INTERNATIONAL IRON METALLICS ASSOCIATION

The Global Ore-based Metallics Market (with emphasis on DRI)

4TH INDIA INTERNATIONAL DRI SUMMIT - AUGUST 13TH 2018

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Presentation overview

- Introduction to IIMA
- Overview of Ore-Based Metallics Market [OBMs]
  - Price development snapshot
  - Cross border trade
  - DRI/HBI supply-side issues and new supply to the market
  - DR grade iron ore pellet supply
- Maritime regulations governing shipment of DRI/HBI

What is IIMA?

IPIA — INTERNATIONAL PIG IRON ASSOCIATION

+

HBIA — HOT BRIQUETTED IRON ASSOCIATION

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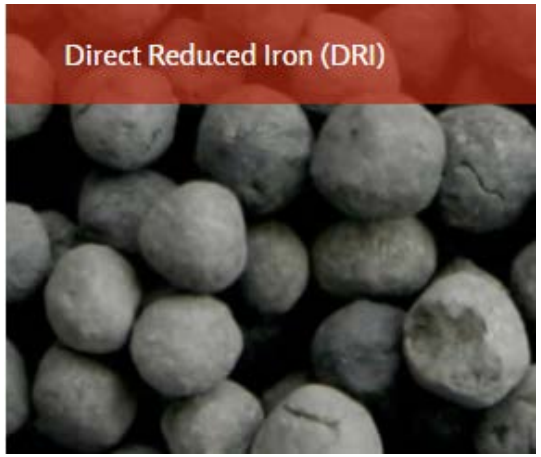
Created in 2011 as the unified voice of the ore-based metallics industry



What does IIMA do?

Communication

Getting the right messages to our stakeholders

Product & Market Support

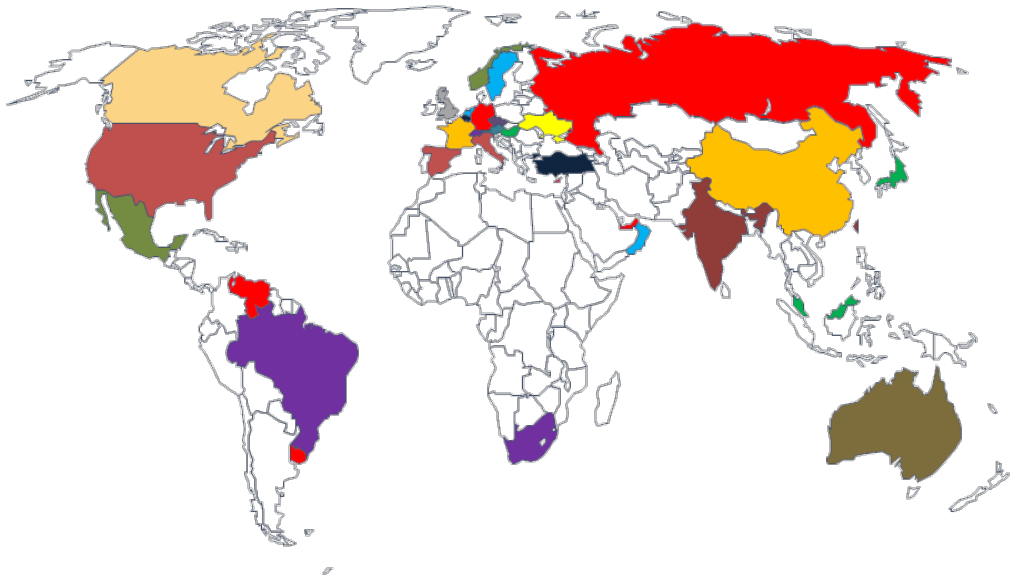
Product information & guides
Value-in-use model
Educational workshops & webinars

