# Whither DRI?

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## Introduction

North America mini-mill growth during the past decade has been tremendous, and now represents nearly 50 percent of steel production. This growth was driven by the availability of scrap, reasonably priced electricity, process flexibility, low capital costs, and EAF technology developments. Along with the tremendous operational performance improvements in electric furnace steelmaking has come a significant change in the charge mix. In 1989, virtually all EAFs ran on a 100 percent scrap charge and almost no alternative iron was used. The term “alternative iron” refers to virgin charge materials, and includes direct reduced iron, hot briquetted iron, merchant pig iron, and hot metal. Today, the percentage of alternative iron fed to the EAF in North America is over 15 percent, and worldwide over 20 percent. DRI alone now comprises about 8 percent of the charge mix in North America, 13 percent globally.

## Metallics Prices

Given the widespread demand and usage of alternative iron, the downturn in steel and metallics prices from early 2000 through year-end was unexpected. The last price trough occurred in late 1998 as a result of the Asian Flu, with US hot rolled coil delivered prices dropping to $275/metric ton (T) and scrap prices reaching the $70-90/T level. Table I and Figure 1 show historical prices, including the last two troughs (1992, 1998) and peaks (1995, 2000).

The recovery from the 1998 downturn was good, with scrap prices reaching the $120-150/T level in early 2000. The outlook then was positive, with increasing steel demand and production. However, since April, the markets have plummeted, with steel and metallics prices reaching lows close to those in 1998. In a severe downturn, prices typically drop to the cash cost of the low cost producer. This has happened, with export prices at the $75-80/T level, which is the cash cost of the Venezuelan plants.

**TABLE I**
**NORTH AMERICAN STEEL AND METALLICS PRICES**
**($/tonne delivered)**

| | Hot-rolled Coil | Scrap No. 1 HMS | Scrap No. 1 Bundles | Scrap Shredded | Pig Iron | HBI |
|---|---|---|---|---|---|---|
| 4th Q 1992 | 185 | 83 | 96 | 95 | - | 122 |
| 1st Q 1995 | 430 | 139 | 172 | 150 | 180 | 160 |
| 4th Q 1998 | 276 | 72 | 84 | 93 | 115 | 109 |
| 1st Q 2000 | 380 | 120 | 145 | 131 | 155 | 136 |
| 4th Q 2000 | 260 | 73 | 87 | 85 | 130 | 111 |

