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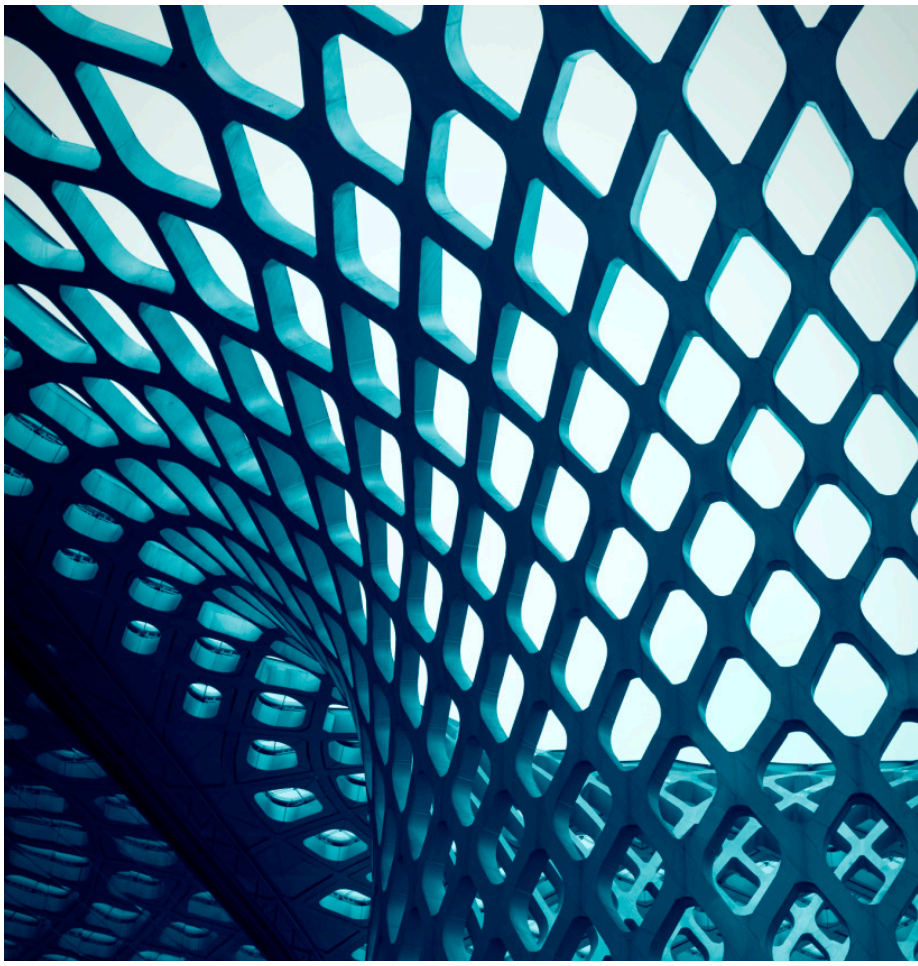
Remaking the global steel industry

Lower-cost natural gas and its impacts



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In an industry as established as steel, it is rare that a new development can have the kind of meaningful impact widely expected from a low-cost, steady, accessible, and long-term supply of natural gas. For several quarters now, the buzz about natural gas has been growing. It has reached the point where global steel companies are being compelled to ask difficult but necessary questions about whether, when, and how to adapt their strategies to take advantage of the bounty of natural gas rapidly being extracted from shale fields in the United States (U.S.).

In steel making, energy accounts for up to 40 percent of the cost of the finished product[1]. In recent years, the steel industry has made significant strides in reducing the energy intensity of the finished product, reducing the amount of energy needed to produce a ton of steel by 50 percent over the past 30 years[2]. Because energy remains an ongoing challenge, any developments in this area will be of great interest.