Regulatory Support

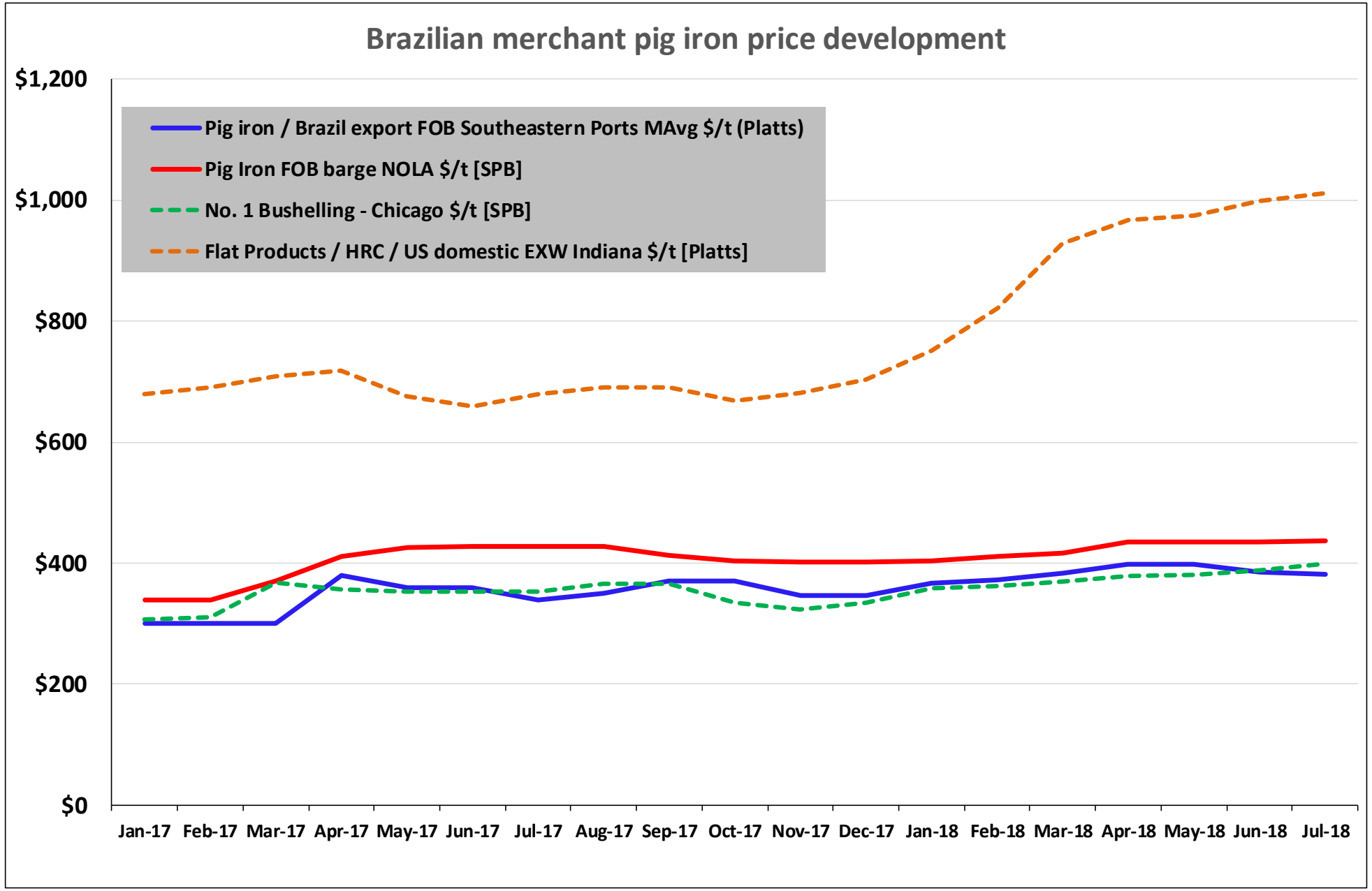
Chemical industry regulation (e.g. REACH)
Maritime regulation
Product stewardship

IIMA members cover the OBM value chain from raw materials to steel mill

- iron ore pellet producers
- pig iron, HBI and DRI producers
- traders and distributors
- OBM consumers
- technology suppliers
- plant and equipment suppliers
- shipping and logistics providers
- sampling and inspection providers
- project developers



... spanning the global supply chain ...