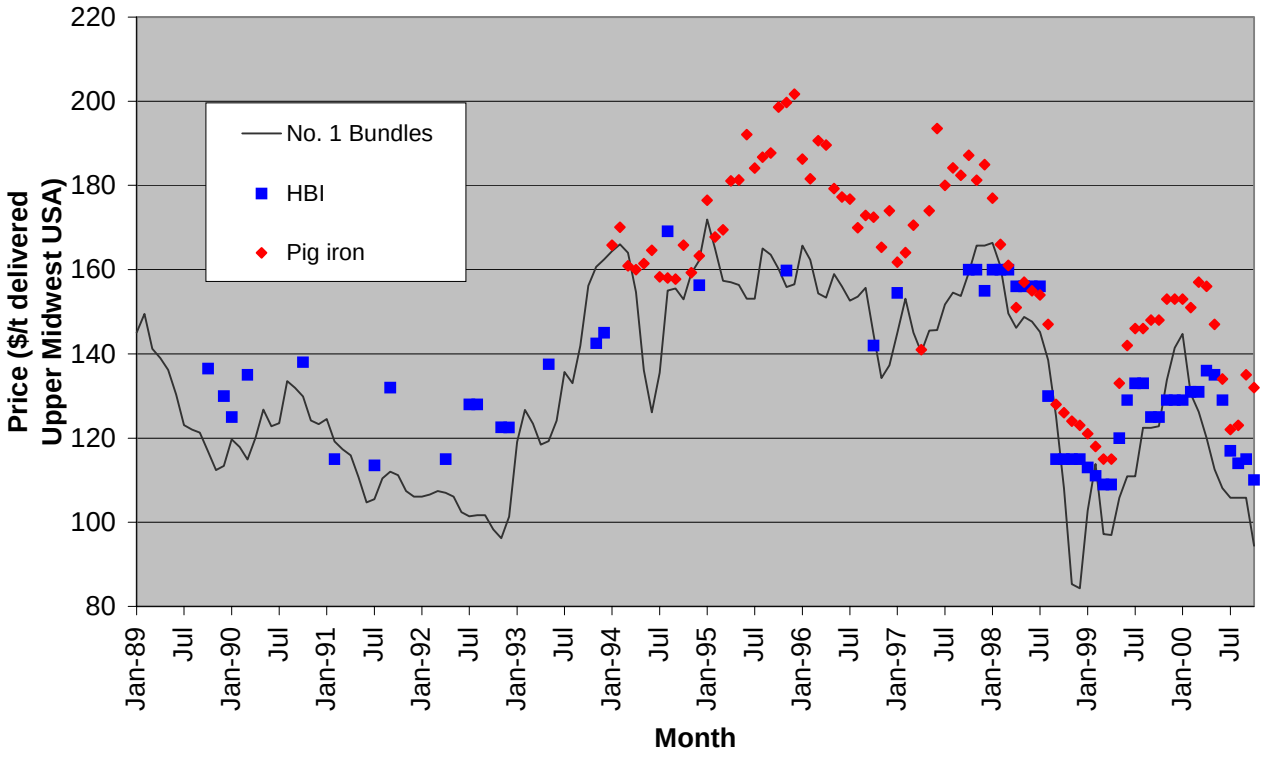


**FIGURE 1.**
**North American Metallics Prices**

This downturn is disturbing for two reasons: 1) world steel production and metallics demand are at all-time highs, 2) this downturn has occurred barely two years since the last deep one – normal steel cycles are 5-8 years trough-to-trough. Does this portend a

change in the relationship between steel production and prices and in steel cycles? What is the future for alternative iron?

## World Metallics Balance

To gain an historical perspective we have looked at the period 1995-2000, since during that time there was unprecedented interest in DRI. From 1995-2000, North American (US and Canada) EAF production increased 17 MT, yet steel and metallics prices have dropped $50-60/T. Why?

One good way to analyze the situation is to perform an EAF metallics balance. The first step is to look at EAF metallics demand, which can be approximated by multiplying EAF production by 1.1, thus assuming a 90 percent yield of metallics to crude steel. It is then possible to determine the sources, given that supply must equal demand in the real world. Data on imported scrap, domestic and imported DRI/HBI, merchant pig iron, and hot metal use is readily available. By definition, the difference is domestic scrap. Table II shows the data.

**TABLE II**
**NORTH AMERICAN EAF METALLICS BALANCE**
**(MT EXCEPT AS NOTED)**

| | 1995 | 1999 | 2000 |
|---|---|---|---|
| *Metallics requirements* | | | |
| Steel production | 108 | 113 | 124 |
| % EAF | 39 | 46 | 48 |
| EAF production | 42 | 52 | 59 |
| EAF metallics required | 46.5 | 57.2 | 64.9 |
| | | | |
| *Metallics sources* | | | |
| Imported scrap | 2.1 | 3.6 | 3.8 |
| Domestic scrap* | 39.2 | 43.9 | 50.3 |
| Total scrap | 41.3 | 47.5 | 54.2 |
| | | | |
| Captive DRI | 1.5 | 1.4 | 1.4 |
| Domestic merchant DRI | 0.0 | 1.2 | 1.0 |
| Imported merchant DRI/HBI | 1.2 | 1.8 | 2.7 |
| Total DRI | 2.7 | 4.4 | 5.1 |
| | | | |
| Domestic merchant pig iron | 0.3 | 0.5 | 0.5 |
| Imported merchant pig iron | 2.3 | 4.9 | 5.0 |
| Total pig iron | 2.6 | 5.4 | 5.5 |
| | | | |
| Hot metal** | 0.0 | 0.0 | 0.2 |

*Includes home, prompt, and obsolete scrap
** Hot metal used in EAFs

## Metallics Sources: 1995-2000

The net increase in North American metallics requirements was 18 MT from 1995-2000. Following is an analysis of the various sources.

***DRI/HBI* -** DRI use increased by 2.4 MT, from a combination of increased domestic merchant DRI (AIR and Corus Mobile) and imports (Venezuela, Trinidad). The high, sustained scrap prices from 1994-98, due to the growth of flat products mini-mills, caused those mills to look for alternative sources of low residual metallics.

***Pig Iron*** - Pig iron imports increased markedly from 1995-2000, by 2.9 MT. The biggest exporter has been Brazil, where all the merchant pig iron is produced in mini blast furnaces using charcoal. Devaluation of the Real has been a major factor keeping Brazilian pig competitive. Russia and the Ukraine are also major suppliers, using their excess blast furnace capacity. This material can be sold cheaply in North America because of the transition of the former Soviet Union economies and the desire to earn dollars.

