



Pig Iron: a value-adding feedstock for ferrous casting

AFS METALCASTING CONGRESS, APRIL 2018

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Presentation overview

- What is IIMA and what does it do?
- Types of merchant pig iron
- Pig iron production process
- Merchant pig iron supply, trade and value chain
- Benefits of using pig iron in ferrous casting
- Prevention of value leakage in transport, handling & storage

What is IIMA?

Created in 2011 as the unified voice of the ore-based metallics industry



Types of merchant pig iron

Typical Pig iron Characteristics - % by weight					
Pig iron Type	C	Si	Mn	S	P
Basic	3.5 - 4.5	≤1.25	≤1.0	≤0.05	0.08-0.15
Foundry	3.5 - 4.1	2.5 - 3.5	0.5 - 1.2	≤0.04	≤0.12
HPPI/Nodular	3.7 - 4.7	0.05 -1.5	≤0.05	≤0.025	≤0.035
Various tighter specifications are available from specific producers					
Ingots typically weigh 7.5 to 12 kg					
Dimensions vary from producer to producer, e.g. 17.5 x 13.5 x 16 cm, 20 x 15 x 5 cm					

Pig iron production process – BF route

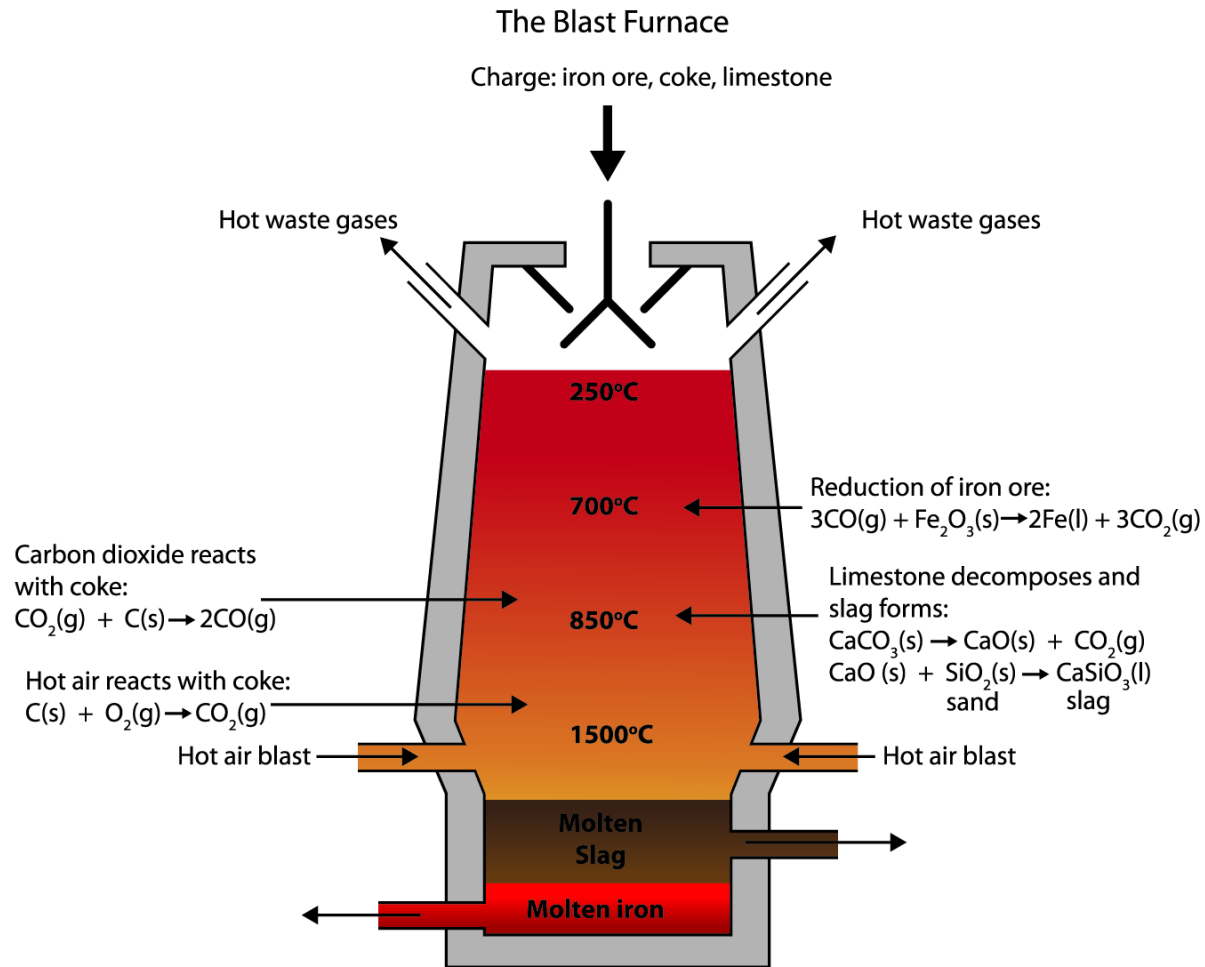


Image: DK Recycling

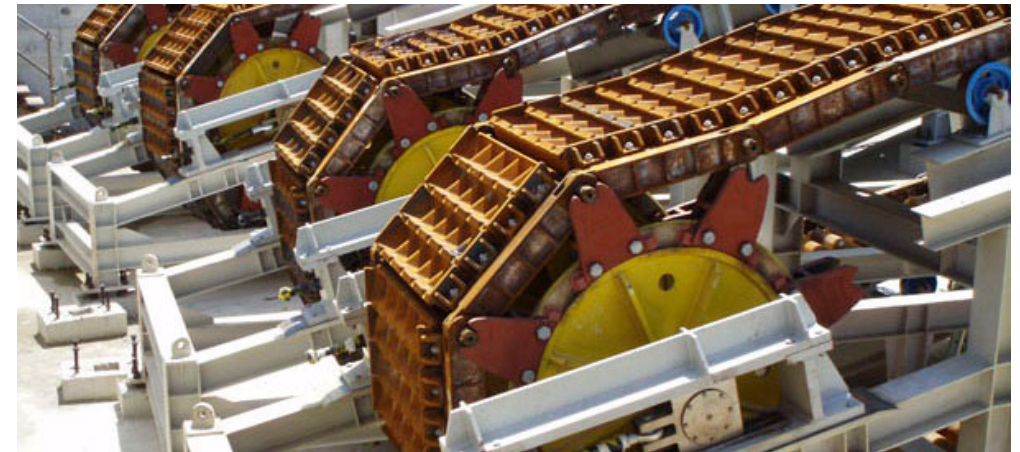
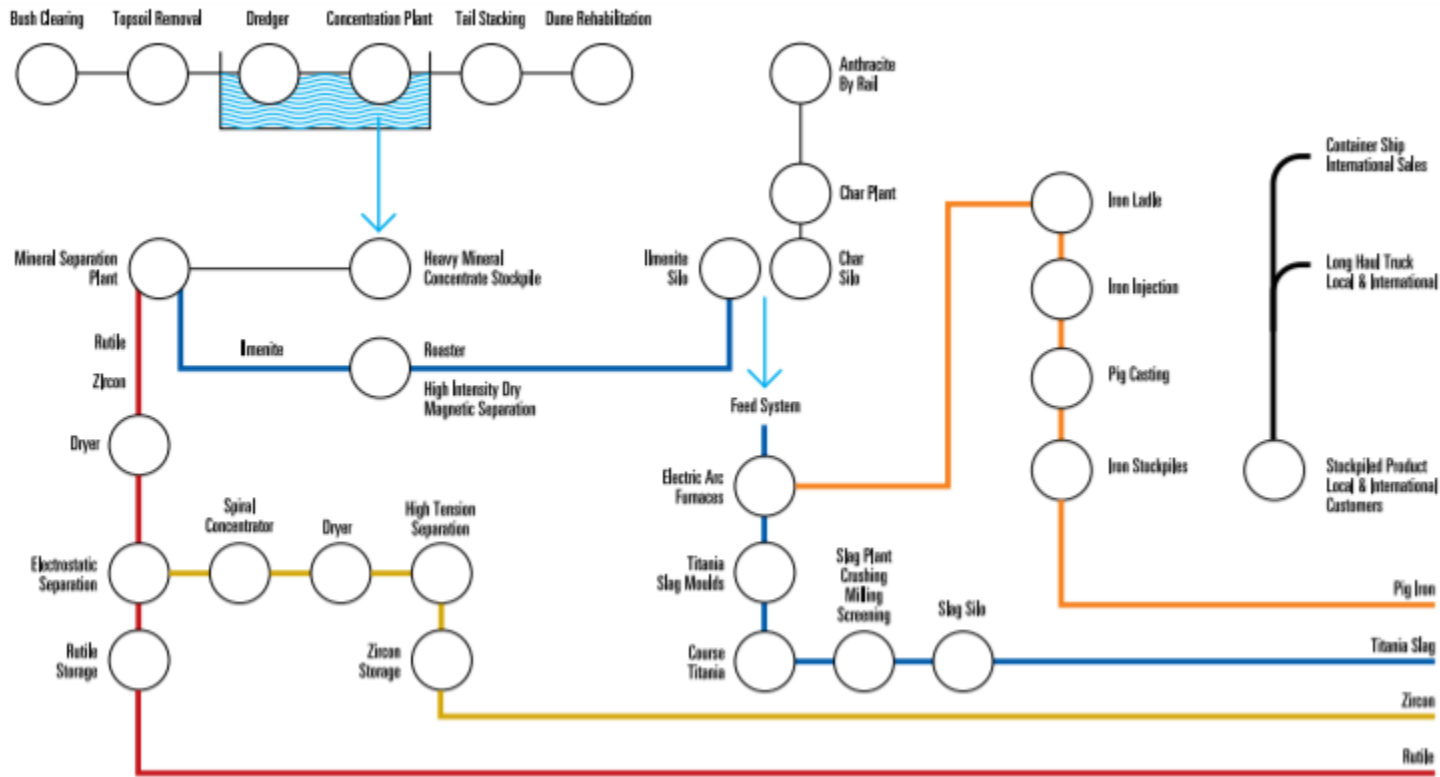