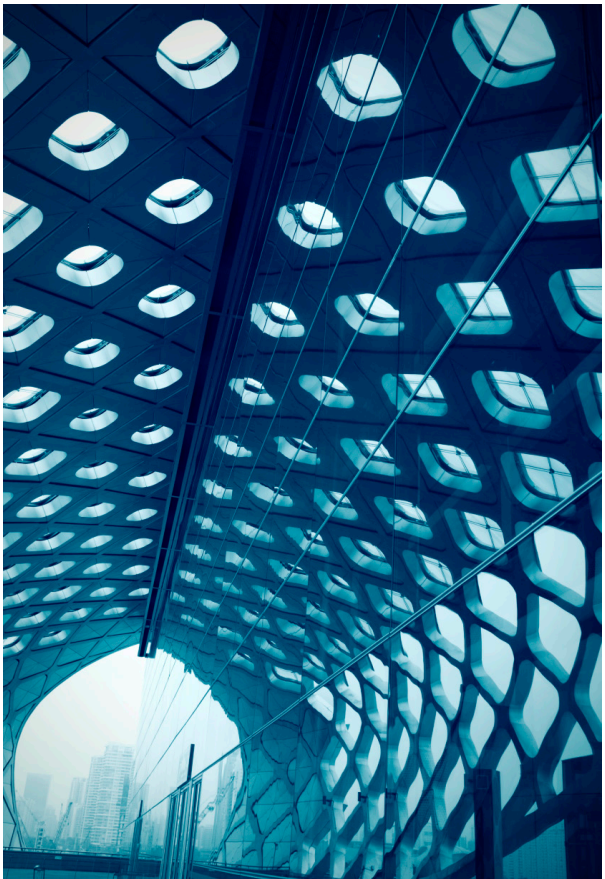
The implications of a low-cost, steady source of natural gas run deep. One immediate beneficiary is direct-reduced iron, or DRI. Long favored over scrap by steel makers because of its purity, DRI has seen only limited use in the steel-making process due to historically higher prices. Now, with an inexpensive, reliable supply of natural gas available, steel manufacturers that have access to DRI can use less scrap and make better quality steel at more competitive prices.

But companies that still rely entirely on scrap may also benefit from growth in DRI, as higher production and consumption of it will likely result in downward pressure on scrap prices. This development will require some repositioning on the part of these companies too, as they decide whether to compete as commodity producers using a low-quality scrap mix, or to concentrate on making higher-quality steel with higher-quality scrap.

Finally, some companies may decide to buy DRI and use it along with differing grades of scrap, either to improve the quality of their product for the same cost or to maintain the same quality at a lower cost.

In short, with natural gas acting initially as a catalyst, the global steel industry is being remade, and a landscape that is already undergoing noticeable change will continue to evolve.

There are uncertainties along the way, however, and for an industry where capital investment rarely happens on a small scale, a broad risk assessment will be an essential element of strategic decision making. It should not be forgotten that major shale gas deposits can be found not only in the U.S. but in other parts of the world, where exploration and extraction may not yet be as advanced but the industry will evolve. The reverberations of an increased emphasis on natural gas will be felt globally over the long term.



1 Deloitte Touche Tohmatsu Limited (DTTL), Global Manufacturing Industry group analysis; World Steel Association, Energy: Fact sheet. October 2008. http://www.worldsteel.org/dms/internetDocumentList/fact-sheets/Fact-sheet_Energy/document/Fact%20sheet_Energy.pdf

2 World Steel Association, Sustainable Steel: At the Core of a Green Economy. 18 June 2012. http://www.worldsteel.org/media-centre/key-facts.html

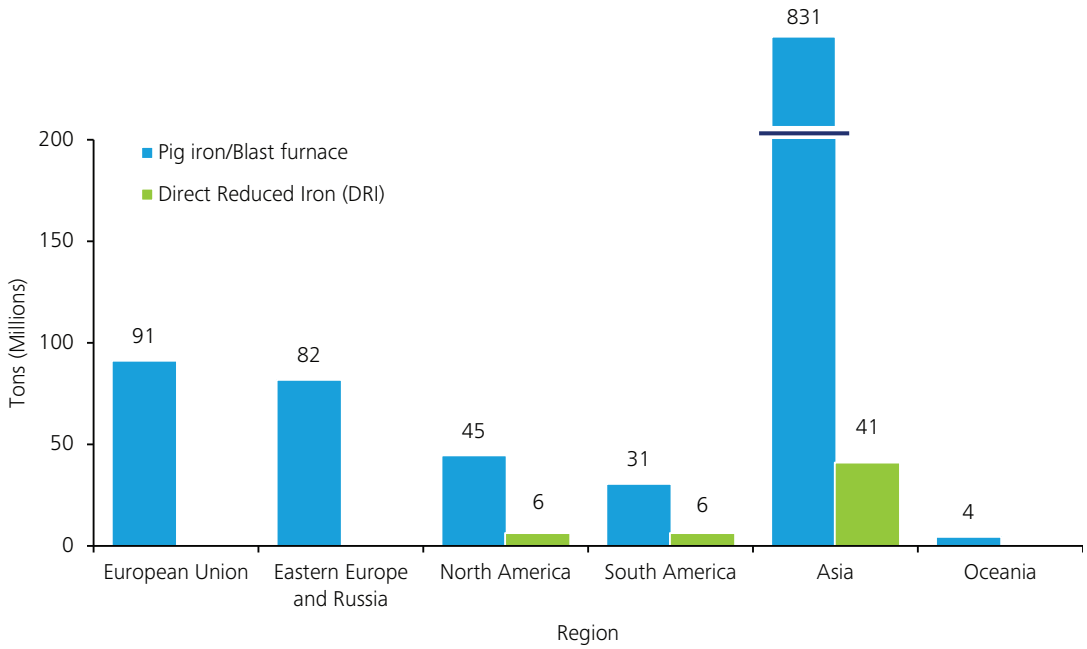
Less expensive, better steel: The natural gas game changer

