2	ISSUED	4/03/18	-	DJP	MES	MES
1	FOR INFORMATION	9/10/16	-	DJP	MES	MES
0	FOR INFORMATION	6/9/16	-	DJP	MES	MES
REV.	**DESCRIPTION**	**DATE**	**PROJ.**	**EXEC.**	**CHECK.**	**APPR.**

Pure Fonte Ltée

PURE FONTE LTÉE

PIG IRON PRODUCTION PLANT – FEASIBILITY STUDY

CUSTOMER Nº: 1821

TENOVA

TECHINT ENGINEERING & CONSTRUCTION

FEASIBILITY STUDY

SECTION 13

MARKET STUDIES AND PRODUCT QUALITY

REVISION 2

ESC.: N/A | JOB: CD-335

2

REVISION

SECTION CONTENTS

1	ISSUED	4/4/18	-	DJP	MES	MES
0	FOR INFORMATION	8/31/16	-	DJP	MES	MES
REV.	**DESCRIPTION**	**DATE**	**PROJ.**	**EXEC.**	**CHECK.**	**APPR.**

Pure Fonte Ltée

PURE FONTE LTÉE

PIG IRON PRODUCTION PLANT – FEASIBILITY STUDY

CUSTOMER Nº: 1821

tenova

TECHINT

TENOVA

TECHINT ENGINEERING & CONSTRUCTION

SECTION 13 MARKET STUDIES AND PRODUCT QUALITY

CHAPTER 13.1

MARKET STUDIES

ESC.: N/A

JOB: CD-335

REVISION 1

REVISION

CONTENTS

FIGURES AND REFERENCES

Chapter references

[1] Raw Materials & Ironmaking Global Consulting Services and Fe Exchange Group, "Pig Iron Market Study Report for North American Iron Corp. (PURE FONTE LTÉE) Plant in Quebec," April 20th, 2015. Dr. Joseph J. Poveromo, RMI [Joe.Poveromo@rawmaterialsiron.com] and Stephen Miller, Senior Trader [smiller@fe-xchange.com].

13.1 Market Studies

This chapter outlines the market for the product to be produced by PURE FONTE LTÉE. The subchapter 13.1.1 comes directly from a study performed by RWI Global Consulting Services, of Dr. Joseph J. Poveromo, RMI, commissioned and complemented by PURE FONTE LTÉE with its own market information. It has been edited by PURE FONTE LTÉE and it has been added by Tenova into this chapter upon permission of PURE FONTE LTÉE.

13.1.1 Pig Iron Market Study Report for PURE FONTE LTÉE Plant in Quebec

13.1.1.1 Pig Iron Market for Steel Mills

The challenges faced by PURE FONTE LTÉE can best be discussed by examining OBM (ore based metallics: merchant pig iron, DRI, HBI) consumption by plant and company and showing this below on a company basis in the following table. The key numbers in this table are shown in bold red as they provide totals by company for Nucor, SDI and ArcelorMittal as well as an aggregate total for a number of mainly long product plants.

METAL STRATEGIES INC.							U.S.	8649	MPI	4087	DRI	4562
Major U.S. and Canada. Users / Buyers of HQ Metallics (at full plant capacity); '000 Short Tor							Check	8649		4087		4562
Company / Products	Capacity		EAF Oper %		EAF Production		Total 2014		MPI 2014		DRI 2014	
	EAF	Rolling	2013	2014	2013	2014	% EAF	KT	% EAF	KT	% EAF	KT
Group Tota ------	49860	44550	0.75	0.77	37619	38145	0.25	9491	0.11	4137	0.14	5354
United Stat ------	44882	40050	0.76	0.77	33917	34397	0.25	8649	0.12	4087	0.13	4562
Canada ------	4978	4500	0.74	0.75	3702	3748	0.22	843	0.01	50	0.21	792
Nucor (10.3 Sheet)	20572	18450	0.80	0.81	16402	16663	0.31	5102	0.12	1949	0.19	3153
Gallatin (Arcelor-Gerdau)	2007	1800	0.82	0.84	1646	1686	0.41	696	0.25	421	0.16	275
Nucor total	**22579**	**20250**			**18047**	**18348**		**5798**		**2370**		**3428**
Steel Dynamics	6300	5950	0.76	0.77	4766	4839	0.12	557	0.09	415	0.03	142
Severstal	3791	3400	0.82	0.81	3109	3071	0.29	903	0.18	553	0.11	350
SDI total	**10091**	**9350**			**7875**	**7910**		**1459**		**967**		**492**
North Star BlueScope	**2230**	**2000**	**0.82**	**0.84**	**1829**	**1873**	**0.30**	**556**	**0.23**	**431**	**0.07**	**125**
Arcelor Mittal	**5519**	**4950**	**0.69**	**0.69**	**3817**	**3817**	**0.32**	**1236**	**0.04**	**135**	**0.29**	**1101**
SSAB-Ipsco	2788	2500	0.80	0.80	2230	2230	0.06	139	0.04	89	0.02	50
Gerdau	2644	2425	0.76	0.75	2009	1980	0.06	113	0.03	56	0.03	57
AK Steel	635	600	0.73	0.76	464	483	0.15	149	0.05	47	0.10	102
ATI Allegheny Ludlum	500	450	0.73	0.76	365	380	0.10	38	0.03	11	0.07	27
Republic	1800	1200	0.36	0.54	648	980	0	0	0	0	0	0
Charter Manufacturing	1057	975	0.77	0.75	814	793	0.10	79	0.01	11	0.09	68
NLMK-Beta	558	500	0.75	0.76	418	424	0.20	85	0.15	64	0.05	21
V&M Star	948	850	0.65	0.62	616	588	0.08	47	0.08	47	0	0
TPCO	600	500	0	0	0	0	0	0	0	0	0	0
Timken	1800	1600	0.82	0.75	1476	1350	0	0	0	0	0	0
Evraz-Ipsco	1744	1600	0.80	0.82	1392	1427	0.04	55	0.04	55	0	0

Table 13.1-1.: Ore Based Metallics Consumption by Plant and Company

The key points inferred from the above:

- Nucor, SDI and ArcelorMittal all have considerable captive sources of OBM's,
- Northstar Bluescope is shown by itself as the only major EAF flat rolled mini mill not associated with Nucor, SDI or ArcelorMittal,

- The remaining plants, nearly all long product EAF plants, are grouped together; these show an EAF production of 10 MTPY but an OBM consumption of only 700 KT.

Nevertheless, the leading targets for PURE FONTE LTÉE pig iron would be:

Ocean access
SDI Columbus, where only a small portion of their 900 KT OBM requirement could be met by increased production at the SDI Mesabi Nugget operation, however, PURE FONTE LTÉE would face intense competition from the leading pig iron importers from Brazil, Russia and the Ukraine, as well as Venezuelan HBI competing for any DRI/HBI that this plant wishes to buy.
Gerdau Beaumont, SSAB Mobile, TPCO (if operating) - offer prospects for small tonnages but the remaining other plants offer both logistical challenges and very limited tonnage prospects.

Great Lakes Access
Northstar Bluescope would be the only truly independent EAF flat rolled minimill and they do prefer pig iron and PURE FONTE LTÉE would have a logistical advantage here, as well.
Nucor Crawfordsville – however rail, truck transport is needed from Chicago or northwest Indiana
AK Steel Mansfield, OH and Butler, PA and ATI Allegheny Ludlum, Midland, PA ; all requiring rail/truck transport from Great Lakes ports
NLMK Beta, Portgage, IN - direct access to Lake Michigan (but has been content to use “beach iron” (dumped hot metal) from the adjacent ArcelorMittal Burns Harbor Plant).
Republic Lorain and Charter Steel, Cleveland, both in OH and located on Lake Erie
Charter Steel, Saukville, WI, ship to Port of Milwaukee; rail, truck to plant

13.1.1.2 Pig Iron Market for Foundries (Basic and Nodular)

The foundry market for pig iron in the USA is estimated at about 1 million TPY. This includes basic pig iron (BPI), Foundry pig iron (FPI) and Nodular pig iron (NPI). The largest segment is BPI, but some of the Russian BPI (Tula and Ural) have natural chemistries with are quite nodular-like and several large ductile foundries (notably Grede) use these BPI grades instead of or to defray the cost of NPI. The next largest segment is NPI estimated at .3-.4 million TPY. This includes Sorelmetal produced in Richards Bay RSA and in Sorel, Que. FPI (.1-.2 million TPY) is a declining commodity as gray iron production in the USA has steadily declined. Nodular or ductile production has steadily grown and will continue to do so.

The general premium for NPI over BPI is $60-80 NT, however, BPI pricing is correlated with scrap pricing but NPI pricing does not necessarily follow scrap pricing.

There are several grades of NPI but the most common USA spec (nicknamed “Triple 5”) is:

C   3.5-4.5   Si .50 max   Mn .05   P .05 max   S .02 max

Another spec that some foundries require have Mn and P restricted to .035% max.

The general spec for foundry BPI is the same as the steel mills:

C 3.5-4.5   Si 1.5 max   Mn 1.5 max   P   .12 max   S .05 max.

Some foundries like certain elements to be lower and specifically seek material made by specific producers or regions (example, Tula or Northern Brazil).

Regarding lake shipments, there are three USA markets which would be reachable by water, Chicago, Northern OH/MI and Northern WI. Please keep in mind that foundries require their suppliers to inventory their NPI at river or lake terminals and ship it to them as they need it. This adds extra expense in terms of discharge, storage charges, shrinkage, screening costs, and other carrying costs. We estimate the WI TPY at 15-25 000 and the Chicago tonnage at 100,000-150,000 TPY, with Northern OH at about 100,000 TPY.. Regarding shipments to US Great Lakes terminals, there is a large NPI demand in Northern Ohio and Western PA. Therefore, Erie and Ashtabula would be likely staging areas. The warehouses in the East Liverpool, OH are used to distribute most of the NPI used in PA, OH, New England and other Mid-Atlantic states. Other main staging areas for Brazilian NPI are Aurora, IN, Chicago, IL, La Crosse, WI and St Paul, MN.

European traders import about 150-200 KT/year from Brazil. The Quebec location would be good for these moves into N. Europe and sometimes Turkey. The European foundries use Russian NPI and low Mn BPI as well. PURE FONTE LTÉE NPI made in Quebec could have a competitive advantage over the Brazilian producers while the Europeans are less inclined to import from Russia. Shipments to Europe tend to around 10,000 MT and have to be combined with BPI or other freight to obtain a favorable ocean freight. The Europeans also buy FPI, but not it the same volumes as NPI. They have domestic FPI production in Germany from DK and several Russian producers (Tula and Kosaya Gora) also make FPI, in addition to NPI.

The following is how all Brazilian NPI is transported to the US.

Most of Brazilian NPI production is in the State of Minas Gerias where the numerous producers are organized into several channels each led by an Executive Director who negotiates prices and tonnages for his group. The channels produce and sell all grades of pig iron, NPI, FPI and BPI. These cargoes are pre-financed by either advance payment or Letter of Credit(L/C). This L/C is 85% drawable when the various producers within the channel deliver their material to an inland warehouse (usually operated by Vale), but before it is shipped via railcar to the coastal ports of Vitoria, ES or Rio de Janeiro. This is not without some risk. The pig iron is accumulated at a storage area outside of the port and is then transferred to the port to meet the vessel chartered by the trading company, which purchased the cargo. Since, the docks in Vitoria are used by steelmakers, their vessels are given priority and demurrage charges occur fairly often. After vessel loading, material testing and weighing, the remaining 15% of the L/C can be drawn. The vessel then departs on a 17-20 day trip to New Orleans, where its cargo is unloaded into barges mid-river for the 17-30 day trip upriver to the terminals mentioned previously. Upon arrival at the terminals, the barges are discharged, weighed into storage and then distributed to customers as they require it. Weight shortages are very common.

The point is, the current procurement method for nodular pig iron is very cumbersome, risky and expensive. Either proposed PURE FONTE LTÉE production sites will cut out some of these expensive steps to become more competitive than the Brazilian producers.

Current pig iron supply coming to the USA is estimated as follows:

<u>NPI only</u>

Brazil	220,000 TPY
RSA	150,000 TPY
Russia	5,000 TPY
Canada	35,000 TPY

The NPI which is produced in Canada and RSA is a by-product of TiO2 production and does not have a distinct production cost but instead is a revenue stream for a by-product. Consequently, they can price to compete with other NPI suppliers. In Brazil, there are clear production costs that influence pricing strategy. The Brazilian producers claim the cost of making NPI is 15% higher than BPI. If Brazilian producers could not get the right price for their NPI, they would revert to making BPI. Currently, there is no USA NPI production.

Opportunities to ship by rail directly to foundry consumers are limited as most foundries take their materials via truck. As noted above, much of the NPI for foundries has to be warehoused and then delivered to the foundries as they need it. In this case, rail shipments to various terminals would be available.

NPI is the most expensive of the three grades of merchant pig iron. Therefore, foundries are always trying to find a less expensive replacement. Some larger foundries have had success in using the Russian BPI grade made by Tulachermet and Ural Steel. Although, the sulfur levels are not always below .02%, the critical Mn levels are usually below .10% and for some types of nodular iron production, this is acceptable. This usage of BPI to substitute for NPI has cut into the overall demand for Brazilian NPI. Overall, the tonnage of the Russian low Mn BPI used by US foundries is approximately 125,000 TPY.

Therefore, if a North American producer could make a similar basic pig iron, they would likely capture this market. The specifications are below:

C 3.5-5.0 Si .75% max Mn .10 max P .05 max S .025 max

Another point to consider is the ongoing alloy contamination of the scrap supply available to nodular foundries in NAFTA and the EEC. The small and mid-sized nodular foundries in NAFTA countries have to use production (mainly automotive) scrap. The scrap has be small (24" & under), have no coatings, free-flow, and have a series 1008/1010 series chemistry. The Mn spec is .40 max (although some foundries have moved up to .50% in recent years). This spec eliminates all but a very few grades of mild carbon steels.

The challenge for these foundries is that the recent introduction of the new High-Strength/Low Weight steels, which the automakers are demanding, contain elements which negatively affect nodular ironmaking. They can contain higher levels of Ti, V, Mn, to name a few. These steels have already resulted in formerly approved scrap supplies to be rendered unusable in nodular iron production. Acceptable scrap materials are getting more difficult to find and the prices are rising. The nodular industry has been slow to recognize this and react to it.

As this contamination becomes more prevalent, these foundries will have to either pay severely elevated prices to obtain acceptable scrap(of which there is not enough) or add something to their melt to neutralize the marginal alloy increase in the scrap charge. After interviewing several foundry melt shop superintendents, the consensus choice was NPI (not Russian low Mn BPI). In my opinion, this should increase NPI demand, but it's hard to quantify at this time or predict the timing. But, it's safe to say, that no self-respecting nodular melt shop, using an electric induction furnace, will be without a handy stockpile of NPI kept nearby.

In conclusion, having a dedicated North American nodular pig iron facility, whether in Ashtabula or Quebec, should be a successful venture. There are not that many producers with which to compete. They are very far away. The challenge for the plant would be to make a high quality nodular pig iron product.

13.1.1.3 Scope of Report – Pig Iron Market for Steel Mills

This pig iron market study would cover the following key areas:

- Views on substitution amongst metallic's (scrap, ore based metallics: pig iron, DRI, HBI) and motivators including details on how much of an EAF feed mixture can be pig iron, DRI or HBI.
- Key reasons why pig iron is used by EAF's. What types of steel generally require ore based metallics (pig iron, DRI, HBI) and what types do not.
- Who and where are the mills that use pig iron and no DRI/HBI
- Provide a sense for who in the market are not likely to drop pig iron for DRI/HBI substitutes. It is recognized that lower priced scrap can get be increased/decreased depending on spreads: is there a cost trade-off between pig iron and scrap that someone would use 31% pig iron rather than the typical 20%.
- In North America PURE FONTE LTÉE wishes to get a sense for a pig iron plant finding a market – ideally in northern USA/Canada – for both steel mills and foundries. What mills in the north are users of pig iron/HBI/DRI and what are the estimated volumes.
- Who is producing pig iron (and DRI) in North American and sense of their estimated volumes
- What would be appealing to a North America mill to use Pig Iron from Canada – assuming price is not the only barometer?

- For the months when the Great Lakes is frozen – what would be best target for Pig Iron (eastern seaboard, NOLA, Europe, etc.)
- Potential other entrants at the pig iron level
- If possible, when identifying the mills that use pig and the quantity. Identifying the source of pig and shipping logistics (route) for delivery.

13.1.1.4 Scope of Report – Pig Iron Market for Foundries (Basic and Nodular)

This pig iron market study would cover the following key areas:

- What would the capacity look like for foundries and what is the general split on Basic vs Nodular
- What are the specs generally sought for Nodular Grade
- What premiums are usually commanded by Nodular Grade
- Location estimates on users; – Great Lakes shipments and NOLA shipments. We would try to establish where the split is for Nodular – what is a practical expectation to reach from the Lakes.
- What specs are generally sought by foundries for basic pig and what is the size of this market.
- Provide an overview and a volume estimate for where the current pig iron supply is coming from to the USA and any sense on what their price points would – namely, if they were to lose market share how would they respond.
- Is delivery to some foundries by rail feasible (eliminates or at least reduces seasonal considerations from Quebec)
- Utilize available estimates on Europe for Foundry grades and discuss if that should play a part, given ease of access to Europe from Quebec (closer and less expensive than Lakes).

13.1.1.5 EAF Consumers for Ore Based Metallics

We divide our discussion into flat products, high end long products and commodity long products.

<u>Flat Products (sheet and plate)</u>

The main overall drivers of demand in this product sector are as follows:

- Construction – in descending order with relative shares: non-residential (50%, including pre-engineered building panels, decking, HR and CR sheet and plate for conduit, culvert and other), public works (40%, including plate bridge spans, water and non-energy storage tanks, signs, metal poles, guard rails, feedstock for conduit, culvert and other) and residential (10%)

- Automotive, HR, CR and HDG sheet in the southern- and Mexican-based transplant automotive producers. Almost 50% of the combined U.S. and Mexican light vehicle production is based in the SE U.S. region. For EAF-based sheet producers applications in this sector are confined to structural components and parts. We expect an additional 5% to 10% (1.0 to 1.5 million units) growth in this cycle. For integrated mills only, growth will be tempered by inroads of aluminum into tonnage applications as the Ford F-150 truck move into an all-aluminum body is ominous. Hopefully, this trend will be confined to larger trucks as the weight reduction provided by switching to aluminum becomes less significant. Other demand drivers are construction and tubular manufacturing from plate grades. Again, this is an issue only for integrated mills, not directly for EAF-based mills.
- Energy, including 2.25 MTPY of substrate for domestic welded OCTG production (actual 2014), 2.3 MTPY for plate and coiled plate substrate for domestic welded line pipe production (projected 2015), and over 1.5 MTPY combined for storage tanks, tank barges, tank railcars, tank trucks and other miscellaneous energy sector applications.
- Other consumer, commercial, and other OEM including appliances, HVAC, electrical equipment, farm, construction and industrial vehicles.
- Non-energy welded carbon and alloy pipe substrate (primarily HR sheet) for domestic producers of these products amounting to a combined market of 6.0 MTPY including 2.7 MTPY of structural tubing, 2.1 MTPY mechanical tubing, 1.1 MTPY standard pipe and 0.1 MTOPY of pressure tubing.