Image: Paul Wurth

Pig iron production process – ilmenite route

Richards Bay Minerals production flowsheet



Source: RBM Sustainable Development Report 2015



Image: Rio Tinto Iron & Titanium, Sorel Tracy

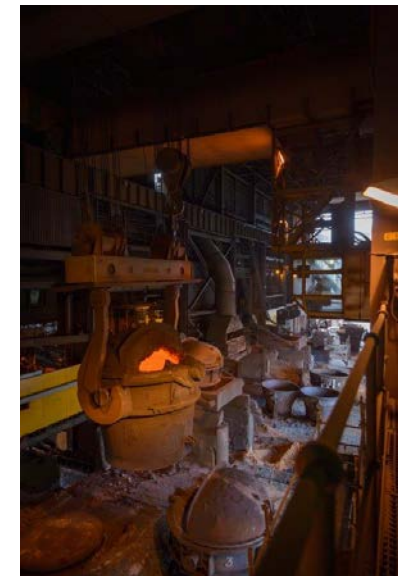
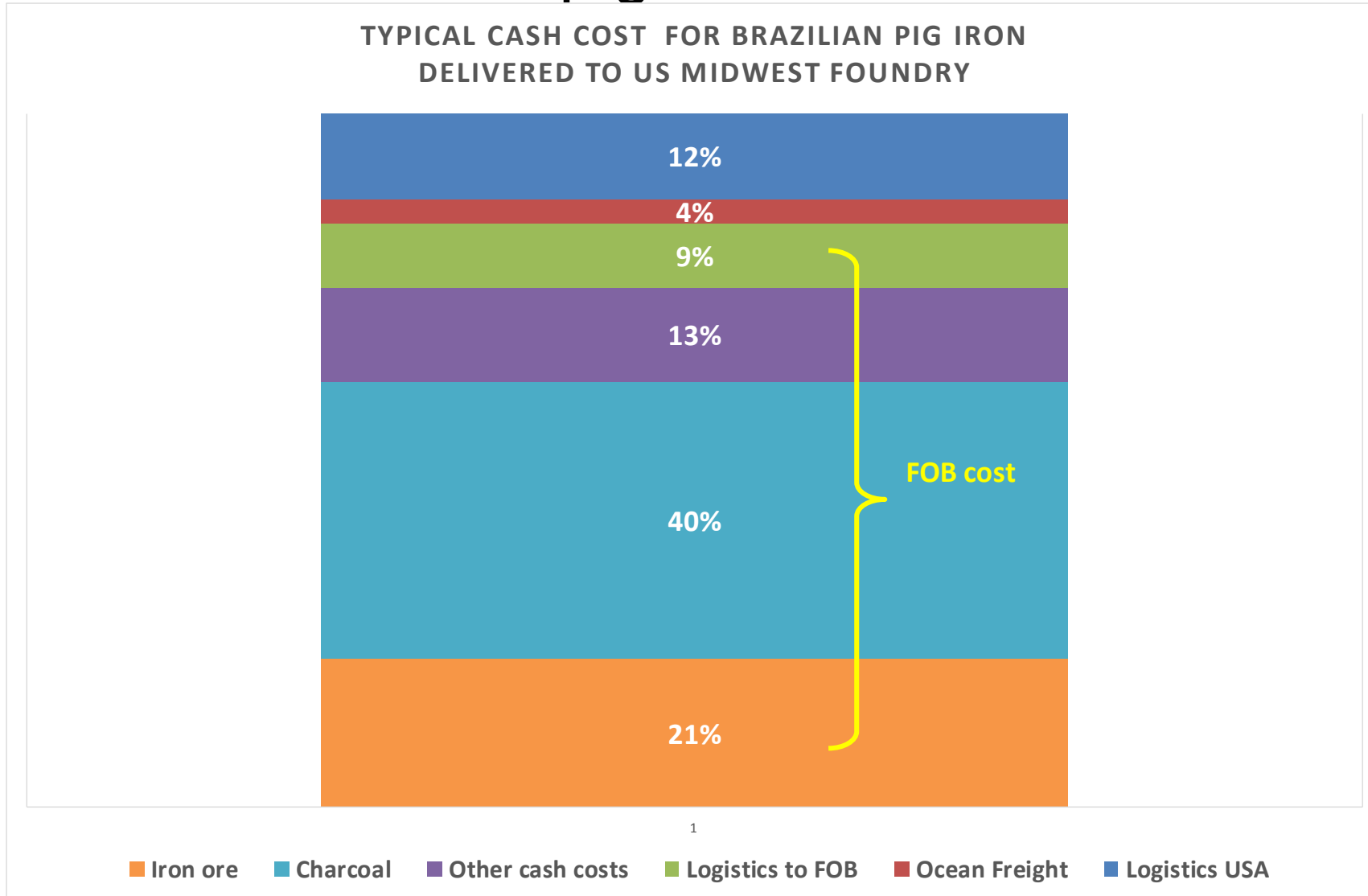