For several decades, most crude iron for steel making has been processed in coke ovens and blast furnaces (CO/BF) (see Figure 1). The rest has been produced by DRI (approximately 8 percent). As recently as 2003, the U.S. produced very little DRI[3]. The relatively low DRI production in the U.S. over the last decade has been a function of the price of its principal fuel, natural gas, which has generally made DRI more expensive than iron made by the CO/BF process.

Worldwide, up to 70 percent of steel is made via blast furnace–basic oxygen furnace (BF/BOF), which uses feed materials of up to 25 percent scrap. Most of the remaining 30 percent of global steel production is made via electric arc furnace (EAF), which is fed almost exclusively by scrap[4]. The popularity of scrap is mostly a result of its price, though its properties (or composition) constrain the range of products that can be manufactured. Now that DRI can be made at a competitive price, it offers a higher-quality alternative to scrap as an EAF feed.

The proportions of steel production processes are slightly different in the U.S., where 40 percent is produced with BOFs (using 25 to 35 percent scrap) and the remaining 60 percent with EAFs (using almost 100 percent scrap)[5].

Figure 1: The current iron production landscape is dominated by the blast furnace process



Source: Deloitte Touche Tohmatsu Limited (DTTL) Global Manufacturing Industry group data analysis of World Steel Association *Iron production*. December 2012.

3 Edmund Newton. Iron Determination: DRI Technology Takes Off with the Availability of Affordable Natural Gas. Forward Online: Global Perspective from MSCI. May/June 2011 edition. http://forward.msci.org/articles/?id=364

4 World Steel Association. Sustainable Steel. At the Core of a Green Economy. 18 June 2012. http://www.worldsteel.org/dms/internetDocumentList/bookshop/Sustainable-steel-at-the-core-of-a-green-economy/document/Sustainable-steel-at-the-core-of-a-green-economy.pdf.

5 American Iron and Steel Institute, How Steel Is Made. 2013. http://www.steel.org/en/Making%20Steel/How%20Its%20Made.aspx. Accessed 5 June 2013

Although the technology has been available since the 1950s, DRI has always been more expensive than iron-processing methods using CO/BF. Gas-fuelled DRI has also historically been subject to fluctuations in gas prices, making it difficult to forecast costs. In the 1970s and again in the early 2000s, the price of natural gas fell to levels that made DRI attractive, but the dips failed to last long enough to have a major impact. As a result, companies have been understandably wary of depending on natural gas. This helps explain why so much of steel production today relies on inputs from CO/BF and lower-quality but cheaper scrap.

The discovery and exploitation of expansive fields of natural gas in the U.S. may overcome some of these challenges. Reserves are so large that the supply/demand dynamic is not expected to alter even in the event of massive increases in use in the steel industry. Low prices for natural gas are expected to continue well into the future (see Figure 2 on next page).

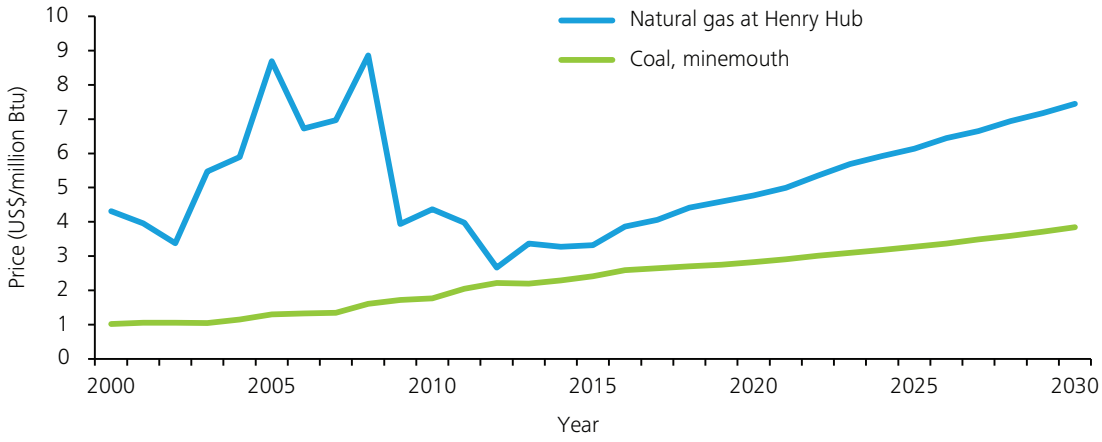
Naturally, lower-priced natural gas would expand the market for U.S.-produced gas in the form of liquefied natural gas (LNG). However, a tighter supply/demand balance is not likely to have a significant impact on natural gas prices. In fact, a Deloitte United States report projects the price impact to be modest, at less than 2 percent[6].