US Pig iron imports increased due to the need for alternative feedstock and the low cost of pig iron production. This material provides a supply of high iron, high carbon material at an attractive price. Many mills have now developed practices for using pig iron and have installed more oxygen capability.

***Scrap Trade -*** North American scrap imports increased 1.7 MT over the period because of high scrap demand and the strength of the dollar. Although North America does not import much scrap from the former Soviet Union, the huge increase in scrap exports from those countries is having a “knock-off” effect. In 1996, the Russian government lifted export controls and granted many scrap exporting licenses. Due to the desire to earn dollars, scrap exports increased significantly. In 1995, the former USSR exported about 3.5 MT of scrap, but by 1999, the figure increased to 13 MT. This scrap supply has disrupted the international market, with European exporters now looking for other destinations to replace the lost Asian tonnage.

***Hot Metal -*** Hot metal use in EAFs is small, but there are plans to expand this application.

***Domestic scrap -*** The balance of the increase in metallics from 1995-2000, 11 MT, was supplied by domestic scrap, both home and prompt scrap. This increase was made possible by the strong US economy, which resulted in greater amounts of steel products and scrap produced, and the drop in US scrap exports.

## Direct Reduction Plant Shutdowns

The severe decrease in metallics prices, down to the cash cost of the lowest cost producer, severely hampered merchant DR plant profitability. The final blow which caused the closure of several North American DR plants was the dramatic increase in natural gas prices. Figure 2 shows US spot natural gas prices, which have tripled since early 2000. This increase was largely due to the growth of natural gas-fired power plants in the US.