Brazilian merchant pig iron price development
$1,200
$1,000
$800
$600
$400
$200
$0
Pig iron / Brazil export FOB Southeastern Ports MAvg $/t (Platts)
Pig Iron FOB barge NOLA $/t [SPB]
No. 1 Bushelling - Chicago $/t [SPB]
Flat Products / HRC / US domestic EXW Indiana $/t [Platts]
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
Mar-18
Apr-18
May-18
Jun-18
Jul-18

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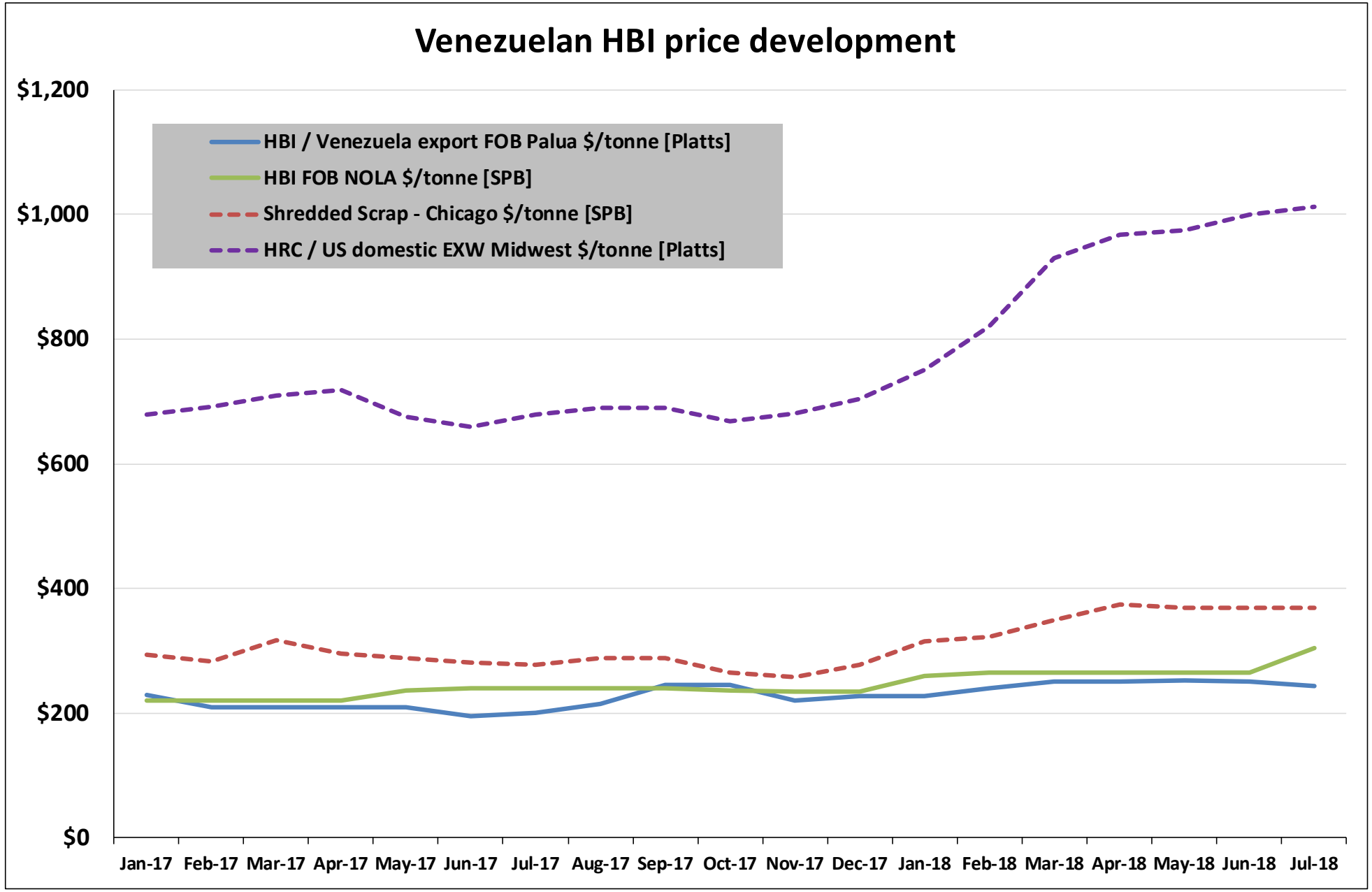
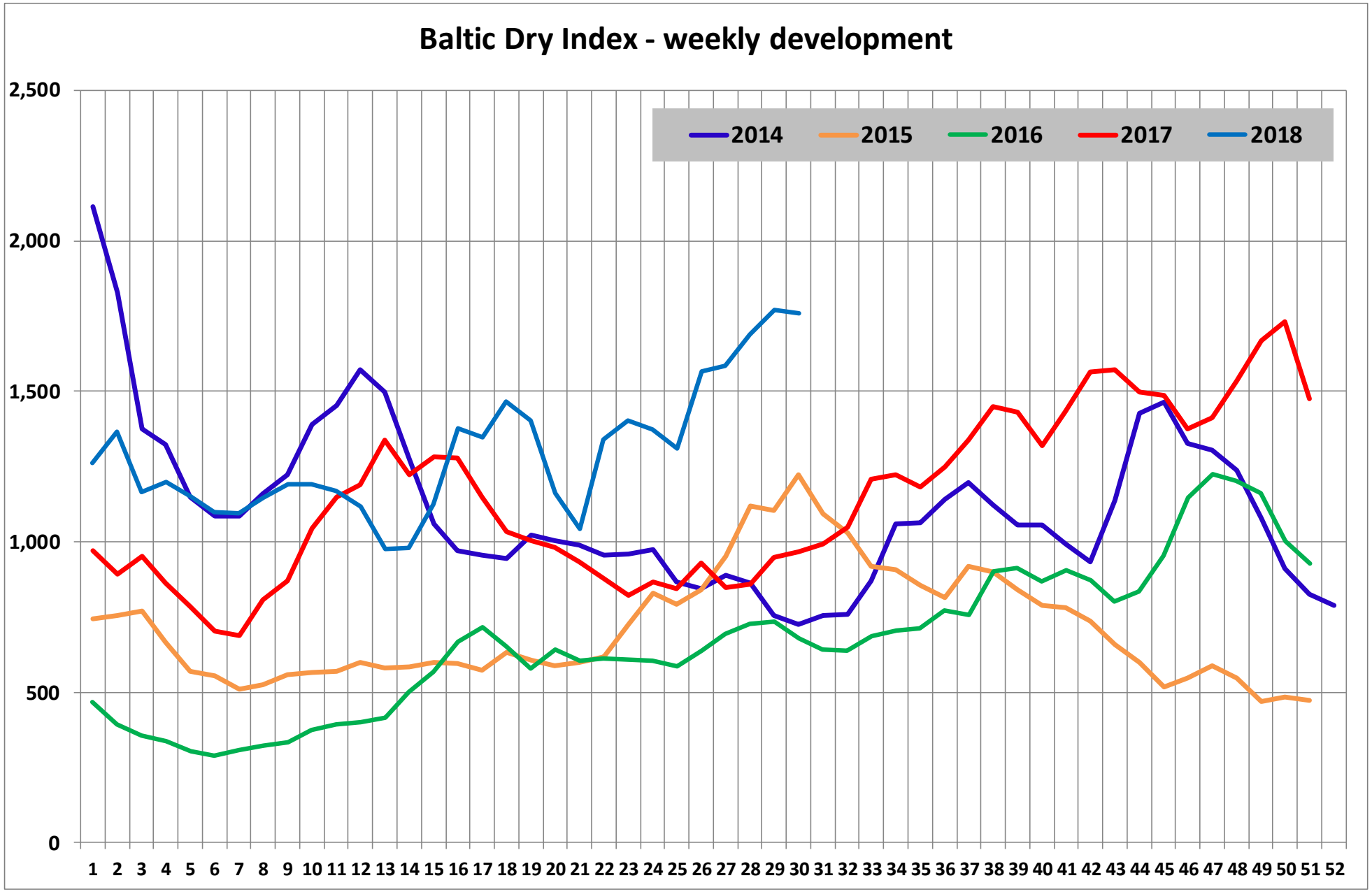
Venezuelan HBI price development