6 Deloitte United States. Deloitte Center for Energy Solutions and Deloitte MarketPoint LLC. Made in America: The Economic Impact of LNG Exports from the United States. 17 October 2011. http://www.deloitte.com/view/en_US/us/Services/consulting/9f70dd1cc9324310VgnVCM1000001a56f00aRCRD.htm

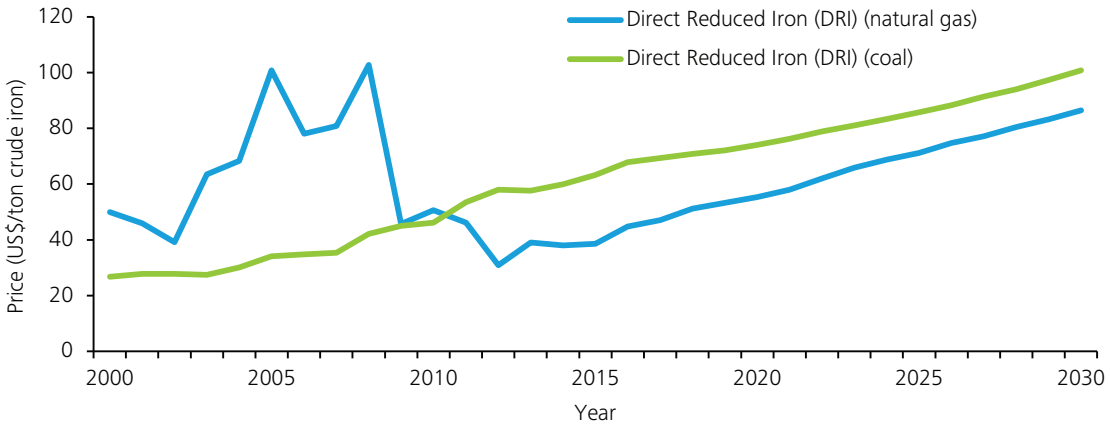
Currently, the global market for LNG (about 30 bcf) is only a tenth of that for natural gas, while U.S. natural gas capacity is two to three times greater than the global LNG market[7]. Moreover, the cost of converting and shipping the product means that even with lower gas prices, LNG demand is unlikely to surge. Finally, LNG handling capacity in the short term is limited, which could hamper delivery capabilities in the event of a spike in demand.

Figure 2: Natural gas prices are projected to remain at historically low levels

Natural gas price trends and projection (2000 to 2030)



Price comparison of Direct Reduced Iron using natural gas and coal



Source: U.S. Energy Information Administration. Annual Energy Outlook 2013.
Assumptions: Consumption of coal per ton DRI — 26.2 million Btu. Consumption of natural Gas per ton DRI — 11.6 million Btu

7 Deloitte United States. Deloitte Center for Energy Solutions and Deloitte MarketPoint LLC. Made in America: The Economic Impact of LNG Exports from the United States. 17 October 2011. http://www.deloitte.com/view/en_US/us/Services/consulting/9f70dd1cc9324310VgnVCM1000001a56f00aRCRD.htm

Examples from industry

Some companies have already begun adjusting to this new landscape. For example, Nucor has invested US$750 million for a DRI plant and related infrastructure in Louisiana[8]. This is in addition to a facility the company established in 2005 in Trinidad[9], where sources of natural gas are quite reliable. Nucor originally planned to expand by investing in a new blast furnace facility but was able to make the commitment to DRI by securing a 20-year gas contract that would not have been possible without shale-gas production projections[10].

The Trinidad plant, which uses Brazilian iron ore as its feedstock, allows Nucor to increase the proportion of nearly pure DRI in its finished product to up to 35 percent, instead of the industry-standard 8 percent, resulting in a higher-quality product and the ability to expand its product breadth[11].

Austria's Voestalpine is scheduled to build a 2 million mt/y hot briquetted iron (HBI) plant in Texas at a cost of €550 million (the company's largest ever foreign investment). Low natural gas prices, about a quarter of that of Europe, is motivating the move[12].