Image: Richards Bay Minerals

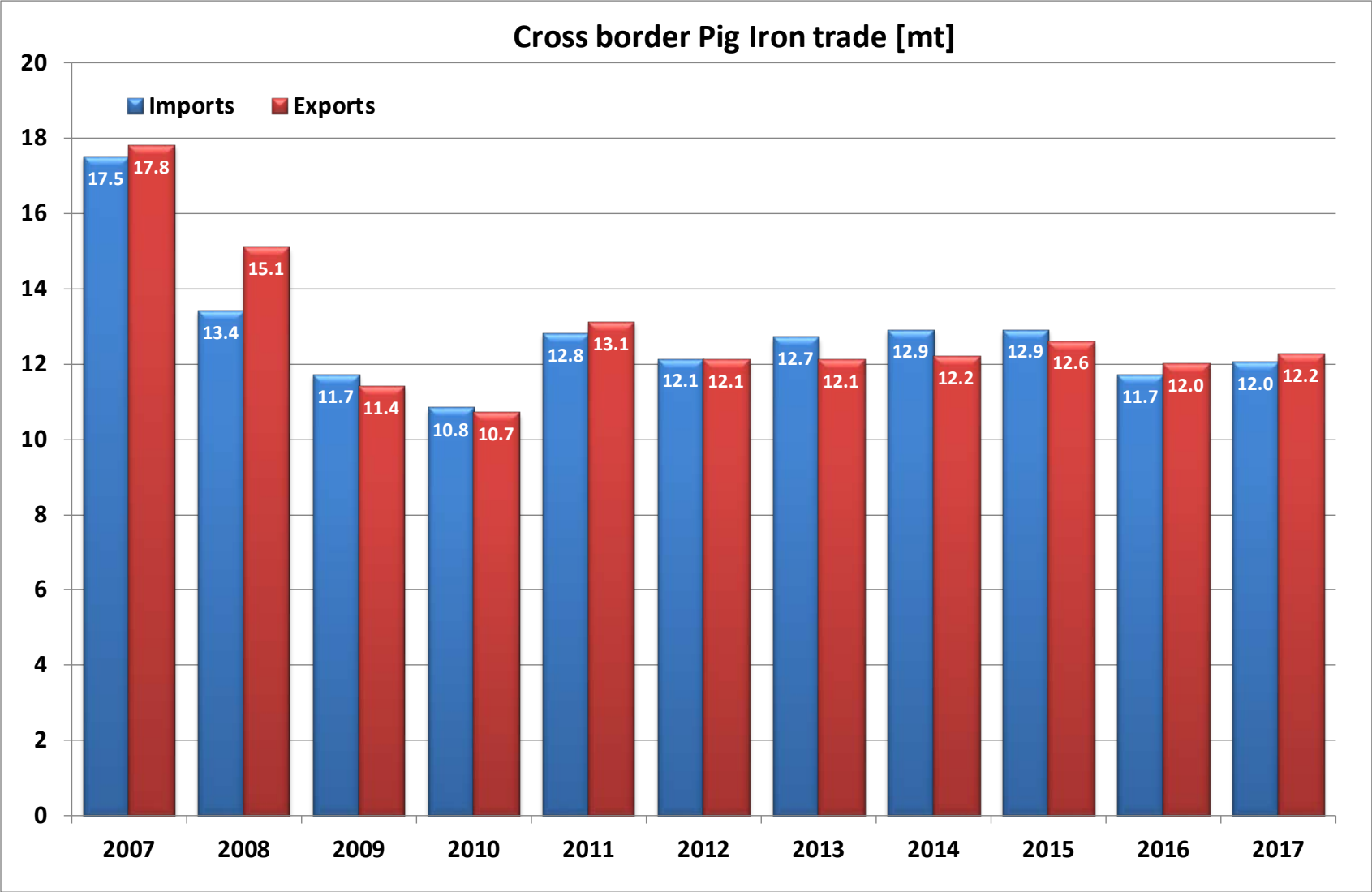
Merchant pig iron value chain



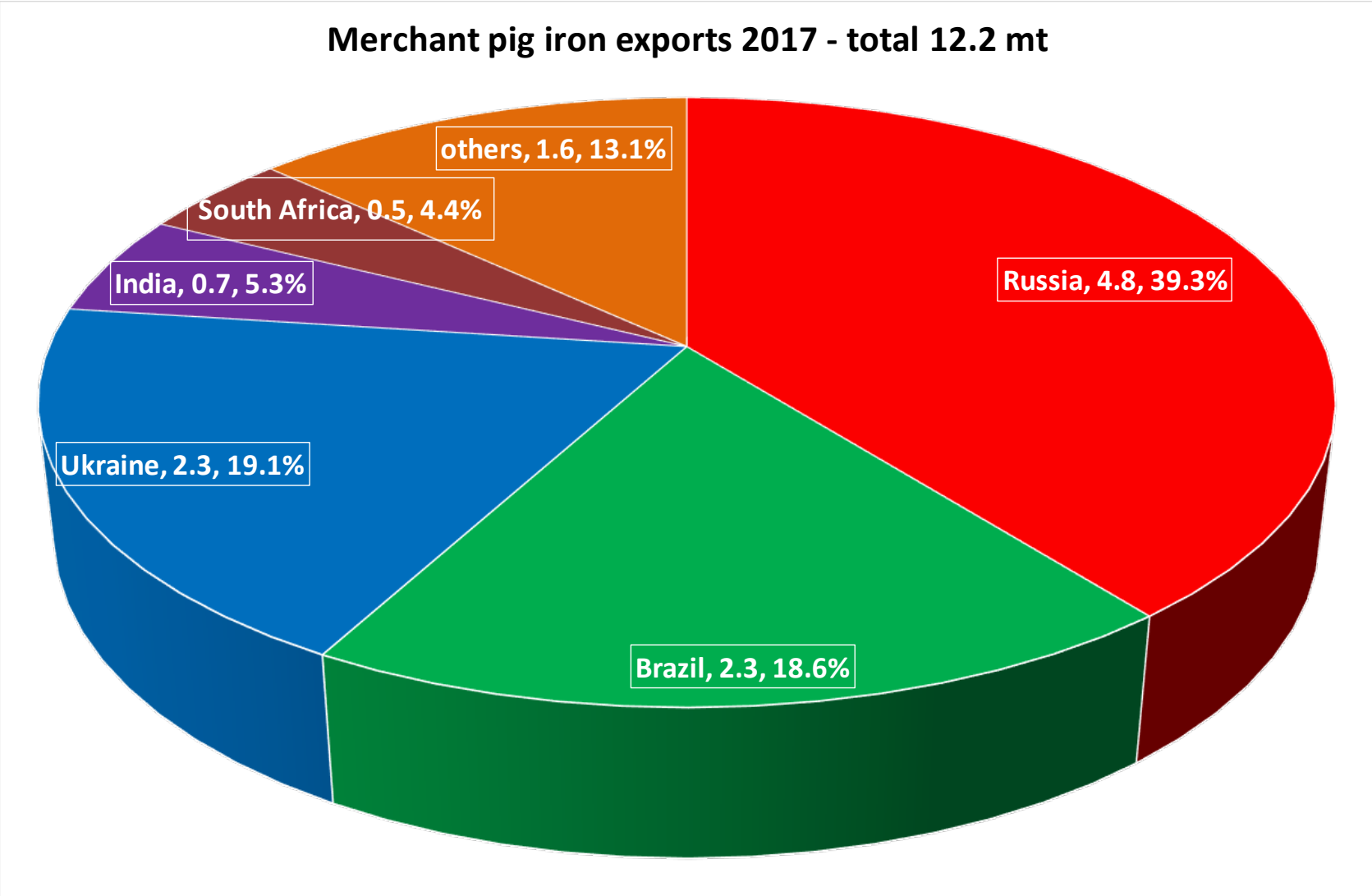
Factors affecting pig iron quality

- Raw material specification: iron ore, coke, etc.
 - P, Si, Mn, trace elements, etc.
- Consistency of raw material quality
- Accuracy of raw material analysis
- Production process control
- Material handling and storage
 - fines & chips, dust, rust