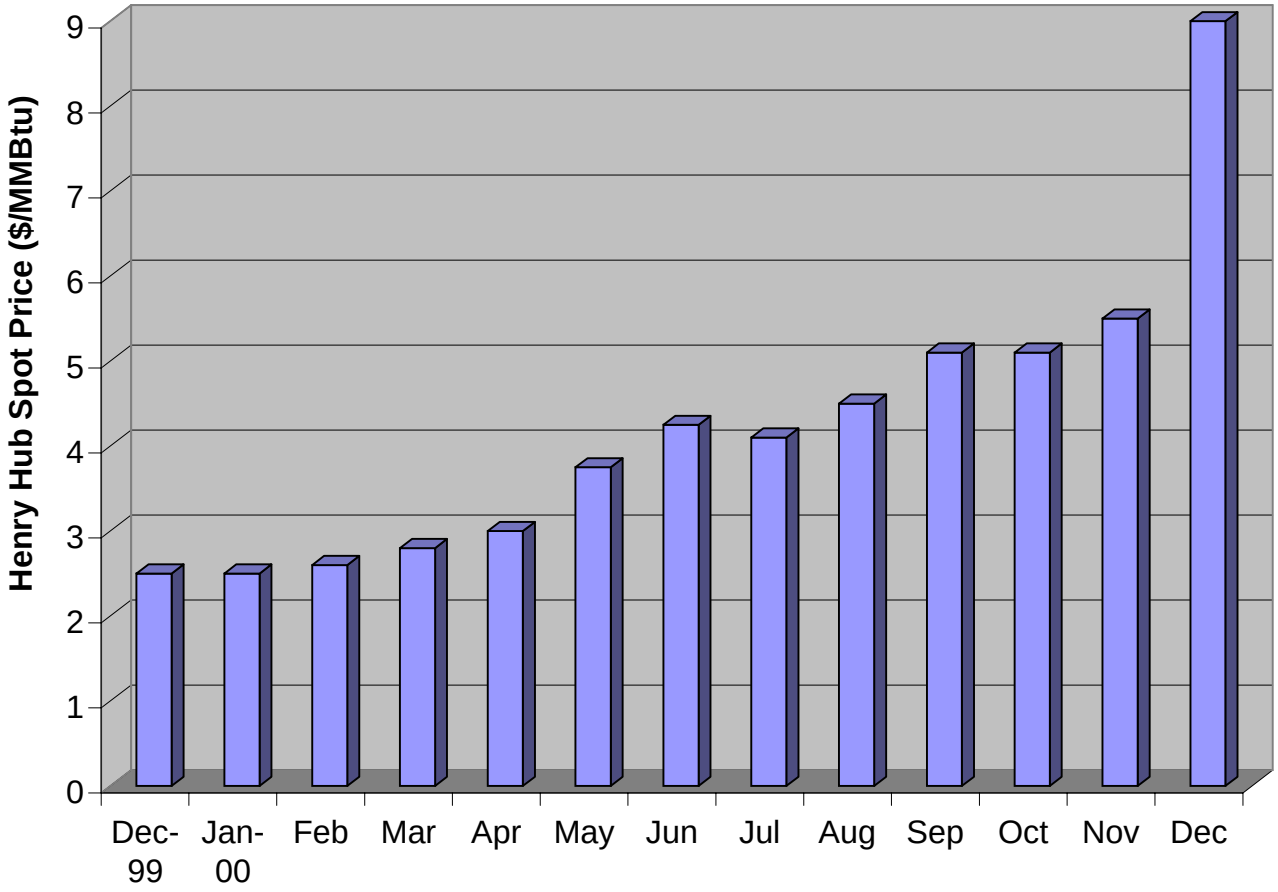


**FIGURE 2.**
**US Spot Natural Gas Prices**
**($/MMBtu)**

Table IV shows the DR plants that have been idled or shut down and those that are threatened.

## TABLE IV
## DIRECT REDUCTION PLANTS IDLED

| Plant | Location | Total Capacity (MT/y) | Merchant Capacity (MT/y) | Notes |
|---|---|---|---|---|
| ***Implemented*** | | | | |
| AIR | Convent, LA, USA | 1.2 | 1.2 | Owners selling plant |
| Corus Mobile | Mobile, AL, USA | 0.8 | 0.8 | Mothballed indefinitely |
| Ispat Sidbec I | Contrecouer, Canada | 0.4 | 0.0 | Mothballed indefinitely |
| Hysla 2M5 | Monterrey, Mexico | 0.25 | 0.0 | Seeking govt. action |
| Hylsa 3M5 | Monterrey, Mexico | 0.5 | 0.0 | Seeking govt. action |
| Hylsa 2P5 | Puebla, Mexico | 0.6 | 0.04 | Seeking govt. action |
| Total | | 3.75 | 2.04 | |
| ***Potential*** | | | | |
| Ispat Sidbec II | Contrecouer, Canada | 0.6 | 0.0 | Evaluation in Spring '01 |
| Georgetown | Georgetown, SC, USA | 0.4 | 0.0 | May reduce output |
| Ispat HSW | Hamburg, Germany | 0.4 | 0.0 | High price for many years |
| Total | | 1.4 | 0.0 | |

Thus, more than 5 MT of DR capacity serving North America and Europe has been, or may be, shut down due to high gas prices alone. In addition, there is 4.2 MT of capacity in Venezuela and Trinidad that has had start-up difficulties. The mini-mills that have their own captive plants face a very difficult choice because DRI is such an essential part of their operations. They need 40 percent or more DRI, but the present economics make it uneconomical to produce it themselves. It is possible to purchase this feedstock on the merchant market, but this may be a risky proposition.

The idling of these DR plants has apparently had an immediate impact on prices for other metallics. US prompt industrial scrap prices rose $6-12/LT in early December and Brazilian pig iron exporters raised prices by $5/T, both of which have been attributed to the closure of DR plants. The 3.75 MT or more of product previously produced by the DR plants shown in Table IV must now be purchased elsewhere, which will raise prices.

## Metallics Sources: 2001-2010

What about the future? In Table V, we revisit the North American EAF metallics balance, adding Midrex's estimates out to 2010. Clearly, mini-mill growth will continue in North America as steel demand increases and blast furnaces are closed. Total EAF metallics demand will grow by 23 MT to 2010. What will be the sources of the required feedstock?