External factors such as geography and infrastructure are likely to inhibit some steel makers from duplicating these moves, but the DRI content of steel is expected to increase significantly over the next 10 to 15 years. Indeed, DRI technology company Midrex Technologies predicts that by 2020, DRI might contribute up to an additional 10 million tons of DRI (assuming no replacement of CO/BF capacity)[13].

The material benefits of natural gas

The Nucor example describes merely one way companies may benefit, directly and/or indirectly, from cheaper natural gas. Natural gas–fuelled DRI can be integrated into the steel-making landscape in myriad ways, and almost all industry players have the option to use more DRI in their operations, whether they make it themselves or source it elsewhere. It may serve as feed for EAFs, for example. While still hot, it can also be introduced into a blast furnace prior to the BOF process.

The cost benefits will vary, however, and the impact on the competitive landscape is an important consideration for any company contemplating a DRI strategy. Steel production costs at a DRI plant vary from US$200 to US$350 per ton. The range is strongly influenced by iron ore prices (captive or purchased on the open market), natural gas prices, and maintenance costs. Capital expenditures for commercial-scale DRI plants also lie between US$200 and US$350 per ton.

8 Nucor Corporation. Nucor Selects St. James Parish, Louisiana, for Iron Making Facility. 15 September 2010. http://www.nucor.com/investor/news/releases/?rid=1471666

9 Nucor Corporation. Nucor Announces Start-Up of Production of DRI in Trinidad press release. 16 January 2007. http://www.nucor.com/investor/news/releases/?rid=950793

10 Nucor Corporation. Nucor Enters Long-Term Natural Gas Agreement press release. 6 November 2012. http://www.nucor.com/investor/news/releases/?rid=1754835

11 Edmund Newton. Iron Determination: DRI Technology Takes Off with the Availability of Affordable Natural Gas. Forward Online: Global Perspective from MSCI. May/June 2011 edition. http://forward.msci.org/articles/?id=364

12 Platts. DRI Market Gains Fresh Impetus, Issue 183. 6 June 2013; Voestalpine. Voestalpine constructing direct reduction plant in texas USA. Press release 13 March 2013. http://www.voestalpine.com/group/en/press/press-releases/2013-03-13-voestalpine-constructing-direct-reduction-plant-in-texas-usa.html

13 Deloitte Touche Tohmatsu Limited (DTTL) Global Manufacturing Industry group, interview with Midrex Technologies Inc. executive. 1 May 2013.

These figures compare well with costs for pig iron from commercial-scale CO/BF plants, which have at least 10 to 15 percent higher production costs and require three times greater capex. In addition, the economic scale needed for CO/BF plants (3 to 3.5 million tons per year) is much larger than for their DRI counterparts (approximately 2 million tons per year), making DRI the preferred choice when it comes to expansion[14]. Operational benefits may come from several areas:

- **Lower processing temperature**. Since the ore does not need to melt, the processing temperature ranges from 800 degree Centigrade to 1,050 degree Centigrade versus the higher than 1,600 degree Centigrade typical in BF processing[15]. Lower temperatures mean less energy expenditure.
- **Streamlined front-end processing**. Less handling during the reduction process decreases the need for purification processing.
- **Lower maintenance costs**. Because the DRI process occurs at a lower temperatures, equipment is subject to less abrasion, corrosion, and general wear and tear, potentially leading to lower maintenance costs.
- **Capacity planning flexibility**. The ability to build relatively small, competitive DRI plants may allow companies to keep overcapacity in check, flattening price dips over the course of the business cycle.
- **A purer product**. Natural gas steam contains fewer impurities than coal steam. The resulting iron is expected to be purer and to produce higher-quality steel.

Impacts beyond the plant floor

Because natural gas prices are expected to remain competitive for an extended period, the impact on the industry is likely to be far reaching[16]. It includes the following factors.

1. A new look for the global manufacturing footprint

Low-cost DRI in the U.S. could alter the global manufacturing footprint, as the American industry may no longer need to look overseas for the lowest-priced iron. In an environment of overcapacity, this may lead to stranded capacity as facilities in China and India are left unable to compete. Moreover, higher DRI-content steel from the U.S. may become more attractive to non-U.S. steel buyers in terms of price and quality, putting further pressure on traditional CO/BF producers.

2. Improved margins

Along the steel value chain, lower total manufacturing costs may lead to improved margins not only because of cheaper iron but also because of factors such as lower emissions-related expenses and waste management costs.