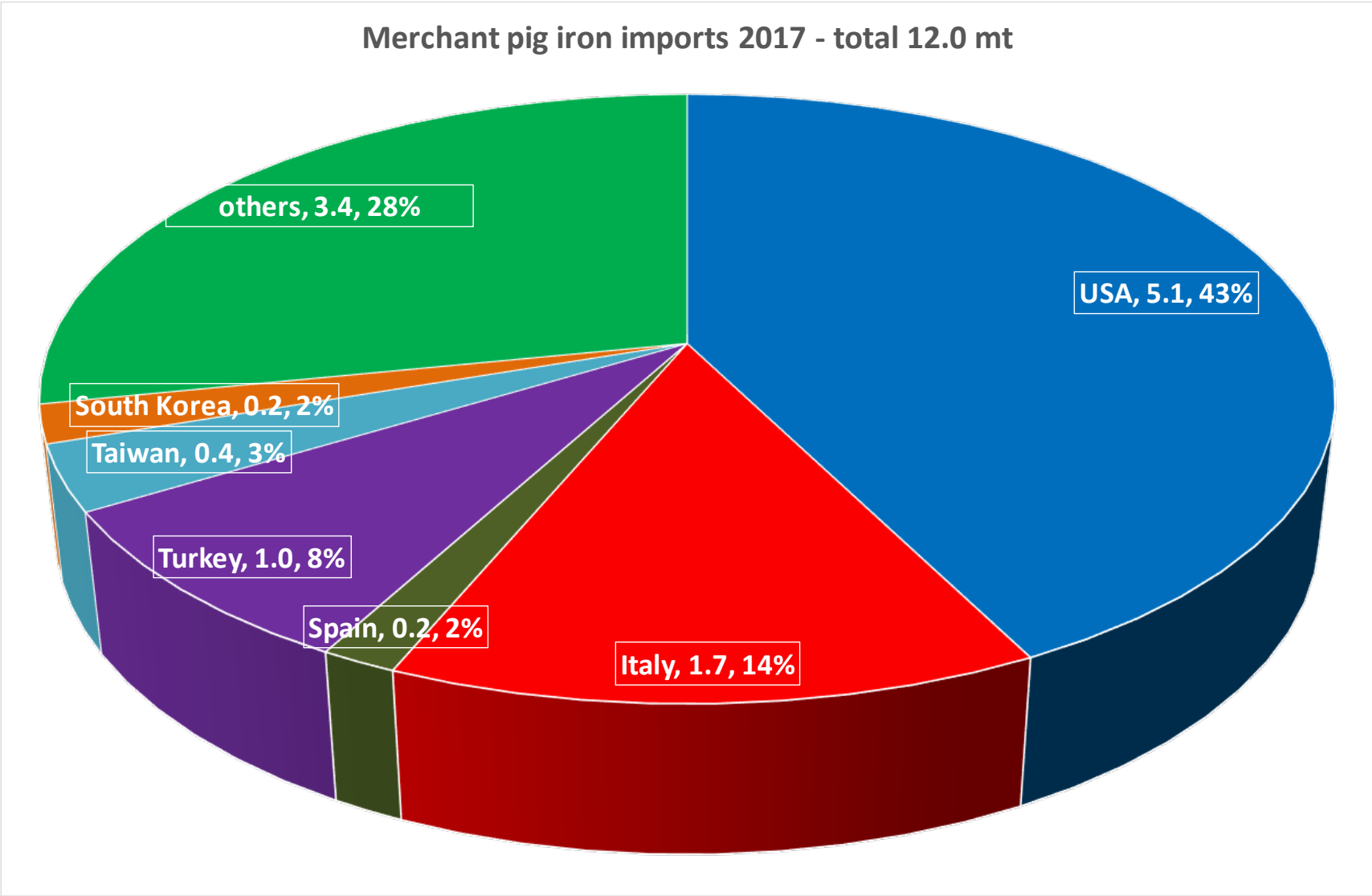
Merchant pig iron trade



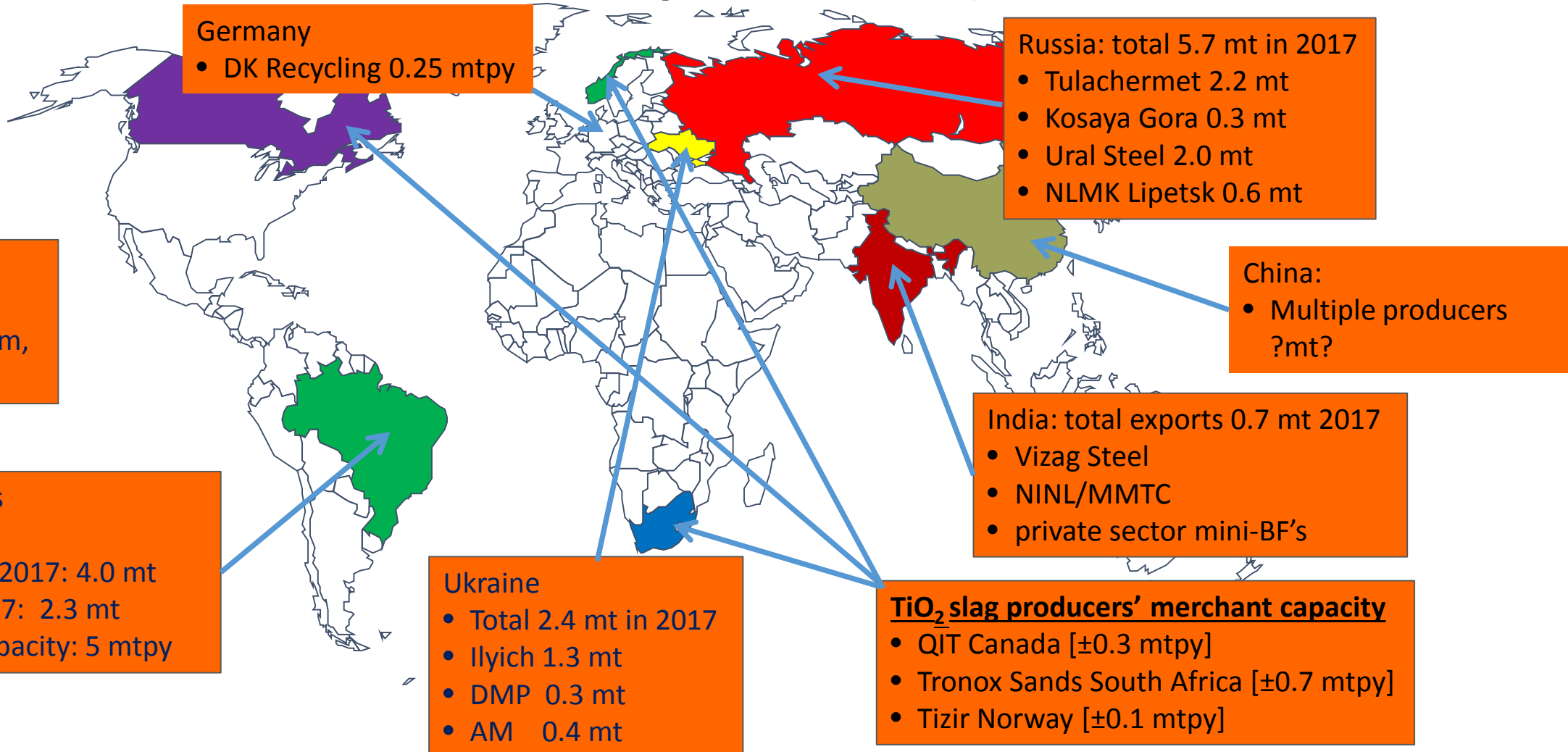
Merchant pig iron export distribution



Merchant pig iron import distribution



Merchant pig iron supply



MERCHANT PIG IRON PRODUCING COUNTRIES

New pig iron supply projects in North America

- North Atlantic Iron Corp: planning 0.425 mt merchant pig iron plant, based on purchased iron ore pellets, considering two locations, in Quebec and Ohio.
- Republic Steel / ERP Iron Ore joint venture: plan is to restart the blast furnace at Lorain, OH and sell 1 mt pig iron, based on pellets from ERP's Reynolds, IN pellet plant.
- BlackRock Metals: plans to exploit V- and Ti- bearing magnetite and ilmenite deposits in Chibougamau, Quebec to produce ferro-vanadium, TiO_2 feedstock and potentially 0.525 mt high purity pig iron

Benefits of using pig iron in ferrous casting

- Being manufactured from selected iron ore or ilmenite sources, Pig Iron has a consistent and predictable chemical and physical analysis which allows better control and variability of melting, tighter control of final casting composition and removes the requirement for costly heat treatment of castings.
- Pig Iron is low in metallic impurities such as copper, tin, chromium, nickel, vanadium, etc. which may be detrimental to the manufacture of certain cast iron qualities and, as such, dilutes such impurities in scrap or enables greater use of cheaper, lower grade scrap.
- Pig Iron is virtually 100% metallic = minimal slag (scrap can be <90% metallic iron) & minimal yield loss.