**TABLE V**
**NORTH AMERICAN EAF METALLICS BALANCE**
**(MT EXCEPT AS NOTED)**

| | 1995 | 1999 | 2000 | 2005 | 2010 |
|---|---|---|---|---|---|
| *Metallics requirements* | | | | | |
| Steel production | 108 | 113 | 124 | 135 | 145 |
| % EAF | 39 | 46 | 48 | 53 | 55 |
| EAF production | 42 | 52 | 59 | 72 | 80 |
| EAF metallics required | 46.5 | 57.2 | 64.9 | 79.2 | 88.0 |
| | | | | | |
| *Metallics sources* | | | | | |
| Imported scrap | 2.1 | 3.6 | 3.8 | 4.0 | 4.0 |
| Domestic scrap* | 39.2 | 43.9 | 50.3 | 62.2 | 69.0 |
| Total scrap | 41.3 | 47.5 | 54.2 | 66.2 | 73.0 |
| | | | | | |
| Captive DRI | 1.5 | 1.4 | 1.4 | 2.0 | 3.0 |
| Domestic merchant DRI | 0.0 | 1.2 | 1.0 | 0.0 | 0.0 |
| Imported merchant DRI/HBI | 1.2 | 1.8 | 2.7 | 5.0 | 5.0 |
| Total DRI | 2.7 | 4.4 | 5.1 | 7.0 | 8.0 |
| | | | | | |
| Domestic merchant pig iron | 0.3 | 0.5 | 0.5 | 0.0 | 0.0 |
| Imported merchant pig iron | 2.3 | 4.9 | 5.0 | 4.0 | 3.0 |
| Total pig iron | 2.6 | 5.4 | 5.5 | 4.0 | 3.0 |
| | | | | | |
| Hot metal** | 0.0 | 0.0 | 0.2 | 2.0 | 4.0 |

*Includes home, prompt, and obsolete scrap
** Hot metal used in EAFs

***Imported scrap*** – this will likely stay at present levels. The dollar is not expected to strengthen further, and there are logistical restrictions on increasing scrap imports. Also, the former USSR economies must eventually reform, which will reduce their need to export metallics at unrealistically low prices.

***Domestic scrap*** – the figures in Table V require a 19 MT increase in domestic scrap generation. Is this possible? Maybe, but this is a large increase, nearly double the increase from 1995-2000.

***DRI*** – Captive DRI production will increase with the growth of coal-based technologies such as FASTMET. There will be no more gas-based plants built in North America, and little merchant production. However, there should be a sizable jump in HBI imports from Venezuela and Trinidad with their low production costs and favorable locations. DRI and HBI will continue to be an essential part of the North American EAF charge mix.

***Pig iron*** – Midrex forecasts that North American pig iron imports will decrease over time. Although the Brazilians tout charcoal pig iron as an environmentally friendly material, the reality is far different. Today, only about 30 percent of the Eucalyptus trees harvested are replanted, whereas the government mandate is 70 percent. The working conditions at the charcoal ovens are not good and would not be tolerated in an industrialized country.

In a true capitalistic economy, the cost of producing and shipping pig iron would not allow steelmakers in Russia and the Ukraine to export to North America or Asia at a profit. It is being done now to earn foreign exchange. However, this situation will not persist indefinitely.

***Hot Metal*** - hot metal use in EAFs is expected to grow dramatically over the next few years because of the EAF productivity benefits. Many new technologies are being developed. These include FASTMELT®, which employs a rotary hearth furnace producing DRI that is melted, then charged to an EAF.

## Conclusions

What, then, is one to make of a scenario in which world steel demand has reached record levels, yet metallics prices are near a trough? The answer appears to be excess metallics supply. Given the large number of metallics sources, the many countries involved, and the uncertainties of the real world, at times there is oversupply and undersupply, as with any market. Special problems are posed by metallics from the former USSR and pig iron from Brazil, which are not necessarily based on true free market economics. In the former case, the economies in that region are not fully capitalistic, and businesses are desperate for foreign exchange. Input prices are often unreasonably low, meaning that metallics can be sold for very low prices at a profit. In Brazil, the charcoal-based pig iron relies on an extremely cheap reductant whose cost does not reflect the total replacement value.

The drop in world steel prices is also due to excess supply. The estimates vary, but there is 200-300 MT of excess steelmaking capacity in the world. Although almost all observers agree there should be major rationalization, this is difficult to do because of political, labor, and pension liability factors.

Another factor resulting in the downturn in metallics and steel prices has been the strong dollar. Since most steel and metallics trade is denominated in dollars, a strong dollar tends to depress prices.

What does the future hold? Assuming the world's economies continue growing at a moderate pace and steel demand does also, EAF production will comprise the bulk of the increase in steel output. This 2-3 percent per year EAF production increase will necessitate an increase in metallics supply, some of which will be provided by DRI/HBI. Midrex forecasts a DRI production increase of 3 MT/y for the period 2000-2010.

The consensus opinion is that 1-2 years will be required for the present low metallics prices to recover substantially. Thus, a new wave of interest in DR plants should occur in 2-4 years; i.e., the 2003-2005 time frame. Despite all the talk about the "new economy," we can expect that business and steel cycles will continue.