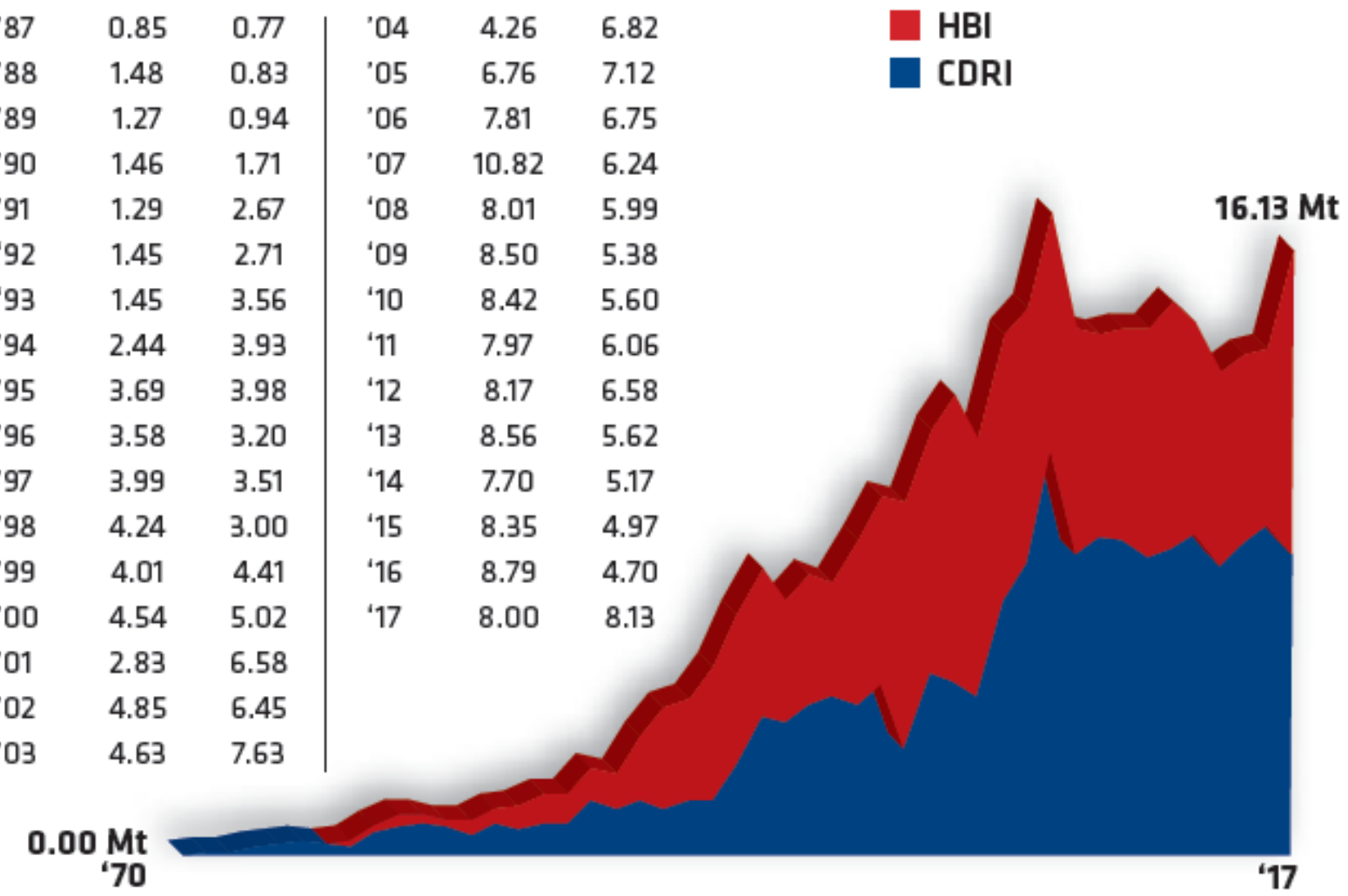



Baltic Dry Index - weekly development
2014
2015
2016
2017
2018
2,500
2,000
1,500
1,000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52