Flat products production in the USA is now dominated by the EAF mini mills including the following:

- Nucor, Berkeley, SC – sheet
- Nucor Crawfordsville, IN – sheet
- Nucor Hertford, SC – plate
- Nucor Gallatin, KY - sheet
- Nucor, Tuscaloosa, AL - plate
- Nucor, Decatur, AL – sheet
- Northstar Bluescope, OH - sheet
- SDI Butler, IN - sheet
- SDI, Columbus, MS - sheet

- Nucor, Hickman, AR - sheet
- SSAB Americas, Mobile, AL - plate
- Big River Steel, Osceola, AR (Breaking Ground in 2015) plate, sheet

The plants listed above include three producing plate including one focusing on rail products (Arkansas Steel associates) while another (SSAB Mobile) supplies plate into the tubular market that had been doing well with the energy boom in the USA. The proposed Big River Steel plate will focus on niche products (tubular for the energy market, electrical sheet steel, etc.)

However, the biggest new entrant is the former Thyssen Krupp Alabama plant in Calvert, Alabama. This plant is now co owned by Nippon Steel and Arcelor-Mittal. It is a sheet finishing facility starting with a hot strip mill (capacity 5 MTPY) that rolls slabs imported from various sources including the JV (TK-VALE) slab plant in Brazil as well as slabs that will be coming from ArcelorMittal plants in the USA, Brazil and Europe. This plant will prosper under the new JV owners and will soak up any increase in demand in sheet steel in this region.

The above EAF sheet mills and the Calvert plant helped to drive out all but one of the integrated (BF/BOF) producers serving the SE USA region and within the next 12 to 18 months, that sole remaining integrated plant (U.S. Steel Fairfield AL) is expected to convert to EAF steelmaking and completely exit sheet steel production. In 2001, Gulf States Steel in northeast AL closed all operations permanently, while in mid-2012, RG Steel closed its Sparrows Point and Wheeling WV plants leaving only the USS Fairfield Plant as the only BF/BOF facility still operating in SE USA.

The USS Fairfield plant does have a successful seamless tubular steel facility that USS wants to enhance while their hot strip portion of the plant is troubled. They recently announced a plan to build an EAF to feed the tubular operation while shutting down the BF/BOF and the hot strip mill. However, some U.S. Steel insiders derided this plan as “pipe dream”.

- Their issue is that replacement of the BF/BOF with an EAF might actually increase liquid steel costs as the BF hot metal costs are minimized by the use of the lowest cost pellets (KeeTac in Minnesota).
- Even with rail transport costs from Minnesota, the hot metal iron unit costs are less than $ 130/ton while liquid steels would be less than $ 400/ton.
- Purchasing large volumes of premium metallics would cause EAF costs to be above this level. USS might wind up enhancing their tubular casting facilities

while trying to maintain the hot strip mill operation at least on a break even basis so as to maintain the economy of scale of the BF/BOF route.

An analysis from Metal Strategies showed the following:

- For the average of 2014, raw materials costs for EAF-based sheet mills averaged $377 per ton while those for integrated mills with captive iron ore averaged $248 per ton.
- For March 2015, raw materials costs for EAF-based sheet mills averaged $264 per ton while those for integrated mills with captive iron ore averaged $222 per ton.
- Both reference points strongly support the argument against converting to EAF steelmaking.
- However, it is in respect to conversion costs that integrated mills lose all and more of their initial raw material cost advantage with conversion costs for integrated mills being $100 to $200 per ton higher than those for EAF sheet mills. Presumably, U.S. Steel could offset the current $22 per ton EAF raw material disadvantage via significantly improved conversion costs. However, U.S. Steel would need an improvement of at least $50 per ton to justify the loss of raw material cost competitiveness and the capital and interest costs of buildings and installing the EAF equipment.

Nevertheless, US Steel has begun construction of this EAF shop at Fairfield but has not yet announced any plans for DRI or merchant pig iron production.

High End Long Products

The Gerdau Ft. Smith, AR and Beaumont TX plants, Nucor Memphis TN, ArcelorMittal Georgetown SC, and the USS Fairfield seamless tubular operations are the leading EAF-based high-quality long products producers in this product category in the SE USA region, with U.S. Steel Fairfield's conversion to EAF still pending. As noted already, the tubular market will continue to grow with the US energy boom thus benefitting USS Fairfield and the billet operations of Nucor Memphis. The SBQ products produced at the Ft. Smith Arkansas plant will continue to be in demand by the automotive, forging, energy and off highway markets.

In the northern USA and Canada high end long products are produced at: SDI Columbia, IN – rail, beams, ArcelorMittal (Montreal, Indiana Harbor (SBQ), Steelton (rail, bar);

Gerdau (Monroe MI, Jackson, MI); Republic (Lorain, Canton, both in Ohio) and Charter (Saukville, WI, Cleveland, OH)

Commodity Long Products

Many other EAF plants in the USA and Canada mainly produce commodity long products, rebar and beams with none using ore based metallics.

13.1.1.6 Analysis of the Customer Base for Ore Based Metallics

EAF Flat Rolled Mini Mills

In this section we start out with the leading user of OBM's (ore based metallics), the EAF flat rolled steel sector. The table below lists all of the EAF sheet steel and plate operations in the USA and Canada. Mexico is omitted as their EAF sector is served by captive DRI operations with additional OBM materials (pig iron and HBI) readily available from Brazil and Venezuela, respectively. Nonetheless, AHMSA, a traditional BF/BOF steel producers in Mexico, reportedly will import up to 400 KT/year of HBI from the Voest Stahl HBI plant to feed to their new EAF operation in Monclova, Mexico. The logistics are more favorable for this source.

The table below for EAF flat rolled and high end long producers shows:

- principal products,
- steel capacity in MTPY,
- EAF utilization and production in 2013, 2014,
- the percentage and total tons of ore based metallics used in the EAF charge in 2014,
- the breakdown in % and KT between DRI/HBI and merchant pig iron

Some comments on OBM sourcing follow:

- Nucor Trinidad DRI ships preferentially to Nucor's seaborne EAF sites while Nucor Louisiana DRI ships to Nucor EAF plants on the river systems,
- The other captive sources include the SDI IDI RHF/SAF hot metal plant in Butler, the SDI Mesabi Nugget plant in Minnesota, the on-site blast furnace operation at AM Dofasco and the on-site DRI plant at AM Canada.

- The beach iron source listed for NLMK is not really a captive; it is hot metal dumped on the ground during BOF delays at the adjacent ArcelorMittal Burns Harbor BF/BOF steel plant. Such pig iron is somewhat lower grade due to contamination and sizing relative to commercial merchant pig iron.
- The market sources would be mainly Brazil and Russian pig iron and Venezuela HBI although some pig iron comes from Canada, Ukraine, also.
- It should also be noted that some OBM's such as merchant pig iron also have significant markets outside of steel production such as the foundry sector. HBI and DRI are not used in the foundry sector due to impurities.

For 2013 and 2014 the total production of these EAF operations is about 38 MT with the total percentage of OBM's about 25 % totalling 9.5 MT with just over 4.0 MT being merchant pig iron and about 5.3 MT being DRI/HBI. These totals are not overwhelming and underscore the site specific and focused use of such ore based metallics.

METAL STRATEGIES INC.

Major U.S. and Canada. Users / Buyers of HQ Metallics (at full plant capacity); '000 Short Tons

	U.S.	8,649	MPI	4,087	DRI	4,562
	Check	8,649		4,087		4,562

Company / Plant	Products	Capacity		EAF Oper %		EAF Production		Total 2014		MPI 2014		DRI 2014	
		EAF	Rolling	2013	2014	2013	2014	% EAF	KT	% EAF	KT	% EAF	KT
Group Total	------	49,860	44,550	75%	77%	37,619	38,145	24.9%	9,491	10.8%	4,137	14.0%	5,354
United States	------	44,882	40,050	76%	77%	33,917	34,397	25.1%	8,649	11.9%	4,087	13.3%	4,562
Canada	------	4,978	4,500	74%	75%	3,702	3,748	22.5%	843	1.3%	50	21.1%	792
Nucor (10.3 Sheet)		**20,572**	**18,450**	**80%**	**81%**	**16,402**	**16,663**	**30.6%**	**5,102**	**11.7%**	**1,949**	**18.9%**	**3,153**
Crawfordsville, IN	Sheet Coil	2,676	2,400	82%	84%	2,194	2,248	35.8%	804	11.3%	254	24.5%	550
Blytheville, AR	Structurals	2,676	2,400	65%	68%	1,739	1,820	19.1%	348	8.5%	155	10.6%	193
Hickman, AR	Sheet Coil	3,122	2,800	84%	86%	2,622	2,685	30.5%	820	11.9%	320	18.6%	500
Decatur, AL	Sheet Coil	2,676	2,400	84%	86%	2,248	2,301	49.8%	1,145	15.0%	345	34.8%	800
Berkeley, SC	Sheet Coil, Strcut	2,899	2,600	83%	83%	2,406	2,406	43.7%	1,052	21.9%	527	21.8%	525
Darlington, SC	SBQ, MBQ	1,115	1,000	80%	80%	892	892	12.0%	107	2.5%	22	9.5%	85
Memphis, TN	SBQ Bar	1,338	1,200	83%	83%	1,111	1,111	21.0%	233	3.0%	33	18.0%	200
Norfolk, NE	SBQ, Tube Rnds	1,115	1,000	74%	75%	825	836	7.0%	58	1.0%	8	6.0%	50
Hertford, NC	Discrete Plate	1,561	1,400	80%	80%	1,249	1,249	12.0%	150	12.0%	150	0.0%	0
Tuscaloosa, AL	Coil Plate	1,394	1,250	80%	80%	1,115	1,115	34.4%	384	12.0%	134	22.4%	250
Company / Plant	Products	Capacity		EAF Oper %		EAF Production		ALT FE 2013		MPI 2014		DRI 2014	
		EAF	Rolling	2012	2013	2012	2013F	%	KT	%	KT	%	KT
Steel Dynamics		**6,300**	**5,950**	**76%**	**77%**	**4,766**	**4,839**	**11.5%**	**557**	**8.6%**	**415**	**2.9%**	**142**
Bulter, IN	Sheet Coil	3,300	3,000	82%	83%	2,706	2,739	15.0%	411	13.0%	356	2.0%	55
Columbia City, IN	Structurals, Rail	2,000	1,800	63%	65%	1,260	1,300	5.0%	66	4.5%	59	0.5%	7
Pittsboro, IN	Sheet Coil	1,000	950	80%	80%	800	800	10.0%	80	0.0%	0	10.0%	80
SDI (ex Severstal		3,791	3,400	82%	81%	**3,109**	**3,071**	**29.4%**	**903**	**18.0%**	**553**	**11.4%**	**350**
Columbus, MS	Sheet Coil	3,791	3,400	82%	81%	3,109	3,071	29.4%	903	18.0%	553	11.4%	350
North Star BlueScope		**2,230**	**2,000**	**82%**	**84%**	**1,829**	**1,873**	**29.7%**	**556**	**23.0%**	**431**	**6.7%**	**125**
Delta, OH	Sheet Coil	2,230	2,000	82%	84%	1,829	1,873	29.7%	556	23.0%	431	6.7%	125
Nucor Gallatin (ex Arcelor-Gerdau)		**2,007**	**1,800**	**82%**	**84%**	**1,646**	**1,686**	**41.3%**	**696**	**25.0%**	**421**	**16.3%**	**275**
Gallatin, KY	Sheet Coil	2,007	1,800	82%	84%	1,646	1,686	41.3%	696	25.0%	421	16.3%	275
SSAB-Ipsco		**2,788**	**2,500**	**80%**	**80%**	**2,230**	**2,230**	**6.2%**	**139**	**4.0%**	**89**	**2.2%**	**50**
Montpelier, IA	Sheet Coil	1,394	1,250	80%	80%	1,115	1,115	9.2%	103	7.0%	78	2.2%	25
Mobile, AL	Sheet Coil	1,394	1,250	80%	80%	1,115	1,115	3.2%	36	1.0%	11	2.2%	25
Arcelor Mittal		**5,519**	**4,950**	**69%**	**69%**	**3,817**	**3,817**	**32.4%**	**1,236**	**3.5%**	**135**	**28.8%**	**1,101**
Hamilton, ON (Dofasco)	Sheet Coil	1,115	1,000	78%	79%	870	881	0.0%	0	0.0%	0	0.0%	0
Contrecoeur East, Que	Various Long	2,119	1,900	68%	68%	1,441	1,441	55.0%	792	0.0%	0	55.0%	792
Contrecoeur West, QE	Various Long	1,338	1,200	63%	65%	843	870	6.0%	52	0.0%	0	6.0%	52
Indiana Harbor East, IN	SBQ Bloom Bar	500	450	70%	70%	350	350	25.0%	88	20.0%	70	5.0%	18
Steelton, PA	Semis, Bar, Rail	1,100	1,000	60%	60%	660	660	12.8%	85	9.8%	65	3.0%	20
Georgetown, SC	Wire Rod	948	850	70%	66%	663	626	35.0%	219	0.0%	0	35.0%	219
Gerdau		**2,644**	**2,425**	**76%**	**75%**	**2,009**	**1,980**	**5.7%**	**113**	**2.8%**	**56**	**2.9%**	**57**
Monroe, MI	SBQ Bar	600	550	80%	78%	480	468	0.0%	0	0.0%	0	0.0%	0
Jackson, MI	SBQ Bar	500	450	79%	76%	395	380	0.0%	0	0.0%	0	0.0%	0
Ft. Smith, AR	SBQ Bar	400	375	80%	78%	320	312	9.8%	31	4.8%	15	5.0%	16
Jacksonville, FL	Billet, Rebar, Rod	544	500	68%	68%	370	370	10.0%	37	5.0%	18	5.0%	18
Beaumont, TX	SBQ Rod	600	550	74%	75%	444	450	10.0%	45	5.0%	23	5.0%	23
Company / Plant	Products	Capacity		EAF Oper %		EAF Production		ALT FE 2014		MPI 2014		DRI 2014	
		EAF	Rolling	2012	2013	2012	2013F	%	KT	%	KT	%	KT
AK Steel		**635**	**600**	**73%**	**76%**	**464**	**483**	**15.0%**	**149**	**5.0%**	**47**	**10.0%**	**102**
Butler, PA	Stain, Carb, Elect	1100	700	70%	70%	770	770	10.0%	77	3.0%	23	7.0%	54
Mansfield, OH	Stain, Carbon Coil	635	600	73%	76%	464	483	15.0%	72	5.0%	24	10.0%	48
ATI Allegheny Ludlum		**500**	**450**	**73%**	**76%**	**365**	**380**	**10.0%**	**38**	**3.0%**	**11**	**7.0%**	**27**
Midland, PA	Stain, Carbon Coil	500	450	73%	76%	365	380	10.0%	38	3.0%	11	7.0%	27
Republic		**1,800**	**1,200**	**36%**	**54%**	**648**	**980**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**
Lorain, OH	SBQ, Tube Rnds	1,000	450	0%	38%	0	380	0.0%	0	0.0%	0	0.0%	0
Lackawana, NY	SBQ	0	750	0%	0%	0	0	0.0%	0	0.0%	0	0.0%	0
Canton, OH	Billet, Tube Rnds	800	0	81%	75%	648	600	0.0%	0	0.0%	0	0.0%	0
Charter Manufacturing		**1,057**	**975**	**77%**	**75%**	**814**	**793**	**10.0%**	**79**	**1.4%**	**11**	**8.6%**	**68**
Saukville, WI	SBQ Rod, Bar	467	425	77%	75%	360	350	10.0%	35	0.0%	0	10.0%	35
Cleveland, OH	SBQ Rod, Bar	590	550	77%	75%	454	443	10.0%	44	2.5%	11	7.5%	33
NLMK-Beta		**558**	**500**	**75%**	**76%**	**418**	**424**	**20.0%**	**85**	**15.0%**	**64**	**5.0%**	**21**
Portage, IN	Sheet Coil	558	500	75%	76%	418	424	20.0%	85	15.0%	64	5.0%	21
V&M Star		**948**	**850**	**65%**	**62%**	**616**	**588**	**8.0%**	**47**	**8.0%**	**47**	**0.0%**	**0**
Youngstown, OH	Sheet Coil	948	850	65%	62%	616	588	8.0%	47	8.0%	47	0.0%	0
TPCO		**600**	**500**	**0%**	**0%**	**0**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**
Corpus Christi, TX	Seamless OCTG	600	500	0%	0%	0	0	0.0%	0	0.0%	0	0.0%	0
Timken		**1,800**	**1,600**	**82%**	**75%**	**1,476**	**1,350**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**
Canton, OH	SBQ, Smless Tube	1,800	1,600	82%	75%	1,476	1,350	0.0%	0	0.0%	0	0.0%	0
Evraz-Ipsco		**1,744**	**1,600**	**80%**	**82%**	**1,392**	**1,427**	**3.8%**	**55**	**3.8%**	**55**	**0.0%**	**0**
Pueblo, CO		544	500	75%	77%	408	419	1.0%	4	1.0%	4	0.0%	0
Regina, SK	Sheet Coil	1,200	1,100	82%	84%	984	1,008	5.0%	50	5.0%	50	0.0%	0

Table 13.1-2.: Major US and Canadian Users / Buyers of HQ Metallics

Future EAF Flat rolled Steel Plants, Maximum OBM Use - Potential furnace EAF flat rolled plants include surely the Big River Plant and possible future plants (one each) from SDI and Nucor. With a projected 2.0 MTPY steel capacity at each plant and 25 % OBM use this would increase OBM demand by 1.5 MTPY.

We also project what the maximum level of OBM consumption might be if all EAF's use 40 % OBM's. This would increase OBM use by 15 % or about 5.7 MTPY based on 2014 EAF steel production levels in the above table. This would only happen as a result of structural changes in the scrap market that would make premium scrap grades much more expensive than HBI.DRI or pig iron. It is beyond the scope of this report to do a detailed study of NAFTA and global scrap markets to determine the probability of such long term high scrap prices. A global analysis is required as scrap is traded globally while some countries distort the scrap trade with restrictions on scrap exports.

We have omitted any mention of reasons for OBM use as we know this is done to meet the chemistry requirements for key residuals such as copper. The one company currently not using OBM's is Evraz, but when questioned about future DRI projects they indicated that their motivation would be cost reduction: e. g.; if premium scrap grades became too expensive, some use of OBM's would be considered. In fact, Evraz is known to be studying an integrated production of DRI based on investing in an iron ore mine and pellet plant to produce DR grade pellets for such a shaft furnace DRI plant.

EAF Long Product Minimills

The above table includes the EAF long products sector with emphasis on the high end long products such as tubular, rail, rod and wire and SBQ where chemistry constraints require some OBM use but typically at lower levels than observed for flat rolled steel production.

As expected the total consumption of OBM's is much less than that in the EAF flat rolled area, at less than 2 MTPY with a maximum potential of about 6 MTPY if all of these plants used 25 % OBM's. The use of captive OBM's is also far less with no on site OBM facilities:

- Nucor Yamato Blythesville would use Nucor Louisiana DRI,
- Other Nucor long product plants could use DRI from either Nucor Trinidad or Nucor Louisiana.