3. Cleaner production

Natural gas emits far less carbon dioxide versus coal-based processes. As emissions become a cost concern, companies that depend less on coal stand to be more competitive. Any legislative pressure is likely to enhance the relative environmental advantage of DRI over competing processes.

Industry-wide implications

Companies along the value chain will be able to develop long-term strategies, assuming the high likelihood that DRI will be a key part of steel making and that scrap prices will fall accordingly. Some of the most significant potential implications are as follows.

1. Pricing and margins for current steel products, distribution of value in the value chain

Where pricing is determined by the marginal producer, the value chain is expected to experience larger margins generated by lower cost and higher quality. How this incremental value will be distributed along the value chain is an interesting and important question. Those with steel-making capacity, for example, may retain a large part of the incremental margin that is driven by lower costs. Those making products for the market may be able to improve their economics by using cheaper scrap in the mix fed to the EAF process.

14 Association of Iron & Steel Technology. The Making, Shaping and Treatment of Steel 11th Edition.

15 R.L. Stephenson and R.M. Smailer.Direct Reduced Iron — Technology and economics of production and use. Published by Iron and Steel Society of AIME. 1980.

16 For more information on the impact of natural gas prices, see Deloitte United States. Deloitte Center for Energy Solutions and Deloitte MarketPoint LLC. Made in America: The Economic Impact of LNG Exports from the United States. 17 October 2011. http://www.deloitte.com/view/en_US/us/Services/consulting/9f70dd1cc9324310VgnVCM1000001a56f00aRCRD.htm

2. Lower-priced scrap
As more DRI is used, the price of scrap, which has been rising in recent years, could potentially fall off. This would likely be a benefit to mini-mills that depend on scrap for their inputs and could have a generally moderating effect on the price of steel. However, scrap price dynamics are complicated by a market that is less than ideally transparent. It is unlikely that buyers can secure long-term contracts. Most deals are made in terms of months or even weeks. This uncertainty means that DRI might be cheaper than scrap one month but more expensive the next, introducing another element of risk to the production process.

3. North American downstream processing facilities
As more crude iron manufacturing occurs in North America, some downstream processes (from steel making via EAFs to various value-added processes and fabrications) may draw closer to the manufacturing source to take advantage of skilled labor and proximity to North American end markets.

4. Changes in strategy and risk management
Greater reliance on natural gas signals significant changes to the industry footprint and supply chain. Naturally, logistics, transportation, and tax issues could also be affected. The spread between the price of scrap and the price of pig iron may no longer follow historical patterns. These and other issues may have a profound impact on strategy and risk management.

Opportunities for producers: An uneven playing field

Companies able to take advantage of cheaper DRI may benefit from several opportunities.

1. Product and market shifts based on cheaper steel
Further spurred by cheaper steel, manufacturers may contemplate using new products they might otherwise have rejected on the basis of their steel price. In some cases, steel might replace non-steel products such as aluminum, plastic, composites, and other metals. U.S. steel makers could become more competitive and find new opportunities in previously unviable export markets.

2. Asset acquisition
Given the currently limited DRI capacity, some companies may look to acquire assets that integrate well within DRI processing as opposed to CO/BF, particularly when faced with the possibility of losing uneconomic capacity. These major purchases are likely to be available only to companies whose balance sheets can withstand the impact and will require careful timing and risk management.

For companies without an overall strong position in iron ore and natural gas, it may make more sense to secure supply from a more advantaged player than build its own capacity, a key make versus buy decision. Resources freed up by such a decision could be targeted at opportunities in other parts of the value chain

Companies will be well advised to carefully assess the outcome of a range of scenarios. With respect to cheap natural gas, for example, they need to plan for scenarios in which the price of the commodity begins to drop in other regions. For example, if ferrous scrap comes under price pressure, steel companies that have recently acquired scrap processors may find their investment less profitable than expected. It may be preferable to invest in DRI (with dual benefits of DRI sourcing and lowering scrap prices).

3. Market share
Steel companies that have access to firm competitive long term supplies of natural gas and iron ore are expected to be better positioned strategically than others, from both the cost and product variety points of view. These companies may take market share from their competitors by producing a range of products at lower prices.

