is Dominated by Coal



Source: IHS CERA, International Energy Agency.
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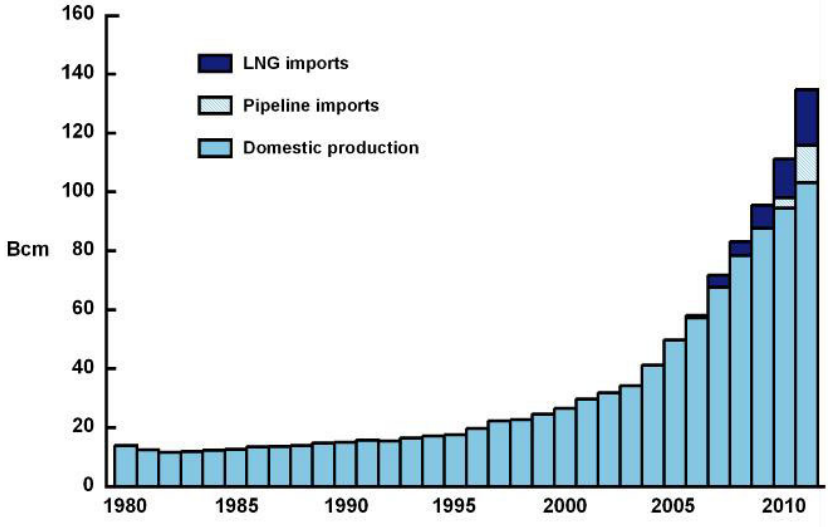
China's domestic gas production has tripled over the past decade while imports have increased from a negligible factor to one-quarter of consumption in 2011. LNG is currently imported on the basis of long-term contracts from Australia, Indonesia, Malaysia, and Qatar, with short-term cargoes coming from 12 countries, chiefly Yemen, Nigeria, and Russia. Total LNG imports reached 12.4 mtpa (17 Bcm) in 2011. Significant regasification infrastructure is under construction in China, with regas capacity expected to increase from today's level of 19 mtpa (26 Bcm) to 42 mtpa (58 Bcm) by 2015. Meanwhile Chinese buyers have already signed firm long-term contracts for LNG deliveries, ramping up to 35 mtpa (48 Bcm) by 2016, mainly based on Australian supply.

The completion of the Central Asia–China Gas Pipeline in 2009 gave China access to pipeline imports of gas for the first time, initially from Turkmenistan, which in 2011 shipped 15.5 Bcm to China, accounting for 46% of total Chinese gas imports. Contracts to supply gas through the same pipeline system are being discussed with Uzbekistan and Kazakhstan, and agreements have been signed to expand the pipeline's total capacity to 65 Bcm per year. Other pipelines are also in the works: A China-Myanmar link is currently under construction, and negotiations with Russia are ongoing, with several pipeline variations under consideration (see Figure 7).

But domestic supplies of unconventional gas could become a big factor and sooner than commonly expected. Recent research carried out by IHS CERA concludes that the geological potential for unconventional gas in China is even larger than in North America; average costs will likely be higher than in North America, but significant volumes should be cost competitive with imported LNG and pipe gas.[7] Our cost analysis—on a risked recoverable basis for 79 unconventional plays—points to roughly 14.2 Tcm that can be produced at less than $8 per Mcf (in a base productivity and medium resource case). This is roughly three decades of cost-competitive gas supply given today's demand growth trajectories. As we move up the supply curve, the unrisked technically recoverable resource potential at a cost-of-supply limit of $18 per Mcf appears to be 2.7 times that of North America.

Figure 7

Imports Increasing in China's Natural Gas Supply



Source: IHS CERA.
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[7] See the IHS CERA Multiclient Study *The Unconventional Frontier—China: Prospects for Shale Gas and CBM,* February 2012.

Because of the time required to develop this new resource, unconventional gas is expected to make only a small contribution before 2020, during which time Chinese demand for imported gas will continue to show strong growth. But after 2020, the availability of unconventional gas could begin to constrain the size of the market for imported gas; and of course the prospect of this occurring will affect Chinese gas policy before this (see Figure 8).

This is not to say that imports to China are bound to disappear or that China will become fully self-sufficient in gas. But the price of gas in existing LNG contracts could come under pressure through price reviews, and new contracts could face stiff competition.