- The DRI use is high at 55 % at ArcelorMittal Contrecoeur where an in site DRI facility is located,
- AM Georgetown continues to use AM Pt Lisas DRI from Trinidad and AM Canada DRI; at one time this plant had an on-site DRI module when it operated as an independent company. When ArcelorMittal took over it was obvious that incremental DRI from Trinidad (with very low gas prices) would be far less costly.
- The ArcelorMittal EAF plants at Indiana Harbor and Steelton can use pig iron from the pig caster operated at the AM Indiana Harbor East blast furnace/BOF plant site

The remaining EAF long product plants would be served by barge and truck shipments large from traders operating on behalf of Brazilian pig iron, Ven HBI and Russian pig iron, HBI producers.

13.1.1.7 Logistics and Purchasing

The details on logistics and purchasing contacts are shown in the next two tables starting with the flat rolled plants and the extending into the high end long product plants. Outside of the Nucor family, the best targets are those that can be approached by only water routes and/or are located in the upper Midwest USA. Among the sheet flat rolled plants these are:

<u>Great Lakes Access:</u>

Nucor Crawfordsville – however rail, truck transport is needed from Chicago or northwest Indiana
AK Steel Mansfield, OH and Butler, PA; both requiring rail/truck transport from Great Lakes ports
ATI Allegheny Ludlum, Midland, PA;
NLMK Portage, IN - direct access to Lake Michigan (but has been content to use "beach iron" (dumped hot metal) from the adjacent ArcelorMittal Burns Harbor Plant).

Other plants such as **SDI Butler** and **Arcelor Mittal** have captive sources.

<u>Ocean Access:</u>

Steel Dynamics Columbus; Mississippi; although the final leg does require either trucking from a river dock or by barge/rail from the Port of Mobile.
SSAB Mobile, AL - a plate mill with access from the Port of Mobile.

Other plants such as those of **Nucor** have captive sources.

Among the long product plants these are:

<u>Great Lakes Access:</u>

Republic Lorain, OH – located on Lake Erie
Charter Steel, Cleveland, OH" "
, Saukville, WI, ship to Port of Milwaukee; rail, truck to plant

Other plants such as **Arcelor Mittal** have captive sources.

<u>Ocean Access:</u>

Gerdau Beaumont, Texas - would be accessible by water.
Tianjin Pipe Company Plant, Corpus Christi, Texas - would be readily accessible but we have no further information on the status of this plant.

Source: Metal Strategies Inc.
Major U.S. and Canada. Users / Buyers of HQ Metallics (at full plant capacity)

Company / Plant	Logistics
Nucor (10.3 Sheet, Bar)	Jim Stanton of DJJ is primary MPI, DRI and (probably in future) iron ore buyer for all Nucor plants; work is (843) 388-1040; cell is (843) 847-7448; email is jrs@djj.com; 1941 Clements Ferry Rd, Suite Nucor buys 50-70,000 tonne shiploads of MPI with 70-80% entering port of New Orleans (NOLA), and balance through Charleston SC and Wilmington NC ports
Crawfordsville, IN	Inland plant in west-central IN, 10-15 miles from Sugar River and Interstate Highway #74; CSX and CN rail; 4537 Nucor Rd., IN 47933; (765) 344-1323 Plant is 50 miles North of Terre Haute and 40 miles northwest of Indianapolis; Ocean-origin raw materials (MPI, DRI) access Mississippi to Wabush River to Sugar River.
Hickman, AR	Located on Mississippi River, direct river barge and port access from New Orleans; has rail access as well (CSX, NS, CN); 7301 E. County Rd; Blytheville, AR 72315; (870) 762-2100
Decatur, AL	In north central Alabama 70 miles due north of Birmingham; near Tennessee border; owns 600-ft dock on TN River (can moor up to 30 1,500-ton barges at a time); also connects south via Tombigbee River; Located off Hwy #20 and Red Hat Rd.; NS Railroad operat
Berkeley, SC	1455 Old Hagan Ave., Huger, SC 29450 (843) 336-6000; Plant is inland, about 15 miles northeast of Charleston SC deep water customs port; Raw materials shipped to plant via rail and truck from
Darlington, SC	Located inland about 100 miles northeast of Charleston SC port and 80 west of Wilmington NC deep water customs port. Raw materials shipped by rail and truck from these two ports.
Memphis, TN	Located on Mississippi River, captive dock with direct barge access from New Orleans; has rail access as well (CSX, NS, CN); 3601 Paul D. Lowrey Rd., TN 38109 (901) 786-5900
Norfolk, NE	Inland plant in northeast Nebraska; accessed by rail (UP, NS); 113 miles northwest of Omaha (accessed on Missouri River to Elkhorn River to Norfolk) on intersections of truck routes #81 and #275
Hertford, NC	Off Atlantic coast; on Cooper River; dock 575-ft vessels, 90-ft wide, 26-ft draft; inland waterway system via port of Wilmington NC; Plant is on Chowan River accessed through Albemarle Sound 80 miles to south; 70 miles south of Norfolk VA; 1505 River Rd,
Tuscaloosa, AL	Inland location in west-central Alabama; Plant is on Black Warrior River accessed via port of Mobile, AL (220 miles away) and Mobile River to Tombigbee River to Black Warrior River; scrap=60% rail (CSX, BNSF), 30% truck, 20% barge; 1700 Holt Rd E., Tuscal
AK Steel (Dearborn MI; sheet)	Sanjeev Badola, Director Scrap & Metallics Procurement; Work (313) 317-6356; Cell (313) 334-2226; (312) 533-3555; As backup, Stan Davis is Manager of Scrap Procurement for Severstal, Columbus, MS Plant address is 1945 Airport Rd,
Steel Dynamics (Sheet, rail, bar)	Fred Hauptstueck is Metallics/MPI Purchasing Mgr at (260) 459-3553; SDI is mostly self sufficient with Mesabi Nugget and Iron Dynamics, so not in market except for very small, periodic volume (0% to 5%) of needs; Ricky Rollins (Melt Mgr), Glen Plushis, Ge
Butler, IN	Inland plant in northeast Indiana; accessed by rail (CSX and NS); also accessed by barge then rail from New Orleans; or via Great Lakes; Plant location in Butler IN is 35 miles northeast of Ft. Wayne, 6 miles
Columbus, MS	Target charge mix (varies) was 30% MPI (actual in 2012 and 2013 was 20% MPI; Original target charge was 30% shred, 30% MPI, 20% bush, 15% DRI, 5% home scrap; See AK Steel Dearborn for Inland river/rail location in east-central MS near AL border; plant-owned port/dock on Tombigbee River; accessed by barge and rail (CSX, NS, CN) via Mobile port.
Pittsboro, IN	Inland plant in southwest Indiana about 25 miles west and north of Indianapolis; accessed by rail (CSX and NS) or by barge, latter from New Orleans to Cairo, IL, then to Ohio River, then to Wabash River,
North Star BlueScope	Willie Harris - Metallics/MPI Purchasing Mgr. (419) 822-2200; Rex McClanahan - Meltshop Director; 676 County Rd. #9, Delta, OH 43615; (888) 822-2165; NSBS apparently insists on delivery right to its plant with its weights as final for settlement.
Delta, OH	5 miles west and south from Toledo, OH and 75 miles south of Detroit; on Lake Erie; accessed by rail (CSX, NS, CN), Great Lakes via St Lawrence, barge and rail from New Orleans; or rail from Toledo/Delta, OH can be accessed via Great Lakes, and Maumee Bay at far western side of Lake Erie
Gallatin (Nucor)	Raymond Furnish (Buyer-Raw Materials including MPI) (859) 567-3208; Barry Blum=Metallics/MPI Purchasing Manager (859) 567-3829; Rick Jackson, GM Raw Mats and Shipping (859) 567-3169
Warsaw, KY	Site is on Ohio River halfway between Louisville, KY and Cincinnati OH with direct river barge access and 2 miles from interstate #71; Address is 4831 Highway #42 West, Ghent/Warsaw, KY, 41045 50% inbound raw materials arrives by barge, 25% by rail and 25% by truck; MPI and DRI/HBI mainly

Table 13.1-3.: Major Users US and Canadian Users / Buyers Purchasing and Logistics

Source: Metal Strategies Inc.
Major U.S. and Canada. Users / Buyers of HQ Metallics (at full plant capacity)

Company / Plant	Logistics
SSAB-Ipsco (plate)	MPI Purchasing Manager is David Heineke office (251) 662-4453, cell is (251) 510-4704 Headquarters: 801 Warrenville Rd., Lisle, IL 60532; (630) 810-4800; Dan Miksta Gen Mgr. Also, see
Montpelier, IA	On Mississippi River; access by barge/rail from New Orleans, or rail (CSX, NS, CN); Address is 1770 Bill Sharp Blvd, Muscatine, IA 52771; (563) 381-5300; Plant Manager is Ed DiCiccio
Mobile, AL	On Tombigbee River (barge) and rail; 12 miles north of port of Mobile; 12400 Highway #43, North Axis, AL 36505; (251) 662-4400; Terry Russo, Mgr. MPI and DRI on rail spur line or can be discharged from ocean vessels in port of Mobile and loaded on 1,500-
ArcelorMittal	Susan Bray, Dir Logistics (312) 346-0300; at AM International; Address is One S. Dearborn St.,
	New suppliers - "no exceptions" - must apply by sending contact email to ArcelorMittal has recently switched form global sourcing to regional/country sourcing of raw materials.
Hamilton, ON (Dofasco)	15 miles west of Toronto off Lake Ontario; access via St. Lawrence, or rail (CN Rail); Brian Benko, Dir Purchasing & Logistics: 1330 Burlington St. E., Hamilton, Ont., Canada L8N 3J5; (905) 544-3761
Contrecoeur, QE	Access to St. Lawrence Seaway and Lake Ontario; direct rail access into plant (CN Rail); Sutye Sanyal GM: 3900 Rt des Acieres, Contrecoeur, QE, Canada J0L 1C0; (450) 392-3200
Georgetown, SC	On Atlantic coast; inland waterway system with ocean vessels entering Charleston, SC port. Danie Devapiriam GM; 420 S. Hazard St. Georgetown, SC 29442 (843) 546-2525
Gerdau (bar, rod)	Metallics Purchasing Manager = Vicky Roche (813) 207-2331; Main # (813) 286-8383; 5100 W. Lemon St., Suite 312, Tampa, FL 33609-1129
Monroe, MI	Inland, off I-#75, 55 miles south of Detroit; 8 miles west of Lake Erie; CN Rail, NS rail and CSX Rail; Otto Alverado GM; P.O. Box 1200, Monroe, MI 48161; (734) 243-2446
Jackson, MI	Inland, 75 miles west and north of Monroe plant (see above); Ronald Kewnsky, GM; 3100 Brooklyn Rd., Jackson, MI 49203; (517) 764-0311
Ft. Smith, AR	Half way up state on western border with OK; located on Arkansas River which connects to Mississippi River about 75 miles south of Memphis; Off of interstate #540 and #71.Darrel Moore is the plant General Manager; Address is 5225 Planters Rd., Ft. Smith,
Beaumont, TX	Accessed via ports of Houston and Port Arthur TX; about 85 miles north and east of Houston/Galveston; has direct plant rail access. Claudio Nacimento Meltshop Mgr; P.O. Box 3869 Beaumont, TX 77704; (409) 768-1211
Republic (SBQ bar)	Michael Humphrey, GM Supply Chain Management (330) 438-5543); 2633 Eighth St., Canton, OH
Lorain, OH	On Lake Erie (w/Lake vessel port) in NW Ohio; direct rail access to plant; new 1.1 MST EAF started
Lackawanna, NY	No melt shop; Off eastern coast Lake Erie; 10 miles south of Buffalo near Canadian border. Direct rail
Canton, OH	1.0 MST EAF meltshop; Located inland in northeast OH, 85 miles north and west of Pittsburgh and 80 miles south of Lake Erie; accessed via rail from port of Philadelphia and via Mississippi and Ohio Rivers supplemented with final truck or rail to plant.
NLMK-Portage IN (Beta) Portage IN	MPI purchaser = Todd Goodwin (219) 628-2838; Michael Morris, Meltshop Manager; 6500 S. Boundary Rd., Portage, IN 46368; (219) 787-8200; NLMK Portage IN operates with variable mix of 1.0 MST EAF and slab imports from parent company. On Lake Michigan, so can be reached via St Lawrence; barge/rail from New Orleans; rail from
Vallourec Star	Mark Rambo GM meltshop (330) 742-6300; 2669 Martin Luther King Jr. Blvd, Youngstown, OH
Youngstown, OH	Inland in northeast OH, 90 miles north and west of Pittsburgh and 90 miles south of Lake Erie; accessed via river barge up Mississippi and Ohio Rivers and final leg by rail or truck, as well as by rail from port
TPCO-Tianjin Pipe Co.	Greenfield plant will start commissioning in 2015-'16; no contacts yet available
Corpus Christi, TX	Plant has its has own direct deep water port as well as multiple rail connections at Corpus Christi, TX; will be commissioned in 2015
Timken	W.P. Bryan VP Supply Chain Mgmt - Steel Operations (866) 284-6536, 1835 Dueber Ave. SW,
Canton, OH	Two EAF steel plants, with 1.8 MST combined EAF capacity, located inland, about 50 miles south of Cleveland and 25 miles southeast of Akron OH; Meltshops at Faircrest (1.0 MST) and Harrison Ave (0.8 MST) plants in Canton OH; Plants located inland in nor
Evraz	Jacob Lubbe, VP Mfg & Supply Chain Management (312) 533-3555 at Evraz headquarters which is at 200 East Randolph St, Suite 7800, Chicago, IL
Portland, OR	Meltshop (0.8 MST) at this plate making plant closed permanently in 2009; uses 100% imported slab
Claymont, DE	Meltshop (0.5 MST) at this plate-making plant closed in 2013; May be for sale to new owner
Pueblo, CO	1.2 MST EAF plants makes rails, rods, seamless OCTG and semis; Plant location is 1612 E. Abriendo Ave, Pueblo, CO 81004; Phone is (719) 561-6000
Regina, SK	Roger Juarez, VP & GM Regina plant; 100 Armour Rd. Regina, SK, Canada S4P 3C7 (306) 924-7700; Headquarters is at 200 E. Randolph St., Chicago, IL 60601; (312) 533-3600. Plant located off of Highway #1 in south central Saskatchewan; Rail access via CN and

Table 13.1-4.: Major Users US and Canadian Users / Buyers – Purchasing and Logistics

13.1.1.8 USA and Canada Supply and Demand Balance

In this section we will look at the sourcing, trade and production of ore based metallics mainly in the USA but also in Canada and Trinidad to establish the above balance to make projections going forward.

The sourcing and utilization of ore based metallics in the USA from 2000 through 2014 is tabulated below Merchant pig iron is predominantly imported with just over 70 % consumed in EAF steel production in recent years with the balance being consumed in foundry's. All DRI is consumed in steel production, mainly EAF's while all DRI was imported between 2009 until the start-up of Nucor Louisiana in late 2013. Within the steel sector, merchant pig iron utilization was greater than DRI utilization in about a 60:40 ratio until the start-up of Nucor Louisiana that will likely reverse this ratio in favour of DRI.

U.S. Ore-based Metallics (OBM) Market
Million Tons

Year	Merchant Pig Iron (MPI						Direct Reduced Iron					Steel OBM Summary		
	Imports	Domestic	Total	Foundry	Foundry %	Steel	Imports	Domestic	Total	Foundry	Steel	OBM	MPI%	DRI%
2000	6.2	0.0	6.2	1.9	30.0%	4.3	4.7	1.56	6.2	0.0	6.2	10.6	41%	59%
2001	5.3	0.0	5.3	1.5	27.3%	3.9	2.1	0.12	2.2	0.0	2.2	6.1	64%	36%
2002	5.6	0.1	5.7	1.4	25.4%	4.2	2.9	0.47	3.3	0.0	3.3	7.6	56%	44%
2003	4.8	0.1	4.9	1.4	29.5%	3.5	2.5	0.21	2.7	0.0	2.7	6.2	56%	44%
2004	7.6	0.2	7.7	1.5	19.2%	6.2	3.3	0.18	3.5	0.0	3.5	9.7	64%	36%
2005	7.1	0.2	7.3	1.5	19.9%	5.9	3.1	0.22	3.3	0.0	3.3	9.2	64%	36%
2006	7.9	0.2	8.1	1.5	18.3%	6.6	3.8	0.24	4.0	0.0	4.0	10.7	62%	38%
2007	5.8	0.3	6.1	1.4	22.8%	4.7	3.4	0.25	3.6	0.0	3.6	8.3	56%	44%
2008	5.5	0.3	5.7	1.3	21.8%	4.5	3.4	0.26	3.6	0.0	3.6	8.1	55%	45%
2009	2.7	0.3	2.9	0.9	29.8%	2.1	1.2	0.0	1.2	0.0	1.2	3.3	63%	37%
2010	4.2	0.2	4.3	1.0	22.1%	3.4	1.9	0.0	1.9	0.0	1.9	5.3	64%	36%
2011	4.6	0.5	5.1	1.2	23.6%	3.9	2.2	0.0	2.2	0.0	2.2	6.1	64%	36%
2012	4.7	0.5	5.2	1.6	29.8%	3.7	3.2	0.0	3.2	0.0	3.2	6.8	53%	47%
2013	4.5	0.5	5.0	1.5	29.2%	3.6	2.7	0.0	2.7	0.0	2.7	6.3	57%	43%
2014	5.1	0.5	5.6	1.5	26.7%	4.1	2.8	1.8	4.6	0.0	4.6	8.6	47%	53%

Table 13.1-5.: US Ore-based Metallics (OBM) Market

We can follow the information above with a look at the intensity of use of ore based metallics in the EAF steel producing and foundry sectors, as shown in the following table. The absence of DRI production in the USA from 2009 through 2013 kept overall steel OBM use at 10 % or lower; it should approach 15 % again with Nucor Louisiana in production. Of course, the overall OBM use percentage is misleading as the majority of EAF's producing commodity construction steel use no OBM's wheras, as shown in the earlier table, the EAF flat rolled and high end long product sectors use roughly 25 and 10 %, respectively.

Foundry Facilities in U.S. The tables above and below mention the foundry sector in the USA. Foundry facilities include both electric furnaces and cupola (coke based) melting facilities. There is one important facts to know about the foundry sector: They will not use DRI but only pig iron (< 2 MTPY) as an ore based metallic and. The foundry sector will be discussed in the next section of this report.