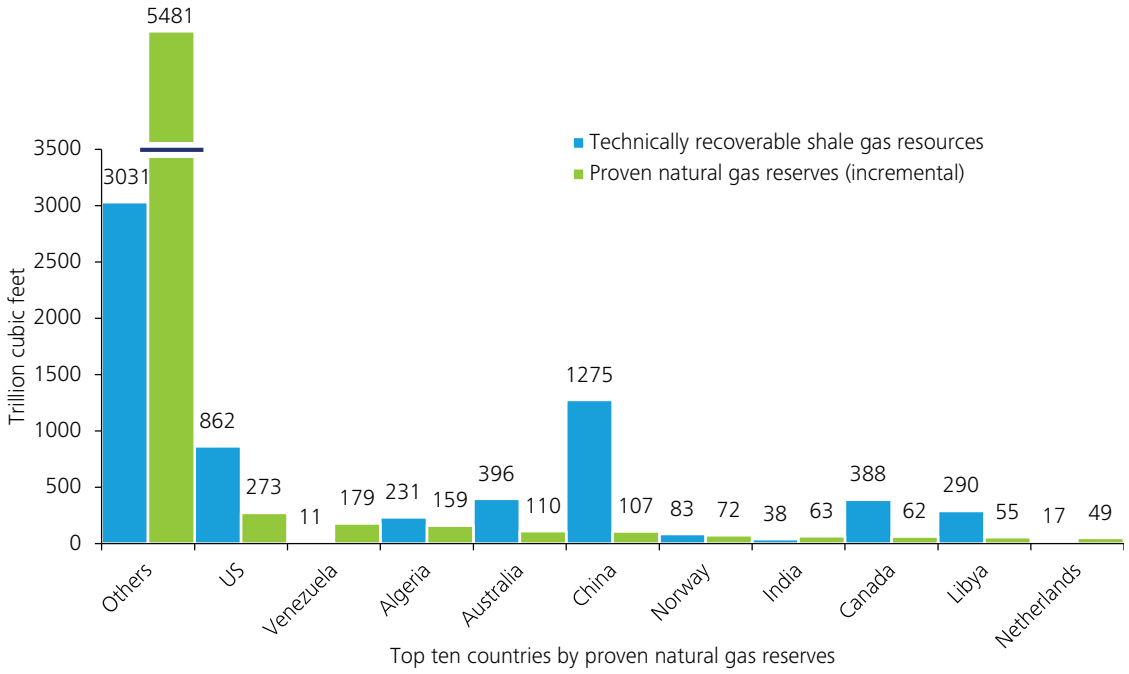
4. Improved margins
Because of the uneven playing field, where the cost of production will drop for some companies but not for others, the opportunity exists for some companies to become more competitive or to widen their competitive gap.

5. Improved environmental performance
The steel industry has an opportunity to reduce its carbon emissions further and to manage current or future environmental risk as it continues to improve its environmental profile by shifting from coal to natural gas.

A few caveats to consider

One of the great advantages the American steel industry has is that shale-gas exploration and extraction is more advanced in the U.S. than in other parts of the world (see Figure 3). That said, the U.S. does not have a monopoly on shale gas, and estimates suggest that reserves in China are even greater[17]. However, China also counts on an abundance of coal and iron and relatively inexpensive construction costs. The impact of a domestic supply of natural gas, once that becomes a reality, is likely to be very different from that in the United States. For now, the U.S. steel industry has a clear head start, but eventually a response will be heard from around the world.

Figure 3: Recent availability of shale gas in large quantities in the U.S. is a major industry shift



Source: U.S. Energy Information Administration. Annual Energy Outlook 2013. World Shale Gas Reserves: An Assessment of 14 Regions by U.S. Energy Information Administration. 5 April 2011. Report outlined estimated shale gas technically recoverable resources for select basins in 32 countries. Countries in "Others" includes France, Chile, India among many other countries.

17 In a 2011 report, the U.S. Energy Information Administration estimated that China had 1,275 trillion cubic feet of recoverable shale gas, the largest reserves of all countries surveyed in that report. See U.S. Energy Information Administration World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States. 5 April 2011.

Currently, Asian and Middle Eastern steel makers are using cheap coal to make DRI. This remains a viable option, albeit with environmental implications in terms of carbon emissions (similar to CO/BF). Moreover, coal energy produces a less pure product than DRI, and at current prices for natural gas is more costly in terms of existing capacity. Understanding how these industry players might respond under various scenarios will be a key component of strategy development for steel producers.

Steel is not the only industry taking a closer look at natural gas. Utilities and chemical companies are also studying how to substitute legacy fuels and feedstocks with cheaper and more readily available natural gas. Because of this, demand for the commodity will come under increased pressure. At the same time, gas producers themselves, always searching out new markets, are exploring ways to make transporting their product more viable (through liquefaction, as one example).

It is inevitable that these variables will eventually affect natural gas prices, and any projections will have to take the range of factors into account.