Comparison of residuals

Typical residual contents in scrap and OBM's

EU steel scrap specifications				
Category	Grade	Cu %	Sn %	Cr, Ni, Mo %
Old scrap	E3	≤ 0.250	≤ 0.010	Σ ≤ 0.250
	E1	≤ 0.400	≤ 0.020	Σ ≤ 0.300
New scrap, low residuals, uncoated	E2	Σ ≤ 0.300		
	E8	Σ ≤ 0.300		
	E6	Σ ≤ 0.300		
Shredded	E40	Σ ≤ 0.250	Σ ≤ 0.020	
Steel turnings	E5M	≤ 0.400	Σ ≤ 0.030	Σ ≤ 1.0
High residual scrap	EHRB	≤ 0.450	Σ ≤ 0.030	Σ ≤ 0.350
	EHRM	≤ 0.400	Σ ≤ 0.030	Σ ≤ 1.0
Fragmented scrap from incineration	E46	≤ 0.500	≤ 0.070	
Ore-based metallics *	pig iron, DRI, HBI	0.002	trace	Σ ≤ 0.015
* Dependent on source iron ore				

Source: EuRIC - EFR



Benefits of using pig iron in ferrous casting

- Pig iron will facilitate the production of as-cast ferritic ductile grades and in particular those grades which require good low temperature impact properties.
- The use of pig iron in the electric induction furnace will allow accurate and consistent charge calculations and provide faster melting rates.
- Pig iron is available in a variety of qualities to suit all iron foundry requirements.

Benefits of using pig iron in ferrous casting

- Lower energy consumption when using pig iron compared to steel scrap in electric melting furnaces (Donsbach, 2006). The lower melting temperature and higher charge density can result in KW man hours per tonne reductions of up to 10% when adding 10 - 20 % pig iron to the charge at the beginning of the melting cycle
- Higher metallic recoveries have been observed when using pig iron compared to steel scrap (Trueba, 2005). Low *surface area:volume* ratios play an important role in the metallic recovery of charge materials, higher ratios generally result in lower metallic recoveries. Steel scrap has typically three times the SA:V ratio of pig iron
- Clean charge. Pig iron is generally free from extraneous materials such as oil and dirt, which can produce noxious fumes and harmful slag.

Fact Sheets

What are Ore Based Metallics (OBM's)

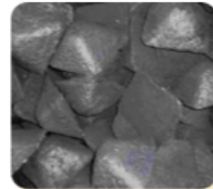
- Direct Reduced Iron (DRI), Hot Briquetted Iron (HBI) and Pig Iron are Ore Based Metallics (OBM's), manufactured from iron ore or titanium-bearing mineral sands (High Purity Pig Iron HPPI, also known as Nodular or Spheroidal Graphite Pig Iron, is produced from smelting of ilmenite)
- OBM's are best used as scrap supplements to dilute impurities in ferrous scrap in EAF steelmaking and iron casting
- OBM's can be used as productivity enhancers in blast furnace (BF) or as trim coolant in the basic oxygen furnace (BOF) steelmaking



Direct Reduced Iron



Hot Briquetted Iron



Pig Iron

Typical Benefits of OBMs in Steelmaking, Ironmaking and Iron Foundries

- Consistent quality and low residual content, e.g. copper, allows dilution of impurities in scrap
- Controlled carbon content, consistent carbon recovery
- Predictable mass and heat balances
- Can be continuously charged to the furnace (DRI and HBI)
- High density can reduce the number of bucket charges, allows for increased use of lower cost, less dense feedstock and reduces storage space requirements
- Better slag foaming
- Easier on hearth refractory & electrodes
- Higher value-in-use for many steel products in comparison to scrap
- Increased flexibility in feedstock supply

The Use of Foundry Pig Iron in Grey Iron Castings

- Pig iron is produced mainly by the smelting of iron ore in blast furnaces with coke or charcoal as reductant. It is a high Fe, low residual metallic material and should not be considered as a scrap substitute, but rather as a source of clean iron units that can be used to supplement and enhance the scrap charge. Many foundries prefer to use Pig Iron to blend with scrap and other feedstock materials due to its high Fe content, low gangue, low residual impurities and chemical purity.
- Foundry Pig Iron [also known as hematite pig iron] is differentiated from steelmaking Basic Pig Iron by its higher silicon content which is derived from the source raw materials and/or from ferro-alloy additions.
- Low residual impurities dilute undesirable elements such as chromium, vanadium, lead and titanium in the melt and offer the potential for use of a higher proportion of lower grade, lower cost scrap.

Foundry Pig iron Characteristics - % by weight					
Pig iron Type	C	Si	Mn	S	P
Basic	3.5 - 4.5	≤1.25	≤1.0	≤0.05	0.08-0.15
Foundry	2.8 - 4.2	1.0 - 4.0	0.5 - 1.2	≤0.04	≤0.12
HPPI	3.7 - 4.7	0.05 - 1.5	≤0.05	≤0.025	≤0.035
Various tighter specifications are available from specific producers					
Ingot weight is typically 7.5-14 kg					
Ingot dimensions vary from producer to producer, examples being 17.5 x 13.5 x 16 cm and 20 x 15 x 5 cm.					

- Being manufactured from selected iron ore sources, Foundry Pig Iron has a consistent and predictable chemical and physical analysis which allows better control and variability of melting, tighter control of final casting composition and removes the requirement for costly heat treatment of castings.