U.S. Ore-based Metallics (OBM) Intensity of UseMarket
Million Tons and % of EAF and Foundry Output

Year	EAF	EAF Intensity of OBM Use			Foundry Intensity	
	Production	MPI	DRI	Total	Production	MPI %
2000	52.8	7.3%	6.2%	13.5%	9.2	20%
2001	47.1	7.2%	4.4%	11.6%	8.3	18%
2002	50.8	7.4%	5.6%	13.0%	8.3	18%
2003	52.7	5.6%	4.7%	10.4%	8.3	18%
2004	57.2	10.0%	5.8%	15.8%	8.4	18%
2005	57.6	9.3%	5.4%	14.8%	8.4	18%
2006	61.8	9.9%	5.6%	15.5%	8.5	18%
2007	62.8	7.4%	5.1%	12.5%	7.9	18%
2008	58.2	7.7%	5.5%	13.2%	7.2	18%
2009	40.5	5.1%	3.0%	8.1%	5.0	18%
2010	54.4	6.2%	3.5%	9.7%	5.5	18%
2011	57.4	6.8%	3.9%	10.7%	6.9	18%
2012	57.8	6.3%	5.5%	11.8%	8.9	18%
2013	58.0	6.1%	4.7%	10.8%	8.4	18%
2014	60.8	6.7%	7.5%	14.2%	8.5	18%

Table 13.1-6.: US Ore-based Metallics (OBM) Intensity of Use Market

The following table lists all DRI/HBI, merchant pig iron and hot metal facilities in the USA and Canada. This listing also includes future facilities such as the Voest Stahl HBI plant and a possible Republic/US Steel DRI plant in Lorain, Ohio. Idle facilities listed include the Circored HBI plant in Trinidad and the pig caster that had been associated with the RG Steel Sparrows Pt. “L” blast furnace; now being liquidated. This pig caster could be relocated elsewhere in the USA adjacent to a blast furnace.

The ore based metallics supply based on effective 2014 production is about 5.44 MT. (6.94 MT from the table below minus about 1.5 MT at ArcelorMittal Pt. Lisas due to 0.63 MT on site EAF consumption and 0.87 exports elsewhere, Europe, Korea). The 2014 consumption of ore based metallics could be tabulated as:

EAF flat rolled steel plants	7.81 MT
EAF long product steel plants	1.94
BF/BOF plants	0.29 (BF use only)
Foundries	1.50

	11.54

The difference between 11.54 MT of consumption and 5.44 MT of effective production implies an import requirement of 6.10 MT. The actual imports for 2014 were 5.07 and 2.76 MT of pig iron and HBI, respectively, for a total of 7.83 MT vs. the 6.10 MY obtained from our calculations. The difference of 1.73 MT could be explained by a combination of the following:

- actual pig iron and DRI production being lower than shown, mainly at Nucor Louisiana,
- export of RTIT pig iron outside of North America
- additional EAF consumption at long product plants not shown and specialty/alloy EAF plants,
- additional consumption at BOF shops,
- additional foundry consumption of pig iron

Looking toward the near future, the import totals of 7.8 MT in 2014 will be reduced by the following:

- full production at Nucor Louisiana should reduce imports by 1.0 MTPY,
- full production at the Voest Stahl HBI plant will supply another 600 KT to the USA market,
- full production at Mesabi Nugget could add 300 KT to the SDI captive supply.

This will still leave nearly 6.0 MTPY of imports required. Since the foundries only use pig iron, about 2 MTPY will be needed here unless some can be supplied by reactivating pig casters relocated from Sp. Pt. and/or at Republic Lorain Ohio (still another idle pig caster not shown below).

The above implies a potential for additional DRI or merchant pig iron projects up to 4 MTPY) (including Nucor Louisiana II) to replace imported supply, however, price competition will be fierce as the leading exporters of pig iron and HBI really have no alternate markets.

Ore Based Metallic Facilities NAI USA, Canada and Trinidad

Current	Company	Facility	Location	Number of Furnaces	Capacity MT/year	Production 2012	2013	2014e	Product	Output Destnation	Ore Source
	Nucor	NuIron	Trinidad	1	1.60	1.54	1.65	1.65	DRI	Nucor EAFs	Market: IOC, LKB Samarco
Dec 2013 Start	Nucor	Louisiana	St. James Parrish	1	2.50	0	0.10	1.45	DRI	Nucor EAFs	" "
	ArcelorMittal	Point Lisas	Trinidad	3	2.20	1.71	1.84	1.75	DRI	on site EAF, 0.63 AM EAF's	AMMC, VALE Market
	ArcelorMittal	Canada	Contrecouer	2	1.20	0.84	1.25	0.80	DRI	on site EAF	AMMC
	ArcelorMittal	Indiana Harbor	BF7 Pig Caster	1	0.30	0.30	0.30	0.30	Pig iron	AM EAF operations	AM Minorca, Empire
	Steel Dynamics	Iron Dynamics	Butler IN	1	0.30	0.23	0.26	0.26	Hot metal	On site EAF	Mill scale, chips dust, CON
	Steel Dynamics	Mesabi Nugget	Hoyt Lakes	1	0.50	0.18	0.21	0.23	Pig iron Nuggets	Butler Colmbia EAF	SDI/Magnetation Concentrate
	Rio Tinto Iron & Titanium	Tracy	Quebec	1	0.50	0.50	0.50	0.50	Pig iron	foundries, EAF's	RTIT ilmenite ore
Total					9.10	5.29	6.11	6.94			
Planned											
Start Early 2016	Voest Stahl	Corpus Christi	Texas	1	2.00				HBI	1.0 to VA BF, 0.4 to AHMSA, 0.6 market	Market
On hold	Republic/USS	Lorain	Ohio	1	1.00				DRI	on site EAF, other?	USS KeeTac
total					3.00						
Potential											
	Ven partners Outotec	Circored	Trinidad	1	0.30	Idle since 2004			HBI		Screened fines VALE
	Maryland Pig (National Material	Needs to be relocated	Sparrows Pt, MD	1	0.50	Idle since '12; needs to be re			Pig iron	Market	

Table 13.1-7.: US Ore-based Metallic Facilities in USA, Canada and Trinidad

The above analysis on the supply/demand balance of OBM's in the USA implies an import requirement of nearly 8.0 MTPY. The actual trade data for merchant pig iron and DR are shown in the following tables. Merchant pig iron had been dominated by Brazil but Russia now matches Brazil while Ukraine is third with small totals from Canada and South Africa. New Orleans is the predominant entry port followed by Charleston (probably serving Nucor Berkeley) and Mobile (probably serving Nucor

Decatur and Nucor Tuscaloosa). Except for the global financial crisis year of 2009 pig iron imports have been in the 4.5 to 5.0 MTPY range.

Year	Merchant Pig Iron (MPI) by Port of Entry							Year	Merchant Pig Iron (MPI) by Country of Origin						
	Total	Can. Bdr	Charleston	Wilm.SC	Mobile	New Orleans	Other		Total	Brazil	Russia	Ukraine	Canada	S. Africa	Other
2000	5,478	256	615	0	139	4,323	145	2000	5,478	3,396	466	1,181	120	159	156
2001	4,820	239	910	0	102	3,512	57	2001	4,820	3,763	577	181	137	99	63
2002	5,096	259	1,211	0	68	3,488	70	2002	5,096	3,792	528	365	122	102	187
2003	4,289	191	1,139	0	66	2,793	100	2003	4,289	3,182	684	210	96	117	0
2004	7,052	188	1,073	0	0	5,456	335	2004	7,052	5,261	1,220	88	105	130	248
2005	6,646	206	917	0	0	5,354	169	2005	6,646	4,912	1,012	302	116	155	149
2006	7,420	276	1,714	100	0	5,231	99	2006	7,420	4,637	2,104	207	111	162	199
2007	5,751	284	1,037	135	155	4,126	14	2007	5,751	3,868	1,254	311	125	123	70
2008	5,486	272	867	67	323	3,946	11	2008	5,486	3,976	784	341	200	102	83
2009	2,672	128	456	18	56	2,007	7	2009	2,672	1,393	828	172	100	132	47
2010	4,165	277	502	66	315	2,940	65	2010	4,165	1,758	1,169	804	156	140	138
2011	4,618	193	718	74	334	3,288	11	2011	4,618	2,476	1,314	323	117	174	214
2012	4,707	211	552	143	444	3,313	44	2012	4,707	2,189	1,560	456	163	225	114
2013	4,539	155	685	110	656	2,930	3	2013	4,539	1,940	1,761	523	83	232	0
2014	5,074	89	596	124	919	3,340	6	2014	5,074	1,750	2,319	672	23	282	28

Year	Merchant Pig Iron (MPI) by Port of Entry							Year	Merchant Pig Iron (MPI) by Country of Origin						
	Total	Can. Bdr	Charleston	Wilm.SC	Mobile	New Orleans	Other		Total	Trinidad	Venezuela	Brazil	Russia	Ukraine	Canada
2000	100.0%	4.7%	11.2%	0.0%	2.5%	78.9%	2.6%	2000	100.0%	62.0%	8.5%	21.6%	2.2%	2.9%	2.8%
2001	100.0%	5.0%	18.9%	0.0%	2.1%	72.9%	1.2%	2001	100.0%	78.1%	12.0%	3.8%	2.8%	2.1%	1.3%
2002	100.0%	5.1%	23.8%	0.0%	1.3%	68.4%	1.4%	2002	100.0%	74.4%	10.4%	7.2%	2.4%	2.0%	3.7%
2003	100.0%	4.5%	26.6%	0.0%	1.5%	65.1%	2.3%	2003	100.0%	74.2%	15.9%	4.9%	2.2%	2.7%	0.0%
2004	100.0%	2.7%	15.2%	0.0%	0.0%	77.4%	4.8%	2004	100.0%	74.6%	17.3%	1.2%	1.5%	1.8%	3.5%
2005	100.0%	3.1%	13.8%	0.0%	0.0%	80.6%	2.5%	2005	100.0%	73.9%	15.2%	4.5%	1.7%	2.3%	2.2%
2006	100.0%	3.7%	23.1%	1.3%	0.0%	70.5%	1.3%	2006	100.0%	62.5%	28.4%	2.8%	1.5%	2.2%	2.7%
2007	100.0%	4.9%	18.0%	2.3%	2.7%	71.7%	0.2%	2007	100.0%	67.3%	21.8%	5.4%	2.2%	2.1%	1.2%
2008	100.0%	5.0%	15.8%	1.2%	5.9%	71.9%	0.2%	2008	100.0%	72.5%	14.3%	6.2%	3.6%	1.9%	1.5%
2009	100.0%	4.8%	17.1%	0.7%	2.1%	75.1%	0.3%	2009	100.0%	52.1%	31.0%	6.4%	3.7%	4.9%	1.8%
2010	100.0%	6.7%	12.1%	1.6%	7.6%	70.6%	1.6%	2010	100.0%	42.2%	28.1%	19.3%	3.7%	3.4%	3.3%
2011	100.0%	4.2%	15.5%	1.6%	7.2%	71.2%	0.2%	2011	100.0%	53.6%	28.5%	7.0%	2.5%	3.8%	4.6%
2012	100.0%	4.5%	11.7%	3.0%	9.4%	70.4%	0.9%	2012	100.0%	46.5%	33.1%	9.7%	3.5%	4.8%	2.4%
2013	100.0%	3.4%	15.1%	2.4%	14.5%	64.6%	0.1%	2013	100.0%	42.7%	38.8%	11.5%	1.8%	5.1%	0.0%
2014	100.0%	1.8%	11.7%	2.4%	18.1%	65.8%	0.1%	2014	100.0%	34.5%	45.7%	13.2%	0.5%	5.6%	0.6%

Table 13.1-8.: Merchant Pig Iron (MPI) Port of Entry and Country of Origin

The DRI/HBI trade has been dominated by Nucor DRI from Trinidad with lesser roles played by ArcelorMittal Point Lisas (Trinidad) DRI and Venezuelan HBI. Small amounts come from Canada and Russia (the numbers from Brazil and Ukraine are mislabeled as no DRI is imported from these countries) Before the Nucor Trinidad start up, the DRI/HBI trade had been dominated by Venezuelan HBI before the collapse there. As with pig iron, imports of DRI for Nucor facilities in Alabama and South Carolina come preferentially through Mobile and Charleston, respectively. The balance of DRI/HBI imports come through New Orleans, mainly.

Year	Direct Reduced Iron (DRI/HBI) by Port of Entry						
	Total	Can. Bdr	Charleston	Wilm.SC	Mobile	New Orleans	Other
2000	1,717	203	406	0	35	890	183
2001	1,953	89	643	0	67	1,011	143
2002	2,383	95	447	0	378	1,300	163
2003	2,281	99	418	0	244	1,108	412
2004	3,125	147	633	0	459	1,415	471
2005	2,909	255	284	36	312	1,701	321
2006	3,229	169	465	15	501	1,926	153
2007	2,957	86	633	18	521	1,629	70
2008	2,950	57	474	117	772	1,465	65
2009	1,208	56	395	39	185	504	29
2010	1,920	60	534	0	442	838	46
2011	2,212	68	561	159	495	823	106
2012	3,188	123	751	165	716	1,395	38
2013	2,721	164	559	34	787	1,135	42
2014	2,762	170	828	210	581	867	106

Year	Direct Reduced Iron (DRI/HBI) by Country of Origin							
	Total	Trinidad	Venezuela	Brazil	Russia	Ukraine	Canada	Other
2000	1,717	71	1,499	0	0	0	100	47
2001	1,953	230	1,508	4	0	39	77	134
2002	2,383	280	1,865	3	0	47	131	104
2003	2,281	326	1,751	10	40	1	99	55
2004	3,125	356	2,004	0	71	1	559	135
2005	2,909	274	1,643	263	0	0	668	61
2006	3,229	267	1,671	365	1	0	789	136
2007	2,957	1,554	1,087	75	1	0	76	164
2008	2,950	1,551	1,241	9	0	0	54	95
2009	1,208	889	230	0	1	1	40	48
2010	1,920	1,402	365	0	0	0	58	95
2011	2,212	1,599	432	32	1	0	65	83
2012	3,188	2,107	856	40	23	0	85	77
2013	2,721	1,959	379	83	43	49	164	93
2014	2,762	2,024	100	143	226	39	166	103

2007-Date Trinidad volume estimated 90% Nucor NuIron and 10% Arcelor Mittal Point Lisas

Year	Direct Reduced Iron (DRI/HBI) by Port of Entry						
	Total	Can. Bdr	Charleston	Wilm.SC	Mobile	New Orleans	Other
2000	100.0%	11.8%	23.6%	0.0%	2.0%	51.8%	10.7%
2001	100.0%	4.6%	32.9%	0.0%	3.4%	51.8%	7.3%
2002	100.0%	4.0%	18.8%	0.0%	15.9%	54.6%	6.8%
2003	100.0%	4.3%	18.3%	0.0%	10.7%	48.6%	18.1%
2004	100.0%	4.7%	20.3%	0.0%	14.7%	45.3%	15.1%
2005	100.0%	8.8%	9.8%	1.2%	10.7%	58.5%	11.0%
2006	100.0%	5.2%	14.4%	0.5%	15.5%	59.6%	4.7%
2007	100.0%	2.9%	21.4%	0.6%	17.6%	55.1%	2.4%
2008	100.0%	1.9%	16.1%	4.0%	26.2%	49.7%	2.2%
2009	100.0%	4.6%	32.7%	3.2%	15.3%	41.7%	2.4%
2010	100.0%	3.1%	27.8%	0.0%	23.0%	43.6%	2.4%
2011	100.0%	3.1%	25.4%	7.2%	22.4%	37.2%	4.8%
2012	100.0%	3.9%	23.6%	5.2%	22.5%	43.8%	1.2%
2013	100.0%	6.0%	20.5%	1.2%	28.9%	41.7%	1.5%
2014	100.0%	6.2%	30.0%	7.6%	21.0%	31.4%	3.8%

Year	Direct Reduced Iron (DRI/HBI) by Country of Origin							
	Total	Trinidad	Venezuela	Brazil	Russia	Ukraine	Canada	Other
2000	100.0%	4.1%	87.3%	0.0%	0.0%	0.0%	5.8%	2.7%
2001	100.0%	11.8%	77.2%	0.2%	0.0%	2.0%	3.9%	6.9%
2002	100.0%	11.7%	78.3%	0.1%	0.0%	2.0%	5.5%	4.4%
2003	100.0%	14.3%	76.8%	0.4%	1.8%	0.0%	4.3%	2.4%
2004	100.0%	11.4%	64.1%	0.0%	2.3%	0.0%	17.9%	4.3%
2005	100.0%	9.4%	56.5%	9.0%	0.0%	0.0%	23.0%	2.1%
2006	100.0%	8.3%	51.7%	11.3%	0.0%	0.0%	24.4%	4.2%
2007	100.0%	52.6%	36.8%	2.5%	0.0%	0.0%	2.6%	5.5%
2008	100.0%	52.6%	42.1%	0.3%	0.0%	0.0%	1.8%	3.2%
2009	100.0%	73.6%	19.0%	0.0%	0.1%	0.1%	3.3%	4.0%
2010	100.0%	73.0%	19.0%	0.0%	0.0%	0.0%	3.0%	4.9%
2011	100.0%	72.3%	19.5%	1.4%	0.0%	0.0%	2.9%	3.8%
2012	100.0%	66.1%	26.9%	1.3%	0.7%	0.0%	2.7%	2.4%
2013	100.0%	72.0%	13.9%	3.1%	1.6%	1.8%	6.0%	3.4%
2014	100.0%	73.3%	3.6%	5.2%	8.2%	1.4%	6.0%	3.7%

Table 13.1-9.: Direct Reduced Iron(DRI/HBI) Port of Entry and Country of Origin

13.1.1.9 Summary – PURE FONTE LTÉE Challenges in Selling Merchant Pig Iron

The challenges faced by PURE FONTE LTÉE can best be discussed by modifying the earlier table showing OBM consumption by plant and company and showing this below on a company basis in the next table, as follows:

- Nucor Gallatin has been added to Nucor other plants to obtain a Nucor total,

- Ex-Severstal Columbus has been added to SDI other plants to obtain an SDI total
- ArcelorMittal is shown by itself as it has captive sources for DRI and pig iron,
- Northstar Bluescope is shown by itself as the only major EAF flat rolled mini mill not associated with Nucor, SDI or ArcelorMittal,
- The remaining plants, nearly all long product EAF plants, are grouped together; these show an EAF production of 10 MTPY but an OBM consumption of only 700 KT.

The key numbers in the following table are shown in bold red as they provide totals by company for Nucor, SDI and ArcelorMittal as well as an aggregate total for a number of mainly long product plants.

Accordingly, the leading targets for PURE FONTE LTÉE pig iron would be:

Ocean access:

SDI Columbus, where only a small portion of their 900 KT OBM requirement could be met by increased production at the SDI Mesabi Nugget operation, assuming that SDI would even be successful in producing more at Mesabi Nugget. However, PURE FONTE LTÉE would face intense competition from the leading pig iron importers from Brazil, Russia and the Ukraine, as these pig iron importers will also recognize this plant as their best remaining target with Nucor and SDI both increasing captive sourcing of OBM's. Venezuelan HBI would also compete for any DRI/HBI that this plant wishes to buy.

Gerdau Beaumont, SSAB Mobile, TPCO (if operating) and offer prospects for small tonnages at locations accessible to PURE FONTE LTÉE. The remaining other plants offer both logistical challenges and very limited tonnage prospects.

Great Lakes Access:

Northstar Bluescope would be the only truly independent EAF flat rolled minimill and they do prefer pig iron and PURE FONTE LTÉE would have a logistical advantage here, as well.