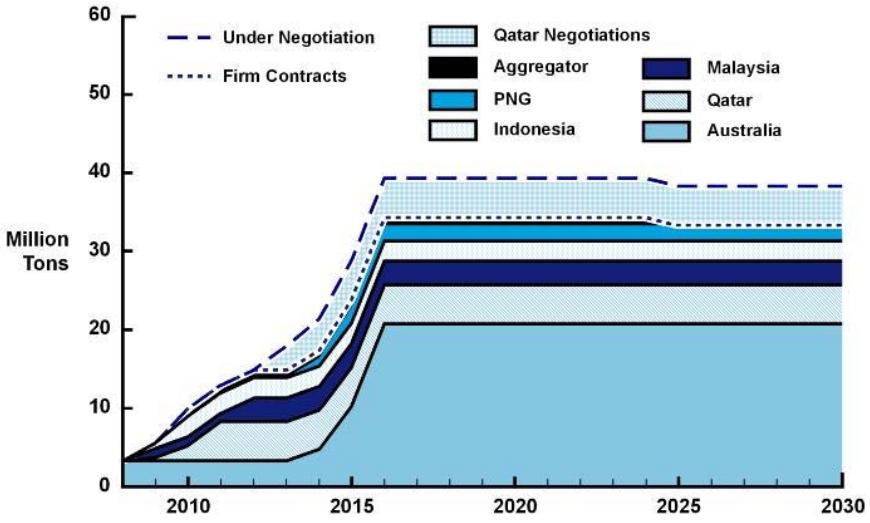
On the demand side, however, large volumes of domestic shale gas and CBM could spur even more rapid growth in gas demand, as other fuels face rising pressure from gas across all sectors: in power generation, industry, and even transportation gas could begin to compete with other supply sources and even with oil and coal. The impact on China's energy sector could eventually compare with the impact of the shale gale in North America in recent years.

As China's Ministry of Mineral and Land Resources works with stakeholders to evaluate the potential of unconventional gas, 2012 is a key year for assessment. The Ministry aims to complete this assessment and select priority areas for exploration in 2013. The decisions from this effort could trigger fundamental changes in the global gas balance and in China's own energy mix.

In a number of other markets that are expected to be importers of pipeline gas or LNG, import requirements could be significantly reduced if they develop their indigenous shale gas. These countries include France, Germany, India, Mexico, Pakistan, Ukraine, and the United Kingdom. India, Pakistan, and the United Kingdom offer a particular threat to LNG growth. France, Germany, and the Ukraine are more in competition with pipeline imports.

Figure 8

China's Long-Term LNG Contract Portfolio



Source: IHS CERA.
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Model 4: Gas Export Surplus

The fourth model is one in which unconventional gas production, CBM and shale, allow a country to develop its gas export business as either LNG or pipeline, although LNG provides more flexibility to target distant markets.

The development of CBM has already driven Australia's LNG export industry. Indonesia already exports LNG, and CBM and shale development could allow for further export growth. Shale development in other markets could both replace imports in the domestic market and establish or grow an export business; e.g., Poland and Argentina. Below we look at the case studies of Australia and Indonesia.

Australia—CBM to Large Export LNG Business

Australia is experiencing an unprecedented boom in construction of LNG export capacity with 61.5 million metric tons [mt] of liquefaction projects currently under construction. These projects alone will require around 94 Bcm per year of gas supply, once ramp-up to base-load capacity is achieved. Setting Australia apart from previous LNG developments is not only the scale but the kind of natural gas reserves tapped for liquefaction. More than 20 mt of the committed capacity will source its gas supply almost entirely from unconventional gas reserves, mostly CBM, but also potential shale gas. International and domestic energy companies have already committed around $50 billion in capital investments for developing the liquefaction infrastructure and associated upstream to monetise the unconventional CBM reserves for export; and an additional $30 billion could be invested over the next 10 years.

Unlike conventional gas reserves, it is more difficult to prove up CBM reserves before extensive development drilling starts. Some of the projects reached a final investment decision before reserves were proved for the full lifetime of the project. CBM projects do not have any significant associated liquids production that can have an impact on project economics. On the plus side, gas from CBM does not have major impurities, making liquefaction costs lower than for conventional gas projects. However, LNG from CBM has a low gross heating value [GHV], and the potential need to inject liquid petroleum gas to increase the GHV at the consumer end means that such LNG may be sold at a slight discount relative to LNG from conventional projects.

Indonesia—Dedicated Shale Reserves for LNG

Based on an outlook for conventional production supplemented by the potential production capacity that could be developed from shale, supply will far exceed domestic demand and current export capacity. Therefore Indonesia will need to be the first country in the world to develop LNG on the basis of dedicated upstream shale reserves. Whereas the United States is also developing LNG export facilities also supplied by shale, this would be sourced on a liquid market, not on a dedicated shale reserve as in Indonesia.

The results of our study suggest that there are abundant resources that are likely to be commercially competitive with existing sources—both conventional gas and imported gas.