Use of High Purity Pig Iron for Foundries Producing Ductile Iron Castings

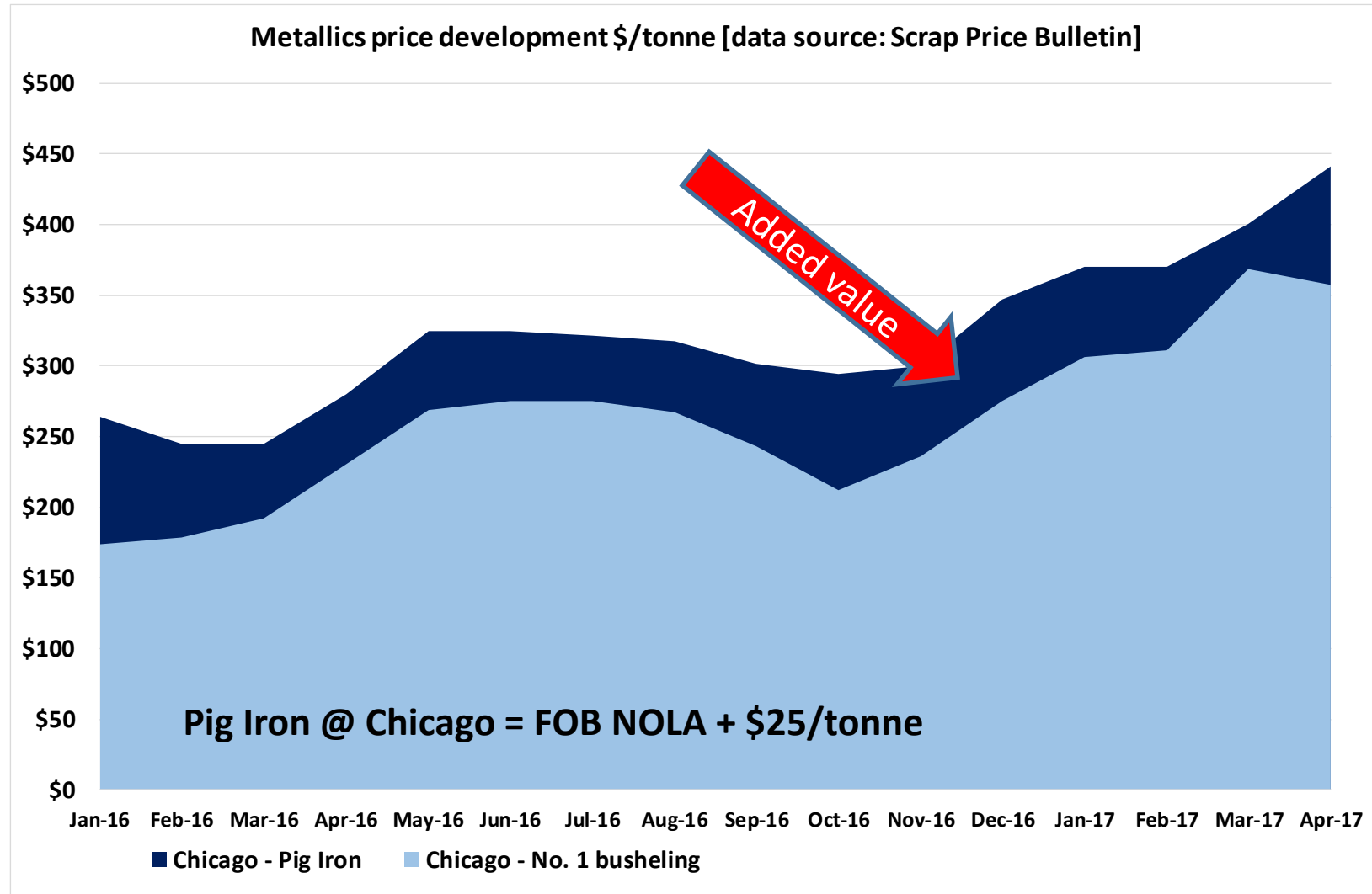
High Purity Pig Iron (HPPI) is differentiated from other types of pig iron by its low manganese, phosphorus and sulphur contents. HPPI is manufactured from the smelting of ilmenite sand in electric furnaces to produce titanium dioxide slag and pig iron. Production facilities are located in South Africa, Canada, Norway and elsewhere. HPPI constitutes the principal ferrous feedstock material for production of ductile iron castings (also known as nodular or spheroidal graphite iron) used in high quality automotive, engineering and energy casting components.

High Purity Pig iron Characteristics - % by weight					
Pig iron Type	C	Si	Mn	S	P
Basic	3.5 - 4.5	≤1.25	≤1.0	≤0.05	0.08-0.15
Foundry	3.5 - 4.1	2.5 - 3.5	0.5 - 1.2	≤0.04	≤0.12
HPPI	3.7 - 4.7	0.05 - 1.5	≤0.05	≤0.025	≤0.035
Various tighter specifications are available from specific producers					
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Aside from its low Mn, P and S contents, HPPI is also low in other undesirable impurity elements. Being manufactured from ilmenite mined on a large scale, HPPI has a consistent and predictable chemical and physical analysis.



Metallics price development



Avoid chips and fines generation

- Fines and chips can be generated along the supply chain:
 - handling and storage at the production site
 - loading into vessels, barges, railcars, etc.
 - during discharge of vessels, etc.
 - handling and storage at the steel plant
 - excess chips and fines impact furnace yield and productivity
 - fines and chips are more susceptible to oxidation
- Minimise the risk:
 - avoid unnecessary material handling
 - minimise transfer points and drops
 - don't overload conveyors and avoid spillage
 - minimise drop during loading – use soft loading techniques
 - careful handling with frontend loaders, etc.



Aspirations

- to be the collective voice of the OBM industry
- strong partnerships with customer industries
 - EAF steel through SMA in USA
 - metal casting through AFS in USA
- engagement with ferrous casting industry to establish informed value chains
- foundries welcome!
 - as members
 - as guests at our meetings

Contact Information



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