Nucor Crawfordsville – however rail, truck transport is needed from Chicago or northwest Indiana
AK Steel Mansfield, OH and Butler, PA; both requiring rail/truck transport from Great Lakes ports
ATI Allegheny Ludlum, Midland, PA; " "

NLMK Beta, Portgage, IN - direct access to Lake Michigan (but has been content to use "beach iron" (dumped hot metal) from the adjacent ArcelorMittal Burns Harbor Plant).

Republic Lorain, OH – located on Lake Erie
Charter Steel, Cleveland, OH" "
" " , **Saukville, WI,** ship to Port of Milwaukee; rail, truck to plant

METAL STRATEGIES INC.							U.S.	8649	MPI	4087	DRI	4562
Major U.S. and Canada. Users / Buyers of HQ Metallics (at full plant capacity); '000 Short Tor							Check	8649		4087		4562
Company / Products	Capacity		EAF Oper %		EAF Production		Total 2014		MPI 2014		DRI 2014	
	EAF	Rolling	2013	2014	2013	2014	% EAF	KT	% EAF	KT	% EAF	KT
Group Tot: ------	49860	44550	0.75	0.77	37619	38145	0.25	9491	0.11	4137	0.14	5354
United Stat ------	44882	40050	0.76	0.77	33917	34397	0.25	8649	0.12	4087	0.13	4562
Canada ------	4978	4500	0.74	0.75	3702	3748	0.22	843	0.01	50	0.21	792
Nucor (10.3 Sheet)	20572	18450	0.80	0.81	16402	16663	0.31	5102	0.12	1949	0.19	3153
Gallatin (Arcelor-Gerdau)	2007	1800	0.82	0.84	1646	1686	0.41	696	0.25	421	0.16	275
Nucor total	**22579**	**20250**			**18047**	**18348**		**5798**		**2370**		**3428**
Steel Dynamics	6300	5950	0.76	0.77	4766	4839	0.12	557	0.09	415	0.03	142
Severstal	3791	3400	0.82	0.81	3109	3071	0.29	903	0.18	553	0.11	350
SDI total	**10091**	**9350**			**7875**	**7910**		**1459**		**967**		**492**
North Star BlueScope	**2230**	**2000**	**0.82**	**0.84**	**1829**	**1873**	**0.30**	**556**	**0.23**	**431**	**0.07**	**125**
Arcelor Mittal	**5519**	**4950**	**0.69**	**0.69**	**3817**	**3817**	**0.32**	**1236**	**0.04**	**135**	**0.29**	**1101**
SSAB-Ipsco	2788	2500	0.80	0.80	2230	2230	0.06	139	0.04	89	0.02	50
Gerdau	2644	2425	0.76	0.75	2009	1980	0.06	113	0.03	56	0.03	57
AK Steel	635	600	0.73	0.76	464	483	0.15	149	0.05	47	0.10	102
ATI Allegheny Ludlum	500	450	0.73	0.76	365	380	0.10	38	0.03	11	0.07	27
Republic	1800	1200	0.36	0.54	648	980	0	0	0	0	0	0
Charter Manufacturing	1057	975	0.77	0.75	814	793	0.10	79	0.01	11	0.09	68
NLMK-Beta	558	500	0.75	0.76	418	424	0.20	85	0.15	64	0.05	21
V&M Star	948	850	0.65	0.62	616	588	0.08	47	0.08	47	0	0
TPCO	600	500	0	0	0	0	0	0	0	0	0	0
Timken	1800	1600	0.82	0.75	1476	1350	0	0	0	0	0	0
Evraz-Ipsco	1744	1600	0.80	0.82	1392	1427	0.04	55	0.04	55	0	0
total (SSAB - Evraz)	**15073**	**13200**			**10432**	**10633**		**705**		**380**		**325**

Table 13.1-10.: Ore Based Metallics Consumption by Plant and Company

13.1.1.10 Other topics of interest to PURE FONTE LTÉE

Evaluation of DRI and merchant pig iron projects that are under construction or being planned

This is currently a short list:

Voest Stahl HBI Plant, Corpus Christi, Texas; construction is ongoing with completion during 2016. The Voest Stahl plan is to ship 1.0 MTPY back to Austria to use in their BF and BOF operations. A contract for shipment of 400 KT per year has been signed with AHMSA in Monclova, Mexico. Any EAF users of the remaining 600 KT will likely be displacing purchased pig iron and/or HBI imported from Venezuela or Russia.

Estimated Production, KT

	2014	2015	2016	2017	2018	2019	2020	2021
Voest Stahl	0	0	500	1500	2000	2000	2000	2000
Shipments								
Voest Stahl	0	0	500	1000	1000	1000	1000	1000
AHMSA				400	400	400	400	400
Others				100	600	600	600	600

Other potential projects:

USSteel/Republic Steel JV in Lorain, Ohio - no contracts have been signed yet but this study would involve a DRI plant constructed at Lorain, Ohio to feed a newly started up EAF plant at this site that produces billets for USS seamless tube operations in Lorain, billets for Republic and possibly billets for USS Fairfield. DR grade pellets would be produced at converted facilities at USS Minntac or USS KeeTac. This DRI will be mainly for captive use and could displace USS Fairfield BF/BOF steel production or replace industrial scrap in a new EAF facility.

Northern Iron HBI Project - Northern Iron (Northern Iron was my client in 2013).is seeking to reopen a low grade magnetite iron ore mine in Red Lake, Ontario and to upgrade this ore to produce about 2.1 MTPY of concentrate that would feed a pellet plant to produce 2.2 MTPY of DR grade pellets. These pellets would be fed to a gas based shaft furnace DRI process to produce 1.5 MTPY of HBI that could be shipped to Thunder Bay for the NAFTA market or shipped to Prince Rupert for the Asian market. This project faces capital cost hurdles that will only be met if off takers become equity investors. So far, Danieli, the supplier of the DR technology, has agreed to off take 500 KT. If this project moves ahead, the likely USA participants would be in the upper Midwest.

IMC HBI Project - A group called IMC (International Materials Corp.) has announced a project to build an HBI/DRI plant in Superior, Wisconsin. The principals named, Daubeny Cooper and Richard Allocca, have long standing mine/steel experience in Africa including in Nigeria with DRI projects there. (IMC was my client in 2014). IMC is now investigating sites in Canada, as well.

Evraz Mine/Pellet Plant/DRI Project – Evraz is studying an integrated project starting with reviving an iron ore mine in Wyoming or Utah and then building a pellet plant and DR module to make DRI for the Evraz Puebla Plant in Colorado. This project is now on hold.

Other - One of my clients is also studying liquid hot metal production starting with hematite concentrate reclaimed from iron ore tailings. The plant would be either a mini BF located at a pellet plant site or at the site of an EAF mini mill.

Demand and Pricing of DRI/HBI and Pig Iron

A key question is what are the raw materials that could be reasonably displaced by domestic DRI and domestic pig iron such as, imported pig iron, DRI, premium scrap and shredded scrap. We are also interested in the displacement order (what will be displaced first, second, third, fourth)

We would expect that these materials will be replaced in the following order:

Imported Pig iron – this is the most expensive material in any EAF feed mix so it will be replaced first as the residual reductions can be accomplished with comparable or even lesser amounts of DRI, especially DRI produced from high quality imported pellets.

HBI – although not more expensive than premium scrap grades, HBI is likely to be replaced due to concerns about stability of supply (Venezuela) or logistics (Russia)

Premium scrap – after displacement of ore based metallics, displacement of premium scrap could occur but tempered by the expected reaction of scrap dealers in cutting the price below DRI production costs. An important conclusion is that EAF steelmakers should not build DRI facilities based solely on displacing scrap as any extended period of lower scrap prices would put them in a position of producing DRI at a higher effective cost than they could purchase scrap. Moreover, financial institutions would not finance any facility based on such a faulty displacement model.

Shredded scrap – the above rationale applies even more so for shredded scrap

We are interested in whether DRI or pig iron is priced at a premium to industrial scrap in the open market. The price trend graphs in the background section clearly indicated that industrial scrap such as busheling always sold at prices well above (30 – 50 $/T) imported HBI so I would expect this to continue, based on value-in-use considerations. However, in periods of excess DRI availability, the prices of both DRI and prime industrial scrap will both be depressed but I believe that the value-in-use differential would be maintained in a broad sense. By contrast, merchant pig iron sells at process comparable to industrial scrap such as busheling and usually above the prices for obsolete scrap such as shredded scrap.

Value-in-use of metallic iron units

It would be desirable to comment on the differences in value-in-use of these metallics. The following table shows what may be expected in typical product chemistry from an iron ore based feedstock with the resulting products in the form of hot metal, pig iron, DRI or HBI.

Typical chemistry of iron units

	Prompt Scrap	pig iron hot metal	DRI/HBI
Fe	98.0	94.5	93.0
Metallization, %	100	100	95
Metallic Fe	98.0	94.5	88.4
FeO	0	0	6.0
Carbon	0	4.5	1.9
Acidic gangue, other	1.0	1.0	2.2
Basic gangue, other	1.0	0	1.5

Scrap, pig iron and hot metal are characterized by 100 % metallization whereas DRI/HBI require additional reduction (to reduce FeO) in a steelmaking process. The major chemistry difference between scrap and pig iron/hot metal is the presence of 4.5 % carbon in the latter that provides energy and a reductant (if needed) in a steelmaking process. The DRI/HBI products contain more gangue and other elements that need to be melted and removed in the slag of a steelmaking process. The marketplace suggests a value in use difference of 80 to 120 $/ton favoring pig iron over HBI. This major difference in value-in-use among the metallics is largely determined by the chemistry and metallization values indicated above.

The value-in-use of scrap vs. DRI can be illustrated by looking at annual *2013) EAF data from a leading global steel company:

Plant	A	B	C
Annual EAF prod., KT	410	670	590
Feed			
Pig iron, kg/T	16	0	30
DRI, “	0	789	1156
Scrap, “	1093	374	35
Total	1109	1163	1221
Yield, %	90.2	87.5	81.9
Power, kwH/ton	419	562	638
Increased power cost, $/ton	base	7.12	10.95
Slag formers, kg/T	61	79	99
Increased flux cost, $/ton	base	1.80	3.80
Tap to tap time, min	81	83	107
Increased fixed costs	base	5.00	16.80
Increased costs, power, flux, fixed		17.64	27.29

The above results that do not all consider all EAF costs but do indicate a value-in-use penalty range of 22 to 24 $/ton per ton of DRI relative to scrap, not including the lower Fe content of DRI relative to industrial scrap; the latter would further increase the value of industrial scrap by over $ 30/ton.

13.1.2 Target Market

Considering what reported in the independent study of 13.1.1, the target product of PURE FONTE LTÉE is high quality MPI, a source of metallic iron derived from smelting of iron ore concentrate. It is used, along with scrap steel, to produce steel and iron castings in foundries, and to make high value crude steel in EAFs. Pig iron has a consistent chemistry and high iron content and thus trades at a premium to scrap steel.

PURE FONTE LTÉE plans to sell to the United States and European MPI markets, two of the largest consumers of MPI. MPI comprises three main types:

- Basic pig iron (“BPI”): used in both EAF steel making and iron foundries for less specialized products. It is the most commonly traded MPI product
- Foundry pig iron (“FPI”): used in mainly in the manufacture of grey iron castings in cupola furnaces
- Nodular pig iron (“NPI”): used in the manufacture of ductile iron castings

The difference between the three types of MPI is their chemistry and impurity levels. NPI has the most stringent requirements and the lowest levels of undesirable elements such as manganese, phosphorus and sulfur.

NPI trades at a significant premium to BPI which can reach levels over US$100/t.

PURE FONTE LTÉE will produce NPI targeting the highest grades and highest prices.

MPI of all qualities is largely imported into the United States and Europe from Brazil, Russia and the Ukraine, creating a market opportunity for a new entrant.

While a majority of the MPI imported into the United States enters through New Orleans (“NOLA”), or the Gulf Coast, a significant portion of this is consumed in the Midwest and must be barged up the Mississippi River. This creates a market opportunity for a supplier to ship from Canada, along the St Lawrence Seaway, at a cost below that to barge from NOLA thus capturing profit margin over competitors.
The NPI market in in the United States and Western Europe is each around 400,000 to 500,000 mtpa. This market has the potential to grow both through organic growth of the foundry industry, as well as increased consumption should more product become available.

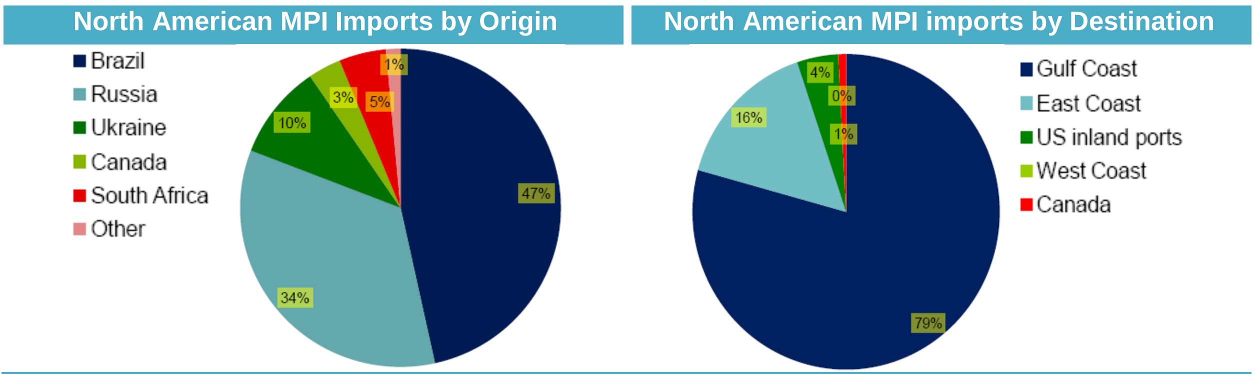

Figure 13.1-1.: North American MPI imports by origin and destination, source CRU

NPI is currently being offered FOB ship at Brazilian port for US$380/t. After transportation and logistics, including ocean transport to NOLA, transhipping to barges and barging from NOLA to the Midwest, this equates to US$450/t warehouse in Chicago. Based on its logistical advantages, PURE FONTE LTÉE would be able to sell its NPI at over roughly US$425/t FOB ship in Saguenay, based on today's market conditions.

Consumption of MPI

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
USA	7.7	5.6	5.0	2.2	3.2	3.6	4.4	4.1	4.6	4.5
Canada	0.0	0.1	0.3	0.2	0.1	0.0	0.0	0.0	0.1	0.1
Europe	10.0	11.0	10.5	7.0	7.2	7.1	7.2	5.2	4.8	4.8
Total	**17.7**	**16.7**	**15.8**	**9.4**	**10.5**	**10.7**	**11.6**	**9.3**	**9.4**	**9.3**

Figure 13.1-2.: Consumption of MPI in USA, Canada and Europe, source CRU

PURE FONTE LTÉE intends to start producing **425,000 tons per year of NPI**

13.1.3 Summary of the Market Studies

13.1.3.1 MPI supply

MPI is produced globally, with the majority of exports coming from Brazil, Russia and the Ukraine. China is a large producer and consumer of pig iron in EAF furnaces, however nearly all production is consumed internally. Like China, India is also a major producer of merchant grade pig iron for domestic consumption.

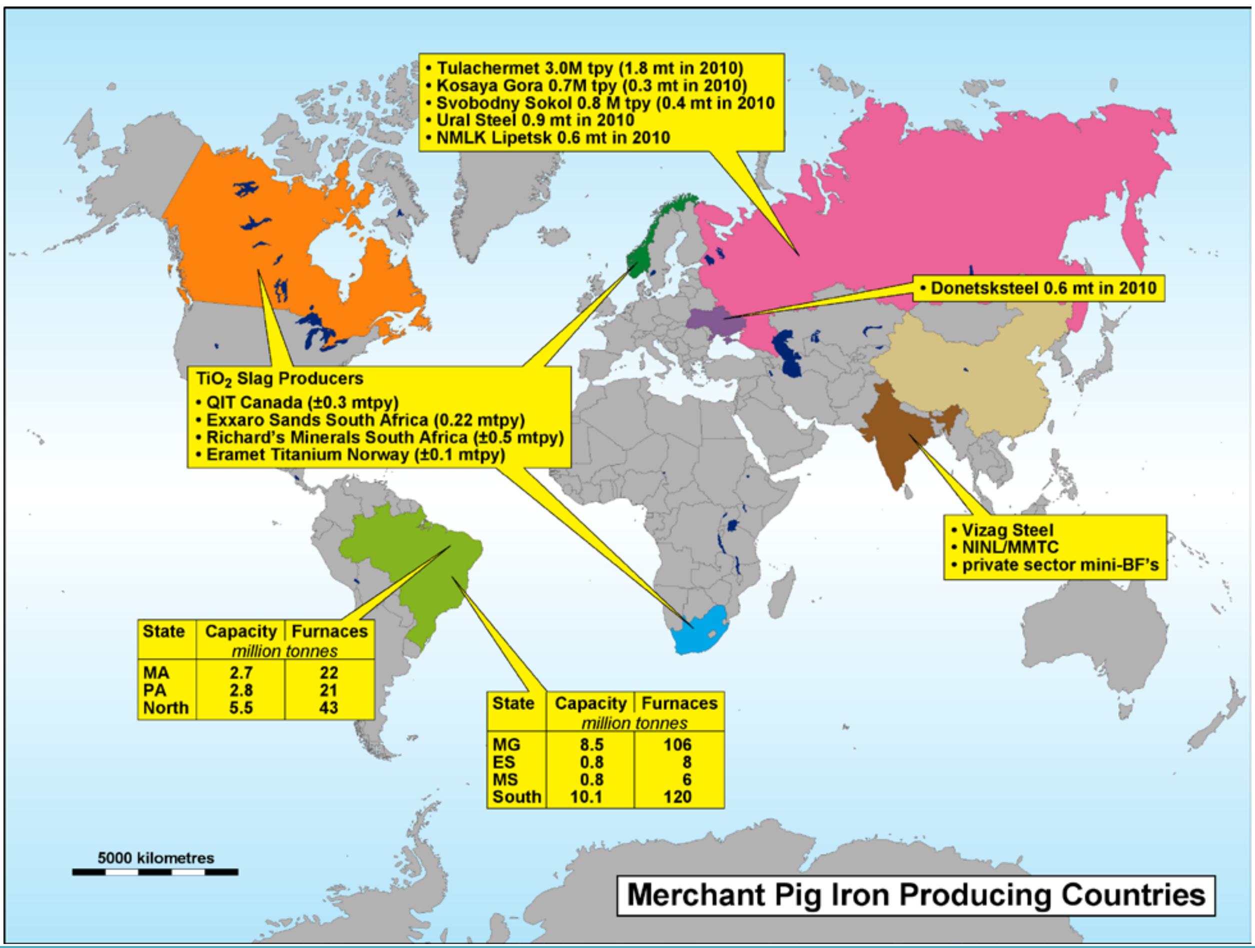

Figure 13.1-3.: MPI Production Capacity

Brazilian production relies to a large extent on the availability of low cost iron ore and the use of charcoal. A significant portion of the charcoal supply has traditionally been sourced from newly deforested areas being converted to agricultural land.