RESULTS: GLOBAL GAS TRADE

Figure 9 shows the impact on global gas trade of the different models. A number of highlights stand out. First, global gas trade has been growing significantly since the mid-1990s driven primarily by LNG. Second, the growth of trade between Models 1 and 2 is not significant. This is because our modelling does not see substantial extra gas demand but rather US LNG exports that displace higher-cost alternative LNG supply projects with the result that this gas is becoming stranded. Third, a localisation scenario which has been modelled based on our current view of unconventional gas leads to a flattening off of global trade growth. Global trade is expected to be broadly flat in absolute terms and will actually decline as a percentage of the global gas market. Fourth, Gas Export Surplus has not been modelled, but by definition both the global gas demand numbers and global trade volumes

will rise in absolute terms. What is unclear is whether gas trade can increase as a percentage of the total market.

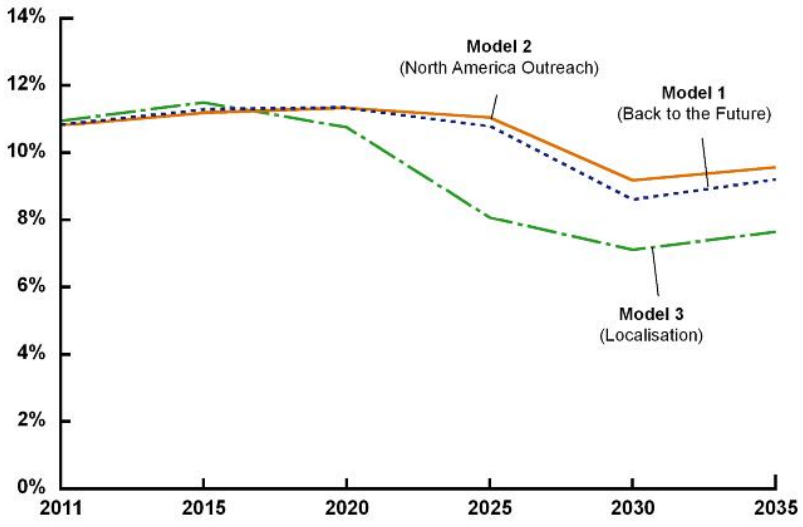
Figure 10 shows the percentage share of LNG and of conventional gas in 2030 for the three models relative to 2010.

SUMMARY/CONCLUSIONS

The gas industry is in the early stages of a revolution as a result of unconventional gas and most particularly shale gas. The traditional conceptual map for global gas—that of a predetermined trend toward globalisation of trade flows on the back of LNG expansion—needs to be recast. This paper has outlined four broad conceptual models or directions for the future of the industry. They all share one common theme—the gas industry is poised for significant growth over the coming decades. Moreover the technological application of unconventional gas exploitation will globalise. Where the future models diverge is on whether the outcome is increased trade flows or more localisation—and that will have an impact on global and regional gas balances and prices, as well as the overall energy mix in different parts of the world.

Figure 9

LNG Share of Total Natural Gas Trade
(percent)



Source: IHS CERA.
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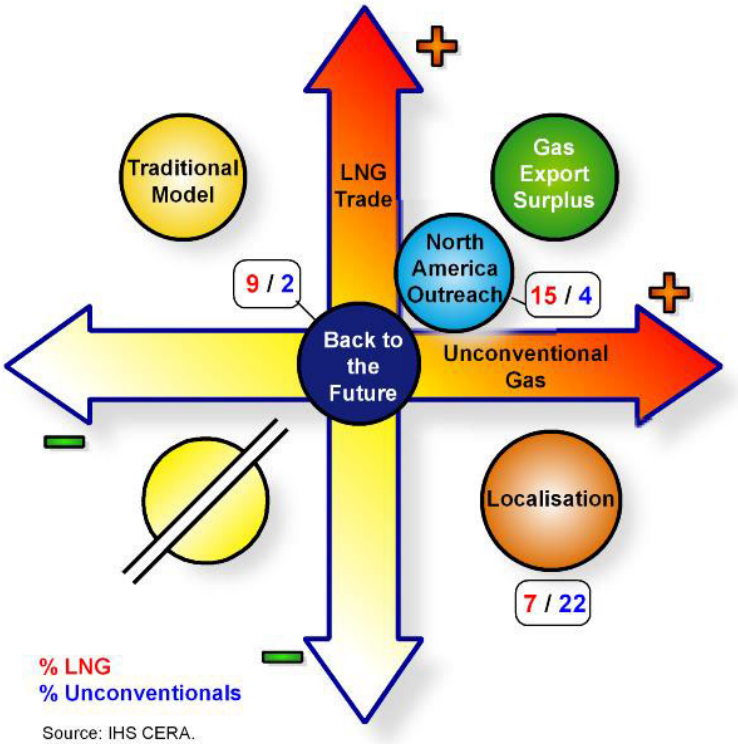
Figure 10

Four Models for the Global Gas Business



Source: IHS CERA.
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