Remaking the industry: Developing a strategy for success

It is unlikely that no company in the global steel industry will be unaffected by cheaper natural gas. Some will take advantage of the supply to produce a higher-quality product. Others will be able to make lower cost steel. And some, the best positioned of all, will be able to do both if they have the following profile:

- A strong balance sheet to fund new capacity
- Competitive assets (including CO/BF) and a way to efficiently integrate with DRI production
- The ability to use the DRI in EAF processing
- The mill capabilities to use DRI for enhanced value products.

Companies with a winning approach to this industry shift will need to make tailored assessments to determine the impact on their business. This will help identify not only opportunities to strengthen their position but also potentially adverse events that must be mitigated.

Answering many questions requires new insights

The changing global steel industry landscape, influenced by the evolution of the natural gas supply, will require significant strategic responses from all companies and their partners. This opportunity, or challenge, will necessitate new thinking enabled by new insights.

At Deloitte United States, the firm's futures thinking and scenario planning has been built on the experience of the Global Business Network™ (GBN), a practice within the Monitor Deloitte strategy consulting group. The group represents a significant source of thought leadership and process innovation to help clients identify and adapt to the forces shaping the future. The GBN group has served many U.S. Fortune 100 companies, leading non-government organizations, and private foundations, along with numerous municipal, regional, and national government agencies, helping to address key questions.

Combining the world-class talents of GBN with the energy industry–leading capabilities of Deloitte MarketPoint supports companies faced with challenges and uncertainties in a dynamic market climate. Robust analytical tools, including MarketBuilder, provide fundamental market modeling of price, supply, and direction of trade flows, to demonstrate how market trends might affect the risks and returns in a company's business and strategic decisions.

The unknowns associated with natural gas pricing are numerous. Scenarios must be developed and thoroughly analyzed in order to understand and assess detailed potential factors such as volume, price, supply, demand, legislation, technology, political environment, and so forth. MarketBuilder modeling provides crucial inputs into the strategy development process and facilitates better-informed decisions.

The MarketBuilder tool has been designed to represent the full market structure of the supply, demand, operation, and transportation chains, and is customizable to a company's unique circumstances. The supply/demand intersection for natural gas, for example, can be computed up to 40 years into the future. By combining broad market data with a company's individual context, MarketBuilder is able to run through the full spectrum of scenarios from best to worst case in order to guide strategic decision making and to answer specific questions regarding location attractiveness, for example, or direction of flow of a commodity in a region (such as where the supply will come from).

Models generated by MarketBuilder are integrated in the same way that natural gas markets are integrated. The analytical tool uses sound economic methods to account for the spatially and technically diverse nature of the market, producing a thorough model of cross-asset characteristics such as price, basis differentials, flow quantities, new capacity, and reserve additions. MarketBuilder can also integrate other market components such as emissions, regulatory issues, or the impact of new shale discoveries in Asia.

MarketBuilder modeling can provide crucial inputs into the strategy development process and facilitate more informed decisions.

Summary: A complex decision

The abundance of cheap natural gas presents global steel companies with strategic questions based on three fundamental effects:

1. Lower costs for making crude iron
2. Suppressed prices for scrap metal in the U.S. as driven by increased use of DRI in EAFs
3. The opportunity to make different products from EAFs by substituting DRI for scrap.

The impacts will be wide ranging. Supply chains will be reconsidered, with the opportunity to source scrap at lower prices or to use DRI. Some companies may choose to mix the two, perhaps using lower-quality (and less expensive) scrap along with DRI to produce on-spec products. EAF companies that do not make their own DRI may have to consider how to source it, possibly by negotiating long-term contracts early on and thereby gaining advantage over other manufacturers.

Manufacturing considerations include deciding what role DRI will play in the asset base. This will depend on whether the company is a pure EAF player or, as in the case of integrated companies, whether it currently has access to or makes its own DRI. There is also the question of immediate versus long-term response. Having access to DRI is a significant factor in any shift to new product possibilities over the long haul, whereas using DRI may not be crucial to lowering manufacturing costs via cheaper scrap in the short term.

The new landscape will give companies the opportunity to develop new products or to reconsider old possibilities that were previously rejected as uneconomical. Companies may choose to partner with end users in the automotive, consumer packaging, industrial equipment, or other sectors to find new uses for these new products.

Deciding when and how to take advantage of natural gas is a complex process that requires companies to take a hard look at their current situation (asset footprint, products, target markets, supply and sales contracts, etc.) and plan for any number of scenarios that might play out. Moreover, as the rest of the world begins to adopt natural gas as a major energy source, North American companies will have to re-evaluate their strategies constantly. Only when prepared with a robust yet flexible path should any company feel confident of its decisions.

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