The Brazilian government has recently placed significant restrictions on charcoal production from native forests. This has had the result of significantly increasing Brazilian pig iron production costs as producers have been forced to convert to the use of higher priced coal.

According to CRU, road freight costs have increased greatly affecting the logistics of inland MPI producers.

Recent weakening of the Brazilian currency has worked to offset some of the challenges facing Brazilian producers.

Russian and Ukrainian pig iron production is based on relatively low priced coal and iron raw materials sourced from mines in the Urals and the Donetsk basin. Production costs are relatively low, offsetting the relatively higher freight costs from Black Sea ports to major markets in Europe and the United States.

Ukrainian and Russian MPI exports are set to decrease as the producers turn towards producing steel for local markets, thus utilizing the pig iron they produce internally.

Pig iron production from Canada, South Africa and Norway is based on ilmenite smelting to produce titanium slag. This type of pig iron has a ductile iron chemistry and is priced at a premium to standard pig iron. It is primarily used in high performance automotive and machinery castings.

Essentially all Canadian pig iron production is exported to the United States, as is a significant portion of South African production. Norwegian production is primarily sold to consumers in Europe.

13.1.3.2 MPI Global Demand

According to the International Iron & Metallics Association ("IIMA"), MPI consumption by the foundry industry will grow from 44 mtpa in 2014 to 55 mtpa in 2205. PURE FONTE LTÉE will be selling into a growing market. Of the foundry market consumption, 1.5 million tonnes is of nodular grade.

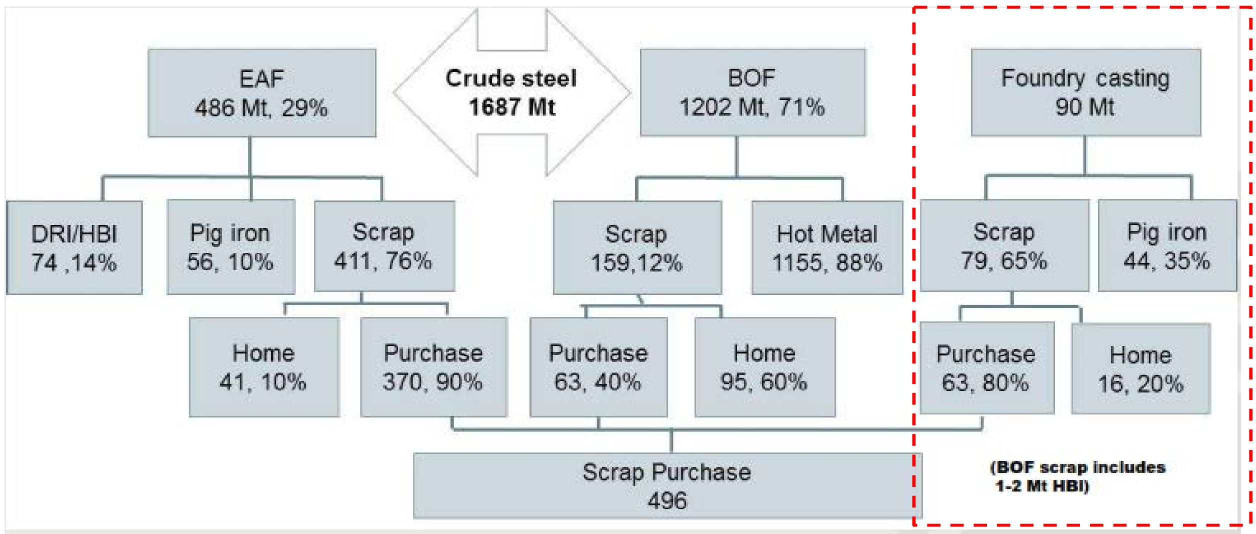

Figure 13.1-4.: Foundry market, Global MPI Market Opportunity – 2014 according to IIMA

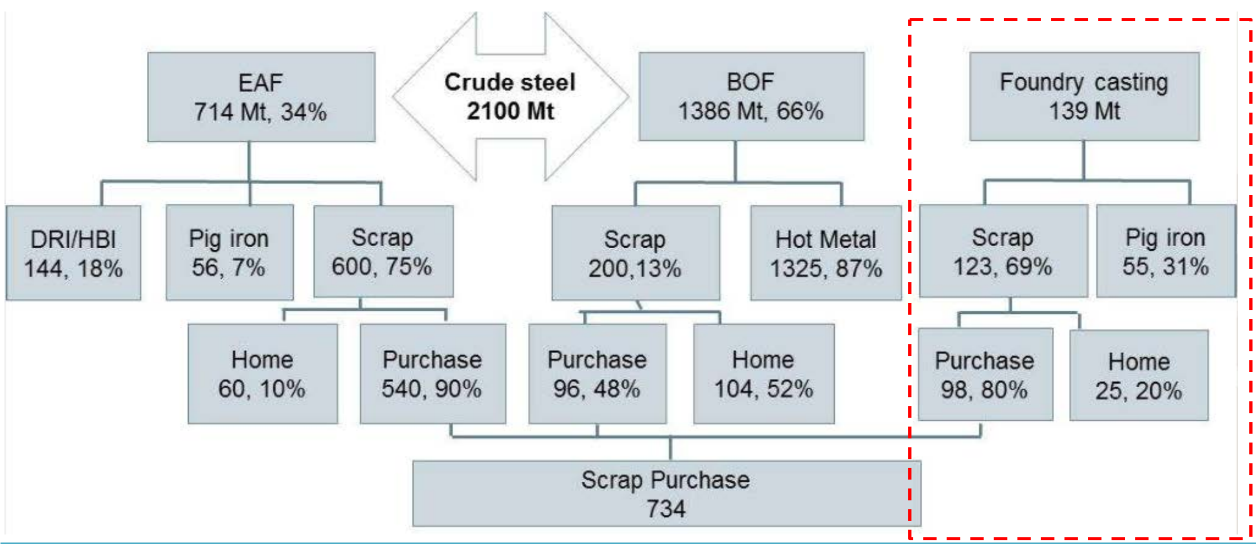

Figure 13.1-5.: Foundry market, Global MPI Market Opportunity – 2025 according to IIMA

Thanks to its chosen location in Port Saguenay, PURE FONTE LTÉE will have easy access to 4 of the top 10 iron foundry industries.

Country	Gray Iron	Ductile Iron	Total Iron
China	20,550,000	11,600,000	32,150,000
U.S.	**4,083,000**	**4,251,500**	**8,334,500**
India	6,700,000	1,000,000	7,700,000
Germany	**2,381,462**	**1,541,737**	**3,923,199**
Japan	2,135,794	1,683,250	3,819,044
Russia	1,811,765	988,235	2,800,000
Brazil	1,825,000	746,300	2,571,300
Korea	1,086,400	705,100	1,791,500
France	**635,414**	**703,141**	**1,338,555**
Italy	**689,000**	**387,600**	**1,076,600**
Total	**41,897,835**	**23,606,863**	**65,504,698**
Total ex- China	**21,347,835**	**12,006,863**	**33,354,698**

Table 13.1-11.: Top 10 Iron Casting Producing Countries (2013 t) according to IIMA

Figure 13.1-6.: Location of Top 20 US Foundry Customers for Nodular Pig Iron

In the United States, the foundry industry is nearly 500ktpa and the Top 20 Consumers are clustered in the Great Lakes region. These customers are ideally suited to be served from Port Saguenay.

Customer	City	State
CWC	Muskegon	MI
Dura-Bar	Woodstock	IL
Dexter Foundry	Fairfield	IA
Dotson Foundry	Mankato	MN
Elyia/Hodge Foundry	Elyria	OH
Elyia/Hodge Foundry	Greenville	PA
Grede Foundries	New Castle	IN
Grede Foundries	Reedsburg	WI
Grede Foundries	St Cloud	MN
John Deere	Moline	IL
Kent Foundry	Greenville	MI
Metal Technologies	Three Rivers	MI
Quality Castings	Orrville	OH
RH Sheppard	Hanover	PA
Aarowcast	Shawano	WI
Anvil Int'l	Columbia	PA
Benton Foundry	Benton	PA
Urick Foundry	Erie	PA
Ward Mfg	Blossberg	PA
Whemco	Canton	OH
Whemco	Lima	OH
Decatur Foundry	Decatur	IL
Waupaca	Marinette	WI
Waupaca	Waupaca	WI
Neenah Castings	Neenah	WI

Table 13.1-12.: Top 20 US Foundry Customers for Nodular Pig Iron

The European foundry market for nodular pig iron is the same size as the U.S. It is also easily accessible across the Atlantic from Port Saguenay.

13.1.3.3 MPI prices

MPI is correlated to the price if iron ore. Basic MPI is currently trading towards the bottom of current pricing cycles, similar to iron ore.

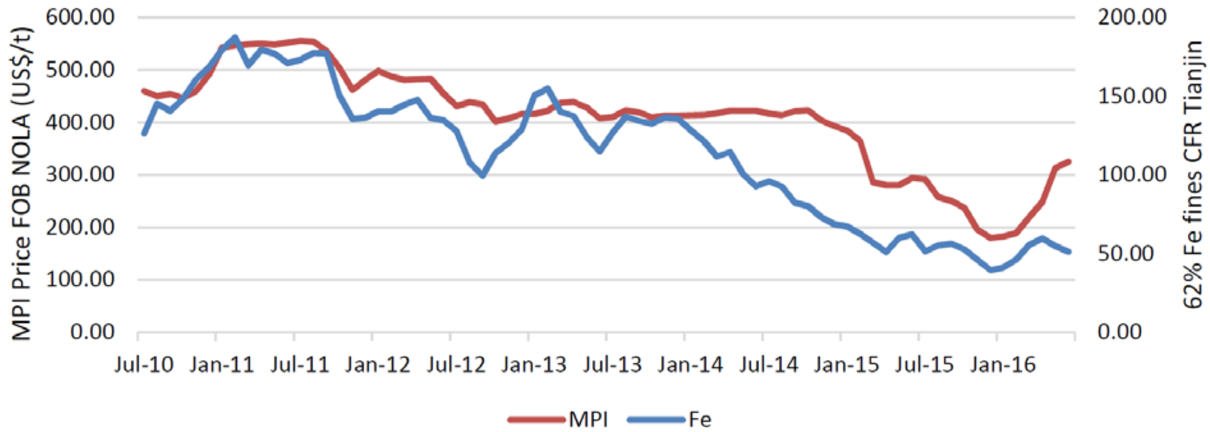

Figure 13.1-7.: BPI Prices (US$/t), source CRU

NPI trades at a premium to BPI (the price shown in figure 1.7-7). This premium generally expands as the price of BPI falls due to a larger inelasticity of demand for the product. There is no replacement for NPI for foundry customers. Currently the **premium is roughly US$100/t**.

PURE FONTE LTÉE determines the current price of NPI by directly speaking to buyers and traders as there is no published price like there is with BPI (published bi-weekly by CRU).

2	ISSUED	4/4/18	-	DJP	MES	MES
1	FOR INFORMATION	9/10/16	-	DJP	MES	MES
0	FOR INFORMATION	8/31/16	-	DJP	MES	MES
REV.	**DESCRIPTION**	**DATE**	**PROJ.**	**EXEC.**	**CHECK.**	**APPR.**

Pure Fonte Ltée

PURE FONTE LTÉE

PIG IRON PRODUCTION PLANT – FEASIBILITY STUDY

CUSTOMER Nº: 1821

tenova

TECHINT

TENOVA

TECHINT ENGINEERING & CONSTRUCTION

SECTION 13 MARKET STUDIES AND PRODUCT QUALITY

CHAPTER 13.2

PRODUCT QUALITY

ESC.: N/A

JOB: CD-335

REVISION 2

REVISION

CONTENTS

FIGURES AND REFERENCES

Chapter references

[1] Raw Materials & Ironmaking Global Consulting Services and Fe Exchange Group, "Pig Iron Market Study Report for North American Iron Corp. (PURE FONTE LTÉE) Plant in Quebec," April 20th, 2015. Dr. Joseph J. Poveromo, RMI [Joe.Poveromo@rawmaterialsiron.com] and Stephen Miller, Senior Trader [smiller@fe-xchange.com].

13.2 Product Quality

13.2.1 Quality of the IO pellets

As indicated in the process section of this FS, the raw material required for the production of DRI and subsequently the high quality pig iron is IO pellet. This chapter outlines the worldwide producers, IO pellets availability and IO pellets quality

13.2.1.1 IO pellets plants

The following table provides an almost comprehensive list of all the Iron Ore Pellet plants in the world (about 80). Some are plants located in the vicinity of iron ore mines, some of them are pure transformation plants located away from the mine and close to the pellet user. Not all the plants listed here below are in operation.

In 2014 world pellets production was about 461.4 million metric tons, a decline of 1.8% compared to the year before, after a 3.9% increase in 2013. World exports were at 137 million metric tons in 2014, a marginal increase of 0.7% over 2013, when exports declined. Since 2011, when global pellets exports reached an historical peak, exports have shrunk by 11% [1].

The consideration above, relevant to the volume of IO pellets traded annually in the World indicates that the entrance of PURE FONTE LTÉE as a new buyer of pellets in the market is only moving of few percentages point the total volume of material traded. Having said that, though, it is important to consider that it will always be important for PURE FONTE LTÉE to secure medium term contracts for raw material purchase, in particular for the first few years of production, so to establish itself as a player in the market.

Plant Name	Country	Owners
BalmoralSouth Pellet Plant	Australia	Australasian Resources Limited
Savage River Pellet Plant	Australia	Australian Bulk Minerals, Grange Resources Limited, Ivanhoe Mines
Sino Iron Pellet Plant	Australia	China Metallurgical Construction Corporation, and CITIC Pacific
Whyalla(OneSteel)	Australia	OneSteel Limited
GIIC Pellet Plant	Bahrain	Gulf Industrial Investment Corporation, andVale S.A
Casa de PedraPlant	Brazil	Companhia Siderurgica Nacional
Fábrica Pellet Plant	Brazil	Vale S.A
Hispanobras JV Pellet Plant	Brazil	ArcelorMittal, andVale S.A
Itabrasco JV Pellet Plant	Brazil	Ilva SpA, and Vale S.A
Kobrasco JV Pellet Plant	Brazil	POSCO, and Vale S.A
Minas-Rio Pellet Plant (Acu Port)	Brazil	
NAMISA Pellet Plants	Brazil	CSN, Itochu, JFE, Kobe, Nippon, Nisshin and POSCO
Nibrasco JV Pellet Plant	Brazil	JFE, Kobe, Nippon, Nisshin, Sojitz, Sumitomo, Vale S.A
Porto do Mangue Pellet Plant	Brazil	MHAG Serviços eMineração S.A.
Samarco Pellet Complex	Brazil	BHP Billiton Limited, and Vale S.A
São Luís Pellet Plant	Brazil	Vale S.A
Tubarão Pellet Plants (I, II & III)	Brazil	Vale S.A
USIMINAS Pellet Plant Project	Brazil	Usinas Siderurgicas de Minas Gerais SA
VargemGrande Pellet Plant	Brazil	Vale S.A
Carol Lake Pellet Plant	**Canada**	**Iron Ore Company of Canada (RioTinto Group)**
KéMag Pellet Plant	Canada	New Millennium Iron Corp.
Port-Cartier (AMMC) Pellet Plant	**Canada**	**ArcelorMittal**
Wabush Mines Pellet Plant	Canada	Cliffs Natural Resources Inc.
Huasco Pellet Plant	Chile	Compania Minera del Pacifico SA
Anshan I&S Pellet Plant	China	Anshan Iron & Steel Group Corporation
Anyang Iron & Steel Plants	China	Anyang Iron and Steel Group Corporation
Baotou Iron & Steel Pellet Plants	China	Baotou Iron & Steel (Group) Co., Ltd.
Benxi Iron & Steel Pellet Plant	China	Benxi Iron & Steel Group Co., Ltd.
Chengchao Pellet Plant	China	Wuhan Iron & Steel Corporation
DagushanPellet Plant	China	Anshan Iron & Steel Group Corporation
Daye Pellet Plant	China	Wuhan Iron & Steel Corporation
Ezhou City Pellet Plant	China	Wuhan Iron & Steel Corporation
GongchanglingPellet Plant	China	Anshan Iron & Steel Group Corporation
Ma'anshan Iron & Steel Plants	China	Maanshan Iron & Steel Company Limited
Nanfen Pellet Plant	China	Benxi Iron & Steel Group Co., Ltd.
Shougang (Shoudu I&S) Plant I	China	Shougang Corporation
Taiyuan I&S Pellet Plant	China	Taiyuan Iron & Steel (Group) Co. Ltd.
Tangshan I&S Pellet Plant	China	Tangshan Iron & Steel Co. Ltd.
Xuanhua I&S Pellet Plant	China	Tangshan Iron & Steel Co. Ltd.
Yingkou Pellet Plant (Karara)	China	
Zhanjiang JV Pellet Plant	China	BaoSteel Co Ltd, andShougangCorporation
Ain El-Sokhana Pellet Plant	Egypt	Gulf Industrial Investment Corporation
Alexandria Pellet Plant	Egypt	Gulf Industrial Investment Corporation

Plant Name	Country	Owners
Brahami Pellet Plant	India	Stemcor Holdings Ltd
ChowguleGroup Pellet Plant	India	Chowguleand Company Private Limited, and NMDC Limited
Essar Steel (Hy-Grade Pellets Ltd)	India	(Various), and EssarGlobal Limited
JSW Steel (VijayanagarWork)	India	Jindal South West Holdings Limited
KudremukhPellet Plant	India	Kudremukh Iron Ore Co Ltd
Ardakan (Chadormalu) Pellet Plant	Iran	National Iranian Steel Company
Gol-e-GoharPellet Plant	Iran	National Iranian Steel Company
SSGPO Pellet Plant	Kazakhstan	Eurasian Natural Resources Corporation PLC
Guelb el AoujPellet Plant	Mauritania	Société NationaleIndustrielle et Minière,
Las Encinas(LESA) Pellet Plant	Mexico	(Various), and Ternium S.A.
MonclovaPellet Plants (AHMSA)	Mexico	Altos Hornos de Mexico SAB de CV
Peña ColoradaPellet Plant	Mexico	ArcelorMittal, and Ternium S.A.
JFE - FoulathPellet Plant	Oman	(Various), Gulf Industrial Investment Corporation, and JFE Holdings
Sohar (Oman) Pellet Plant	Oman	
Marcona Pellet Plant	Peru	(Various), and Shougang Corporation (Hierro Peru)
Kachkanarsky (KGOK) Pellet Plant	Russia	(Private), and Evraz Group S.A.
Karelsky Okatysh Pellet Plant	Russia	Government of Karelia Republic, and OAO Severstal
Lebedinsky GOK Pellet Plant	Russia	(Various),Metalloinvest Holding, and ZAO Gazmetall
Mikhailovsky GOK Pellet Plant	Russia	(Private),Metalloinvest Holding, and ZAO Gazmetall
Oskolsky Electric Metallurgy Plant	Russia	Metalloinvest Holding, and ZAO Gazmetall
Stoilensky GOK Pellet Plants	Russia	Novolipetskiymetallurg. komb. OAO
Kiruna & Svappavaara Pellet Plant	Sweden	LKAB
Malmberget Pellet Plants	Sweden	LKAB
Centralniy GOK Pellet Plant	Ukraine	Metinvest Holding LLC, and Smart Group LLC
Poltava Pellet Plant	Ukraine	(Private), and Ferrexpo plc
Severniy GOK Pellet Plant	Ukraine	Metinvest Holding LLC, and Smart Group LLC
Empire Mine Pellet Plant	USA	ArcelorMittal, andCliffs Natural Resources Inc
Hibbing Pellet Plant	USA	ArcelorMittal, Cliffs Natural Resources Inc, and US Steel
Keetac Pellet Plant	USA	US Steel
Minnesota Steel Pellet Plant	USA	Essar Global Limited
Minntac Pellet Plant	USA	US Steel
Minorca Pellet Plant	USA	ArcelorMittal
NorthshorePellet Plant	USA	Cliffs Natural Resources Inc
Tilden Pellet Plant	USA	Cliffs Natural Resources Inc, and US Steel
United Taconite Pellet Plant	USA	AK Steel Holding Corporation, Cliffs Natural Resources Inc,
Piar Division (Toppca) Pellet Plant	Venezuela	Corporacion Venezolana de Guayana
Sidor Pellet Plant	Venezuela	Siderúrgica de Orinoco C.A.

Table 13.2-1.: list of pellets plant in the World

13.2.1.2 IO pellets quality

In general IO pellets quality can be divided in two main categories:

1. IO pellets for Blast Furnace use (BF pellets)
2. IO pellets for Direct Reduction (DR pellets)

About 10% of the world IO pellets' production is made of DR pellets, while the rest if made of BF pellets.

The following tables provide a comparison of the chemical characteristics of IO pellets proceeding from some of the above listed IO pellet plants. The first table is relevant to DR pellets and the second to BF pellets.

The main difference between the chemistry of a BF pellet and a DR pellet is the content of iron and silica. Considering the data reported in the tables below, the content of iron for a DR pellet is more than 2.5% higher as an average compared to the content of iron of the BF pellet. This characteristic is achieved by processing the concentrate of iron ore in order to reduce the content of silica and lime. The result is a higher metallization and a higher basicity

Figure 13.2-1.: IO pellets of AMMC

tenova

DR pellets comparisons

Company	**AMMC**	Samarco	LKAB	VALE	VALE	GIIC	H. Peru	**IOC**	CAP	Oskol	Sidor	PECO	Essar	AMLC
type	**BBS**		KPRS	Tubarao	DRPH*									
Chemistry														
Fe	**67.7**	67.9	67.9	67.8	66.7	67.6	68.2	**67**	67.33	67.2	67.6	65.98	66.9	67.24
SiO2	**1.6**	1.23	0.75	1.25	1.4	1.4	1.6	**1.2**	1.4	3.26	1.25	2.19	1.74	1.94
Al2O3	**0.4**	0.49	0.16	0.55	0.5	0.3	0.3	**0.25**	0.23	0.35	0.8	0 0.97	1 6	1.02
CaO	**0.55**	0.76	0.9	0.65	1.6	1.1	0.3	**0.7**	1.36	0.28	1.8	1.78	0.85	0.5
MgO	**0.3**	0.09	0.65	0.3	0.6	0.3	0.6	**0.45**	0.22	0.2	0.05	0.45	0.25	0.15
Mn	**0.03**	0.04	0.06	0.1	0.12	-	0.02	**0.15**	-	0.03	-	0.09		
P	**0.01**	0.053	0.025	0.028	0.025	0.022	0.01	**0.008**	0.033	0.011	0.05	0.029		0.051
S	**0.002**	0.002	0.002	0.002	0.002	0.004	0.006	**0.003**	0.005	0.002	0.004	0.005	0.004	0.001
TiO2	**0.15**	0.04	0.16	-	-	-	0	**0.04**	0.1	0.03	0.08	0.29		
Na2O	**0.035**	0.04	0.04	-	-	-	0.13	**0.02**	0.125	-	-	0.1		
K2O	**0.015**	0.008	0.03	-	-	-	0.04	**0.015**	0.125	-	-	0.1		
V	**0.005**	0.003	0.11	-	-	-	-	**<0.01**						
Cu	**0.0002**	0.003	0.001	-	-	-	0.007	**<0.001**	-	0.002	-	-		
Pb	**0.001**	0.05	-	-	-	-	-	**<0.002**	-	0.0001	-	-		
Zn	**0.0015**	0.002	0.004	-	-	-	-	**<0.002**	-	0.001	-	0.01		
Cr	**0.018**	0.05	0.002	-	-	-	-	**0.012**						
CaO/SiO2	**0.34**	0.62	1.38	0.52	1.14	0.78	0.26	**0.6**	0.97	0.09	1.44	0.81	0.48	0.26
B/A	**0.44**	0.49	1.94	0.53	1.16	0.82	0.47	**0.77**	0.97	0.13	0.9	0.7	0.39	
H20	**2**	1.5	1.5	3.02	.0 1.0	-		**2**	2	-	2.3	-		

Table 13.2-2.: Comparison of Direct Reduction Pellet Chemistry

BF pellets comparisons (table 1)

company	**AMMC**	**IOC Lim**	**IOC**	Hierro	LKAB	Kostomu.	Poltrava	Poltrava	Lebedinsky	**AMMC**	**AMMC**	VALE	VALE	VALE
type	**BHF**	**Acid**	**LS acid**	Peru	KPBA	Acid	1	2		**BMC**	**BAF**	Tubarao	Fabrica	Vargem
Chemistry														
Fe	**65.1**	**65**	**67.3**	66	66.9	65	65	62	66	**65.5**	**63.3**	65.7	64.8	65.2
SiO2	**5.2**	**4.75**	**2.6**	3.95	2.6	6.20	5.8	9.8	4.8	**3.6**	**3.75**	2.45	3.5	2.55
Al2O3	**0.5**	**0.25**	**0.25**	0.4	0.23	0.35	0.3	0.4	0.25	**0.45**	**0.5**	0.65	0.95	0.95
CaO	**0.6**	**1**	**0.75**	0.4	0.55	0.2	0.35	0.46	0.22	**1.5**	**3.68**	2.64	2.6	2.55
MgO	**0.25**	**0.4**	**0.35**	0.84	0.52	0.12	0.6	0.8	0.34	**0.62**	**1.3**	0.05	0.05	0.05
Mn	**0.035**	**0.15**	**0.14**	0.02	0.12	0.06	0.035	0.045	0.041	**0.03**	**0.035**	0.1	0.25	0.15
P	**0.019**	**0.008**	**0.008**	0.01	0.025	0.015	0.011	0.007	0.012	**0.01**	**0.015**	0.03	0.044	0.048
S	**0.002**	**0.003**	**0.003**	0.008	0.001	0.005	0.002	0.003	0.005	**0.01**	**0.011**	0.003	0.002	0.005
TiO2	**0.25**	**0.04**	**0.04**	0.09	0.18	0.03	0.035	0.035	0.034	**0.15**	**0.18**	0.05	0.05	0.05
Na2O	**0.04**	**0.02**	**0.02**	0.17	0.04	0.180	0.12	0.16	0.15	**0.035**	**0.035**	0.004	0.004	0.004
K2O	**0.02**	**0.01**	**0.01**	0.07	0.04		+		+	**0.025**	**0.025**	0.005	0.005	0.005
V	**0.005**	**<0.010**	**<0.01**		0.11	0.11		0.003		**0.005**				
Cr	**0.0155**	**0.012**	**0.012**							**0.016**				
Other	**-**	**-**												
CaO/SiO2	**0.11**	**0.21**	**0.37**	0.15	0.21	0.22	0.06	0.05	0.04	**0.41**	**0.98**	1.08	0.75	1
B/A	**0.15**	**0.26**	**0.48**	0.26	0.38	0.39	0.15	0.12	0.1	**0.52**	**1.17**	0.87	0.6	0.74

Table 13.2-3.: Comparison of Blast Furnace Pellet Chemistry (1)

BF pellets comparisons (table 2)														
company	Samarco	Algorrobo	CVG	VALE	LKAB	LKAB	Savage	Krivoi	**IOC**	Kobe	Tata	OneSteel	GAN/	Kostomuksha
type	BF		Sidor	Carajas	KBPO	MBPO	River	Rih	**fluxed**		Ijmuiden	Whyalla	AHMSA	Fluxed
Chemistry														
Fe	66.72	65.7	65.6	65.34	66.6	66.8	66	60.15	**61.9**	61.33	65.3	64.25	61.31	63.5
SiO2	2	2	2.25	1.8	2.1	1.8	2	8.08	**4.75**	3.11	3.3	4.21	4.37	5
Al2O3	0.5	0.47	0.8	1.4	0.23	0.32	0.4	0.21	**0.3**	1.42	0.97	0.46	0.89	0.35
CaO	1.64	2.46	2.3	1.8	0.46	0.45	0.15	4.95	**4.3**	4.45	0.23	4.32	4.86	3.2
MgO	0.15	0.5	0.6	0.05	1.4	1.3	1.72	0.41	**1.8**	1.79	1.5	0.32	1.41	0.3
Mn	0.057	0.04	0.09	0.05	0.06	0.04	0.05	0.09	**0.11**	0.09	0.2	0.6		0.04
P	0.046	0.047	0.05	0.04	0.025	0.025	0.013	0.009	**0.01**	0.051		0.015	0.137	0.015
S	0.004	0.004	0.003	0.005	0.001	0.001	0.001	0.022	**0.015**	0.013		0.003	0.032	0.05
TiO2	0.046	0.13	0.11	0.08	0.18	0.35	1.67	0.01	**0.04**	0.4	0.2	0.2		0.1
Na2O	0.036	0.04	0.016		0.04	0.04	0.028	0.05	**0.02**	0.019			0.073	0.06
K2O	0.011	0.05	0.013		0.04	0.02	0.011	0.04	**0.01**	0.021			0.097	0.15
V					0.11	0.11			**<0.010**	-				0.003
Cr					<0.01	<0.02		0.0027	**0.012**					
Other														
CaO/SiO2	0.82	1.23	1.02	1	0.23	0.2	0.07	0.61	**0.91**	1.43	0.07	1.03	1.07	0.64
B/A	0.72	1.2	0.72	0.56	0.88	0.91	0.73	0.65	**1.21**	1.38	0.4	0.99	1.21	0.65

Table 13.2-4.: Comparison of Blast Furnace Pellet Chemistry (2)

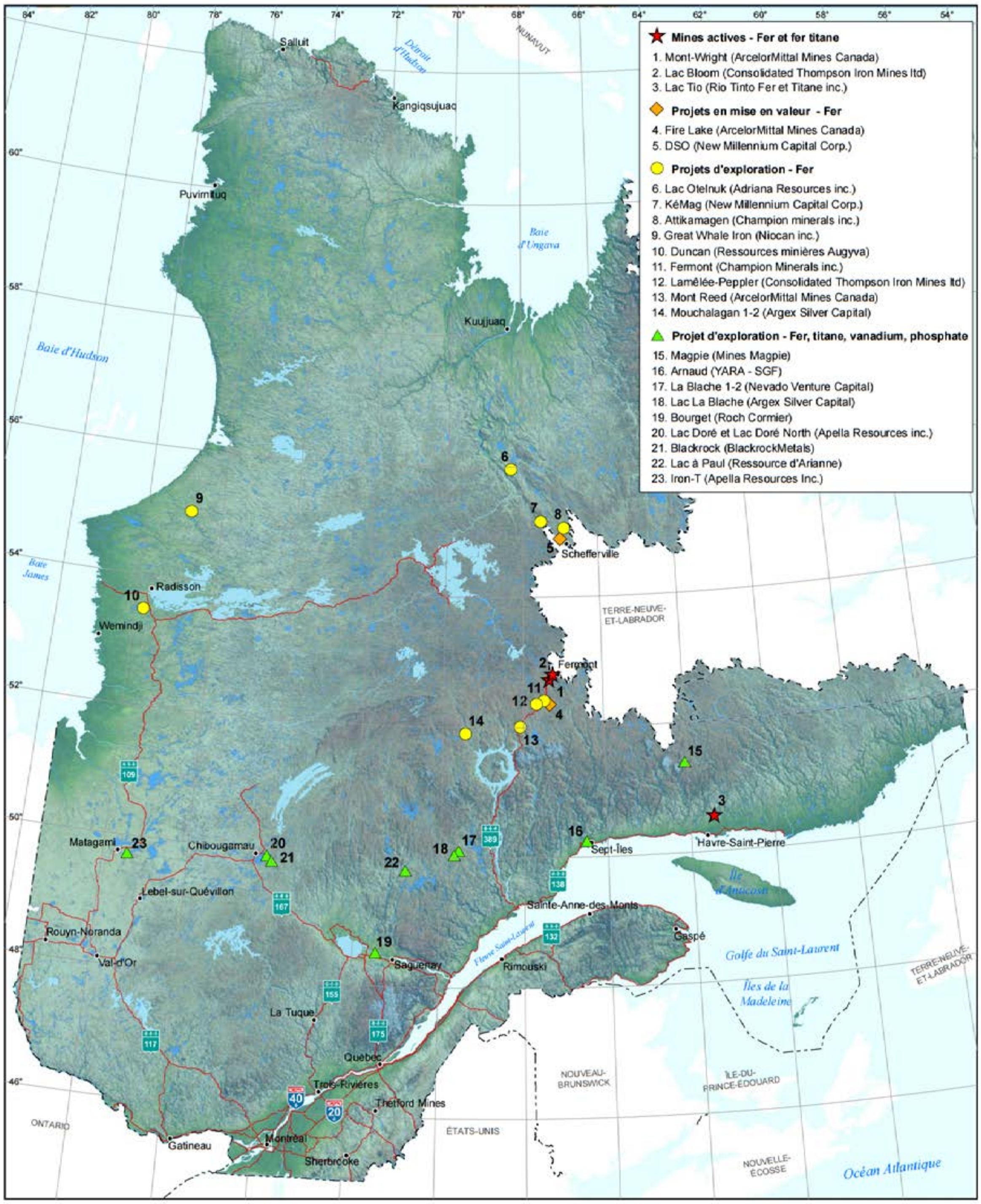

Figure 13.2-2.: Mines and Iron exploration projects of Quebec in 210 [2]

13.2.1.3 Canadian IO pellets

This FS considers as primary source of IO pellet the two Canadian mines closer to PURE FONTE LTÉE site: AMMC and IOC. In the tables above the chemistry of pellets from AMMC and IOC has been highlighted. In general it is possible to observe that the metallization of the DR pellets proceeding from these Canadian mines is well over 67%, while the metallization of a BF pellet is more than 2% lower.

Canadian IO pellets analysis:

- DR pellet Fe = 67.35% BF pellet Fe = 64.68%
- DR pellet SiO2 = 1.40% BF pellet SiO2 = 3.93%
- DR pellet CaO = 0.62% BF pellet CaO = 2.07%

To a more accurate analysis, the two suppliers present some differences, not much comparing iron and silica, but comparing other important elements for the quality of the end product:

- AMMC pellet Fe = 65.4% IOC pellet Fe = 65.3%
- AMMC pellet SiO2 = 3.26% IOC pellet SiO2 = 3.32%
- AMMC pellet CaO = 1.73% IOC pellet CaO = 1.68%
- AMMC pellet S = 0.005% IOC pellet S = 0.006%
- AMMC pellet P = 0.013% IOC pellet P = 0.0085%
- **AMMC pellet Mn = 0.032% IOC pellet Mn = 0.137%**
- **AMMC pellet V = 0.005% IOC pellet V = 0.010%**
- **AMMC pellet TiO2 = 0.182% IOC pellet TiO2 = 0.04%**

Based on the metallurgical consideration that the process choice made for melting the DRI into liquid pig iron would have a natural tendency to remove SiO2, TiO2 and P, even considering the non-over oxidizing atmosphere of the EAF, the FS has considered as primary IO pellet source the AMMC BMC pellet outlined below, due to the lower value of Mn and V.

13.2.1.4 AMMC pellets

The full data sheets and details of the AMMC IO pellets are included Appendix VII to this FS. Here below the main characteristics are reported:

AMMC self fluxed pellet (BAF)

	TYPICAL	*MIN*	*MAX*	
Fe	**63.3**	**62.2**		For purposes of determining conformance with the specifications shown on this sheet, an observed value or a calculated value shall be rounded "to the nearest unit" in the last right-hand digit used in expressing the specification limit, in accordance with the **rounding method** of **ASTM Practice E29-13, for** *Using Significant Digits in Test Data to Determine Conformance with Specifications.*
SiO_2	**3.75**	**3.5**	**4.0**	
Al_2O_3	**0.5**		**0.7**	
CaO	**3.68**			
CaO/SiO_2	**0.98**	**0.88**	**1.08**	
MgO	**1.30**	**1.10**	**1.50**	
TiO_2	**0.18**		**0.4**	
P	**0.015**		**0.03**	
S	**0.011**		**0.03**	
Mn	**0.035**		**0.06**	
K_2O	**0.025**		**0.04**	
Na_2O	**0.035**		**0.06**	
Moisture	**1.5**		**2.5**	**ISO 3087 : 2011**

Figure 13.2-3.: chemical characteristic of the AMMC self fluxed pellet (BAF)

AMMC low silica acid pellet (BBS)

	TYPICAL	*MIN*	*MAX*	
Fe	**67.7**	**67.4**		For purposes of determining conformance with the specifications shown on this sheet, an observed value or a calculated value shall be rounded "to the nearest unit" in the last right-hand digit used in expressing the specification limit, in accordance with the **rounding method** of **ASTM Practice E29-13, for** *Using Significant Digits in Test Data to Determine Conformance with Specifications.*
SiO_2	**1.6**		**1.8**	
Al_2O_3	**0.40**		**0.6**	
CaO	**0.65**	**0.45**	**0.9**	
MgO	**0.30**	**0.20**	**0.40**	
TiO_2	**0.15**		**0.30**	
P	**0.01**		**0.02**	
S	**0.002**		**0.005**	
Mn	**0.030**		**0.06**	
K_2O	**0.015**		**0.04**	
Na_2O	**0.035**		**0.06**	
Moisture	**2**		**3**	**ISO 3087 : 2011**

Figure 13.2-4.: chemical characteristic of the AMMC low silica acid pellet (BBS)

AMMC pellet (BMC)

	TYPICAL	MIN	MAX	
				For purposes of determining conformance with the specifications shown on this sheet, an observed value or a calculated value shall be rounded "to the nearest unit" in the last right-hand digit used in expressing the specification limit, in accordance with the **rounding method** of **ASTM Practice E29-13, for** *Using Significant Digits in Test Data to Determine Conformance with Specifications.*
Fe	**65.5**	**65.0**		
SiO_2	**3.5**	**3.25**	**3.75**	
Al_2O_3	**0.45**		**0.65**	
CaO	**1.40**			
CaO/SiO_2	**0.4**	**0.3**	**0.5**	
MgO	**0.62**	**0.47**	**0.77**	
TiO_2	**0.15**		**0.3**	
P	**0.010**		**0.03**	
S	**0.01**		**0.02**	
Mn	**0.030**		**0.06**	
K_2O	**0.025**		**0.04**	
Na_2O	**0.035**		**0.06**	
Moisture	**1.5**		**2.5**	**ISO 3087 : 2011**

Figure 13.2-5.: chemical characteristic of the AMMC pellet (BMC)

The AMMC DR pellets are the so called BBS while the BF pellets are the BMC and BAF. The substantial difference between these qualities is the content of iron and Silica, which is directly related to the transformation cost of the IO pellet into DRI, and the second important difference is the content of sulfur, which is five times lower for the DR pellets compared to the BF pellets.

To the extent of the metallurgical calculations of the composition of the high purity pig iron, the FS is considering in principle the use of the BF pellet BMC, although comparisons with other DR grades are made.

Figure 13.2-6.: AMMC mine site

13.2.2 Quality of the nodular pig iron

13.2.2.1 Quality requirements for high purity pig iron

As seen in the previous chapter of this section, the nodular pig iron for special foundry applications is defined as follows:

	C	Si	S	P	Mn
Triple Five	3.5 – 4.5	< 0.5	< 0.020	< 0.050	< 0.050
T35	3.5 – 4.5	< 0.5	< 0.002	< 0.035	< 0.035
Russian	3.5 – 4.5	< 1.0	< 0.020	< 0.055	< 0.090

Table 13.2-5.: general categories of high purity pig iron for special foundry applications

The peculiarity of these grades is to have Manganese and Phosphorous as low as possible. Triple-Five grade is the main grade used in particular in the North American foundry where nodular ductile castings are produced. T35 grade is of even higher quality and is commonly chosen in Europe for exacting applications such as windmill parts.

The most significant difference between these two grades of nodular pig iron is the amount of sulfur contained in the end product. To this extent, the process route chosen is helping to maintain under control the amount of Sulfur that will be present in the Pig Iron after melting the DRI. Usually Sulfur in the Pig Iron proceeds from the carbon used to produce pig iron in Blast Furnaces. For the case of PURE FONTE LTÉE, Natural Gas is the reducing agent for the iron oxides and NG provides virtually no S additions to the material.

Despite that characteristic, the S value from the IO pellet to DRI is naturally increasing during the reduction process, but only because of a mass effect (oxygen is moving out of the material and Sulfur is staying, so increasing in volume percentage).

In reality, the process route considered for PURE FONTE LTÉE can foresee a desulfurization phase. In fact, the conditions of temperature inside the EAF would favor the migration of S to the slag in case of enough addition of the proper fluxes (generally lime). This is an important factor of risk mitigation for sulfur, because in case one heat would present unexpected higher sulfur levels, by adding more lime, the problem could be corrected.

As it is possible to see in the calculations provided below, achieving the required values of S, but also of Mn, it will not be a problem for PURE FONTE LTÉE when producing the Triple Five pig iron grades.

The interesting situation to analyze is the production of the T35 grade. Besides the spec presented in table 13.2-5, clients of T35 grades are demanding not just what generically stated above, but a set of pig iron characteristics that can be summarized as follows:

- Sulfur between 0.004 and 0.006, where consistency is very much required
- Si between 0.25 and 0.30, required for the physical integrity of the pig iron
- Mn between 0.025 and 0.040
- Trace elements not more than 0.03, where 0.04 would be the high end, not in all cases. What is expected is that the sum of Ti and V would not exceed 0.03

The above four points have been gathered during technical discussions with clients.

13.2.2.2 Estimation of Pig Iron composition

AMMC-BBS

The following table presents the estimated composition of DRI, EAF slag and pig iron in case of use of IO pellet BBS from AMMC based on the process described in Section 8.

BBS	IO pellet	DRI	EAF slag	Pig Iron
Fe tot	67.7000			
Fe met	0.0000	83.8949	0.0000	95.9694
Fe2O3	96.46	0.0000	0.0000	0.0000
FeO	0.3000	6.8892	5.5113	0.0000
SiO2	1.6000	2.1093	17.3434	0.2593*
CaO	0.6500	0.8569	50.8587	0.0000
MgO	0.3000	0.3955	20.0901	0.0000
Al2O3	0.4000	0.5273	4.1071	0.0000
TiO2	0.1530	0.2017	1.5710	0.0050*
K2O	0.0150	0.0198	0.1540	0.0006*
Na2O	0.0350	0.0461	0.3594	0.0000
P	0.0100	0.0132	0.0000	0.0142
Mn	0.0300	0.0395	0.0000	0.0427
S	0.0020	0.0035	0.0018	0.0035
V	0.0050	0.0066	0.0007	0.0070
Cr	0.0180	0.0237	0.0025	0.0254
C	0.0200	5.0000	0.0000	3.6728
Tot	100.0	100.0	100.0	100.0

Table 13.2-6.: Estimated composition of DRI, EAF slag and Pig Iron in case of use of BBS pellets from AMMC

Note: where noted with *, element present in Pig Iron as metal and not oxide

The result of this metallurgical simulation returns a composition of iron ore in line with the spec of the high purity NPI of T35 grade.

AMMC-BMC, Canada

The following table presents the estimated composition of DRI, EAF slag and pig iron in case of use of IO pellet BMC from AMMC based on the process described in Section 8.

BMC	IO pellet	DRI	EAF slag	Pig Iron
Fe tot	65.5000			
Fe met	0.0000	80.0695	0.0000	95.6889
Fe2O3	91.98	0.0000	0.0000	0.0000
FeO	1.5000	6.5751	5.2600	0.0000
SiO2	3.6000	4.6817	28.1173	0.2991
CaO	1.5000	1.9507	44.2304	0.0000
MgO	0.6200	0.8063	17.3516	0.0000
Al2O3	0.4500	0.5852	3.4298	0.0000
TiO2	0.1500	0.1951	1.1433	0.0050
K2O	0.0250	0.0325	0.1905	0.0007
Na2O	0.0350	0.0455	0.2668	0.0000
P	0.0100	0.0130	0.0000	0.0147
Mn	0.0300	0.0390	0.0000	0.0441
S	0.0100	0.0138	0.0073	0.0145
V	0.0050	0.0065	0.0007	0.0072
Cr	0.0160	0.0208	0.0023	0.0232
C	0.0200	5.0000	0.0000	3.9026
Tot	100.0	100.0	100.0	100.0

Table 13.2-7.: Estimated composition of DRI, EAF slag, Pig Iron in case of use of BMC pellets from AMMC

Note: where noted with *, element present in Pig Iron as metal and not oxide

The result of this metallurgical simulation returns a composition of iron ore in line with the spec of the high purity NPI of Triple Five grade.

It is possible, though that with the addition of lime during EAF tapping, a mild desulfurization could take place, with a further reduction of the S content, so to achieve the T35 high purity pig iron grade.

AMMC-BAF, Canada

The following table presents the estimated composition of DRI, EAF slag and pig iron in case of use of IO pellet BAF from AMMC based on the process described in Section 8.

BAF	IO pellet	DRI	EAF slag	Pig Iron
Fe tot	63.3000			
Fe met	0.0000	76.3742	0.0000	95.6009
Fe2O3	88.72	0.0000	0.0000	0.0000
FeO	1.6000	6.2716	5.0173	0.0000
SiO2	3.8000	4.8775	23.6479	0.3289
CaO	3.7300	4.7877	48.8463	0.0000
MgO	1.3000	1.6686	17.9777	0.0000
Al2O3	0.5000	0.6418	3.0403	0.0000
TiO2	0.1800	0.2310	1.0945	0.0050
K2O	0.0250	0.0321	0.1520	0.0007
Na2O	0.0350	0.0449	0.2128	0.0000
P	0.0150	0.0193	0.0000	0.0228
Mn	0.0350	0.0449	0.0000	0.0533
S	0.0110	0.0149	0.0081	0.0161
V	0.0050	0.0064	0.0007	0.0075
Cr	0.0160	0.0205	0.0024	0.0239
C	0.0200	5.0000	0.0000	3.9410
Tot	100.0	100.0	100.0	100.0

Table 13.2-8.: Estimated composition of DRI, EAF slag, Pig Iron in case of use of BAF pellets from AMMC

Note: where noted with *, element present in Pig Iron as metal and not oxide

The result of this metallurgical simulation returns a composition of iron ore in line with the spec of the high purity NPI of Triple Five grade.

It is possible, though that with the addition of lime during EAF tapping, a mild desulfurization could take place, with a further reduction of the S content.

IOC-DR, Canada

The following table presents the estimated composition of DRI, EAF slag and pig iron in case of use of IO pellet DR grade from IOC based on the process described in Section 8.

IOC-DR	IO pellet	DRI	EAF slag	Pig Iron
Fe tot	67.1000			
Fe met	0.0000	82.8470	0.0000	95.7418
Fe2O3	95.60	0.0000	0.0000	0.0000
FeO	0.3000	6.8031	5.4425	0.0000
SiO2	1.5500	2.0359	15.6168	0.2195
CaO	1.0500	1.3792	51.0037	0.0000
MgO	0.7000	0.9194	22.4530	0.0000
Al2O3	0.5000	0.6567	4.7638	0.0000
TiO2	0.0400	0.0525	0.3811	0.0050
K2O	0.0150	0.0197	0.1429	0.0006
Na2O	0.0200	0.0263	0.1906	0.0000
P	0.0080	0.0105	0.0000	0.0115
Mn	0.1800	0.2364	0.0000	0.2581
S	0.0030	0.0048	0.0025	0.0049
V	0.0100	0.0131	0.0014	0.0142
Cr	0.0120	0.0158	0.0017	0.0170
C	0.0200	5.0000	0.0000	3.7274
Tot	100.0	100.0	100.0	100.0

Table 13.2-9.: Estimated composition of DRI, EAF slag, Pig Iron in case of use of DR pellets from IOC

Note: where noted with *, element present in Pig Iron as metal and not oxide

The result of this metallurgical simulation returns a composition of iron ore not in line with the spec of the high purity NPI because of the manganese content, the only element that is exceeding the ranges required for NPI.

IOC-Low silica acid, Canada

The following table presents the estimated composition of DRI, EAF slag and pig iron in case of use of IO pellet BF grade from IOC based on the process described in Section 8.

IOC LS acid	IO pellet	DRI	EAF slag	Pig Iron
Fe tot	67.3000			
Fe met	0.0000	82.7411	0.0000	95.8751
Fe2O3	91.88	0.0000	0.0000	0.0000
FeO	3.9056	6.7944	5.4356	0.0000
SiO2	2.6000	3.4006	25.2538	0.3289
CaO	0.7500	0.9809	47.4555	0.0000
MgO	0.3500	0.4578	18.8443	0.0000
Al2O3	0.2500	0.3270	2.3478	0.0000
TiO2	0.0400	0.0523	0.3756	0.0050
K2O	0.0100	0.0131	0.0939	0.0007
Na2O	0.0200	0.0262	0.1878	0.0000
P	0.0080	0.0105	0.0000	0.0115
Mn	0.1400	0.1831	0.0000	0.2005
S	0.0030	0.0047	0.0025	0.0049
V	0.0100	0.0131	0.0014	0.0142
Cr	0.0120	0.0157	0.0017	0.0170
C	0.0200	5.0000	0.0000	3.5423
Tot	100.0	100.0	100.0	100.0

Table 13.2-10.: Estimated composition of DRI, EAF slag, Pig Iron in case of use of LS acid pellets from IOC

Note: where noted with *, element present in Pig Iron as metal and not oxide

As seen in the previous case for the IOC pellet DR grade, the result of this metallurgical simulation returns a composition of iron ore not in line with the spec of the high purity NPI because of the manganese content, the only element that is exceeding the ranges required for NPI.

Poltrava, #1, Ukraine

The following table presents the estimated composition of DRI, EAF slag and pig iron in case of use of IO pellet BF grade from Poltrava based on the process described in Section 8.

Poltrava #1	IO pellet	DRI	EAF slag	Pig Iron
Fe tot	65.0000			
Fe met	0.0000	79.0822	0.0000	95.7566
Fe2O3	90.4536	0.0000	0.0000	0.0000
FeO	2.2314	6.4940	5.1952	0.0000
SiO2	5.8000	7.5070	42.0589	0.3686
CaO	0.3500	0.4530	33.2323	0.0000
MgO	0.6000	0.7766	16.1162	0.0000
Al2O3	0.3000	0.3883	2.1425	0.0000
TiO2	0.0350	0.0453	0.2500	0.0050
K2O	0.0200	0.0259	0.1428	0.0007
Na2O	0.1200	0.1553	0.8570	0.0000
P	0.0110	0.0142	0.0000	0.0163
Mn	0.0350	0.0453	0.0000	0.0519
S	0.0020	0.0034	0.0018	0.0036
V	0.0100	0.0129	0.0015	0.0146
Cr	0.0120	0.0155	0.0018	0.0175
C	0.0200	5.0000	0.0000	3.7652
Tot	100.0	100.0	100.0	100.0

Table 13.2-11.: Estimated composition of DRI, EAF slag, Pig Iron in case of use of BF pellets from Poltrava

Note: where noted with *, element present in Pig Iron as metal and not oxide

The result of this metallurgical simulation returns a composition of iron ore in line with the spec of the high purity NPI of T35 grade.

Kostomuksha, Russia

The following table presents the estimated composition of DRI, EAF slag and pig iron in case of use of IO pellet fluxed from Kostomuksha, based on the process described in Section 8.

Kostomuksha	IO pellet	DRI	EAF slag	Pig Iron
Fe tot	63.5000			
Fe met	0.0000	76.8268	0.0000	95.6074
Fe2O3	90.3413	0.0000	0.0000	0.0000
FeO	0.4027	6.3088	5.0470	0.0000
SiO2	5.0000	6.4355	28.2152	0.3587
CaO	3.2000	4.1187	49.2648	0.0000
MgO	0.3000	0.3861	13.8287	0.0000
Al2O3	0.3500	0.4505	1.9292	0.0000
TiO2	0.1000	0.1287	0.5512	0.0030
K2O	0.1500	0.1931	0.8268	0.0020
Na2O	0.0600	0.0772	0.3307	0.0000
P	0.0150	0.0193	0.0000	0.0228
Mn	0.0400	0.0515	0.0000	0.0608
S	0.0050	0.0073	0.0039	0.0077
V	0.0030	0.0039	0.0004	0.0045
Cr	0.0130	0.0167	0.0019	0.0193
C	0.0200	5.0000	0.0000	3.9139
Tot	100.0	100.0	100.0	100.0

Table 13.2-12.: Estimated comp. of DRI, EAF slag, Pig Iron in case of use of fluxed pellets from Kostomuksha

Note: where noted with *, element present in Pig Iron as metal and not oxide

The result of this metallurgical simulation returns a composition of iron ore in line with the spec of the high purity NPI of Triple Five.

Shougang Hierro Peru DR, Peru

The following table presents the estimated composition of DRI, EAF slag and pig iron in case of use of IO pellet from Shougang Hierro Peru, based on the process described in Section 8.

Shougang DR	IO pellet	DRI	EAF slag	Pig Iron
Fe tot	68.0000			
Fe met	0.0000	84.3402	0.0000	96.2139
Fe2O3	96.7751	0.0000	0.0000	0.0000
FeO	0.4027	6.9257	5.5406	0.0000
SiO2	1.5000	1.9792	14.0854	0.2394
CaO	0.2500	0.3299	52.0989	0.0000
MgO	0.5500	0.7257	24.0047	0.0000
Al2O3	0.2500	0.3299	2.1753	0.0000
TiO2	0.0800	0.1056	0.6961	0.0030
K2O	0.0400	0.0528	0.3480	0.0030
Na2O	0.1200	0.1583	1.0441	0.0000
P	0.0100	0.0132	0.0000	0.0142
Mn	0.0200	0.0264	0.0000	0.0285
S	0.0060	0.0087	0.0044	0.0089
V	0.0100	0.0132	0.0014	0.0141
Cr	0.0070	0.0092	0.0010	0.0098
C	0.0200	5.0000	0.0000	3.4652
Tot	100.0	100.0	100.0	100.0

Table 13.2-13.: Estimated comp. of DRI, EAF slag, Pig Iron in case of use of pellets from Hierro Peru

Note: where noted with *, element present in Pig Iron as metal and not oxide

The result of this metallurgical simulation returns a composition of iron ore in line with the spec of the high purity NPI of Triple five and with a further addition of lime after EAF tapping, the S level can be brought back below the value of 0.006%, so that it is possible to achieve the grade of T35. It is interesting to note that the IO pellets proceeding from this source have a very low value of Manganese

Shougang Hierro Peru BF, Peru

The following table presents the estimated composition of DRI, EAF slag and pig iron in case of use of IO pellet from Shougang Hierro Peru, based on the process described in Section 8.

Shougang BF	IO pellet	DRI	EAF slag	Pig Iron
Fe tot	65.8500			
Fe met	0.0000	80.6176	0.0000	95.9080
Fe2O3	92.7190	0.0000	0.0000	0.0000
FeO	1.2865	6.6201	5.2960	0.0000
SiO2	3.9500	5.1445	27.5504	0.3289
CaO	0.4000	0.5210	41.5585	0.0000
MgO	0.8400	1.0940	20.6438	0.0000
Al2O3	0.4000	0.5210	2.7085	0.0000
TiO2	0.0900	0.1172	0.6094	0.0030
K2O	0.0700	0.0912	0.4740	0.0030
Na2O	0.1700	0.2214	1.1511	0.0000
P	0.0100	0.0130	0.0000	0.0147
Mn	0.0200	0.0260	0.0000	0.0293
S	0.0080	0.0112	0.0059	0.0117
V	0.0100	0.0130	0.0014	0.0144
Cr	0.0070	0.0091	0.0010	0.0101
C	0.0200	5.0000	0.0000	3.6769
Tot	100.0	100.0	100.0	100.0

Table 13.2-14.: Estimated comp. of DRI, EAF slag, Pig Iron in case of use of pellets from Hierro Peru

Note: where noted with *, element present in Pig Iron as metal and not oxide

The result of this metallurgical simulation returns a composition of iron ore in line with the spec of the high purity NPI of Triple Five. Also in this case it is possible to reduce of about 50% the level of Sulfur with a mild desulfurization based on lime additions after tapping the EAF, so also in the case of BF pellet coming from Hierro Peru, the T35 grade is possible to be achieved

13.2.2.3 Conclusions for Pig Iron quality achievable

The metallurgical simulations presented in this chapter confirm that PURE FONTE LTÉE will be able to produce high purity pig iron to the grades of T35 and Triple five, using as raw material the Canadian pellets of AMMC

Moreover, the metallurgical simulation has been run also considering IO pellets of other sources and the NPI grades are achievable also using pellets proceeding from European and south American suppliers.

This is an important factor, because it allows PURE FONTE LTÉE to guarantee production continuity in case of temporary interruptions of supply from its Canadian sources

	Origin	IO pellet grade	MPI grade achievable	Note
AMMC BBS	Canada	DR grade	T35, Triple Five	
AMMC BMC	Canada	BF grade	Triple Five	
AMMC BAF	Canada	BF grade	Triple Five	
IOC-DR	Canada	DR grade	Basic	High Mn
IOC-LS acid	Canada	BF grade	Basic	High Mn
Poltrava	Ukraine	BF grade	T35, Triple five	
Kostomuksha	Russia	BF grade	Triple Five	
Hierro Peru	Peru	DR grade	T35, Triple five	
Hierro Peru	Peru	BF grade	T35, Triple five	