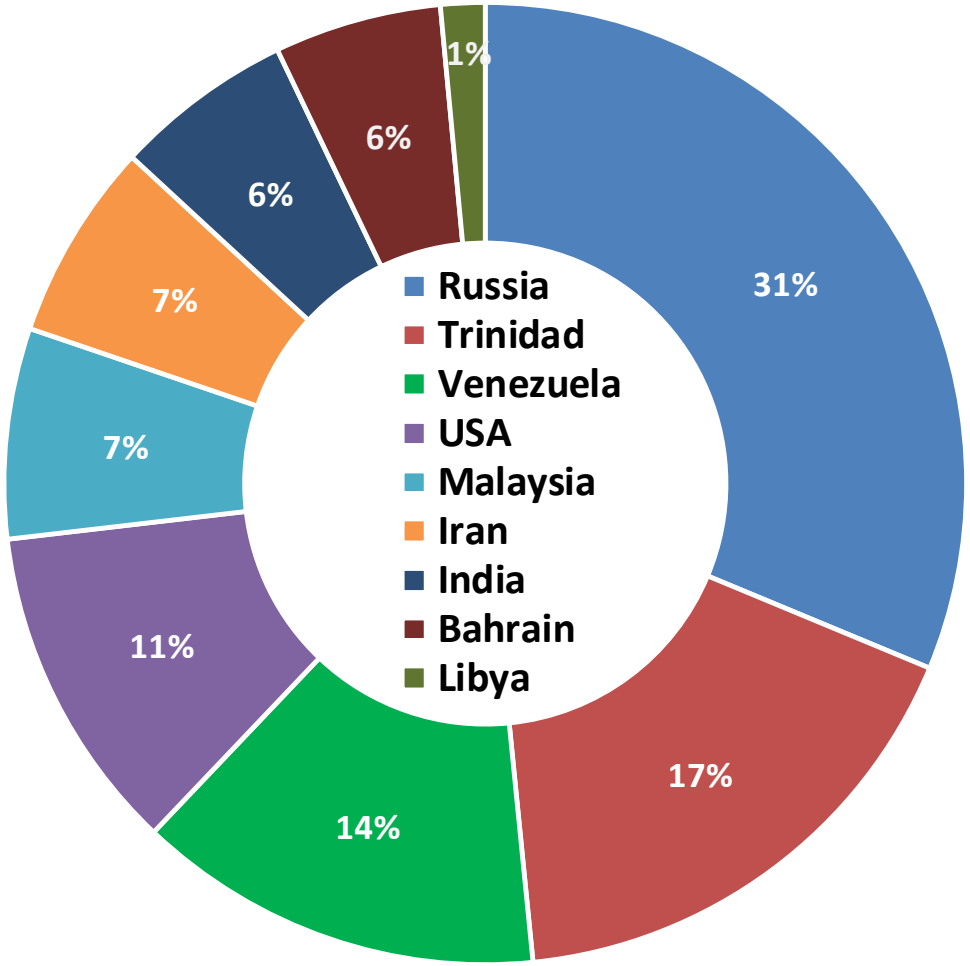
World DRI Shipments (Mt)

Source: Midrex Technologies, Inc.

Year	CDRI	HBI	Year	CDRI	HBI	Year	CDRI	HBI
1970	0.00	–	'87	0.85	0.77	'04	4.26	6.82
'71	0.04	–	'88	1.48	0.83	'05	6.76	7.12
'72	0.08	–	'89	1.27	0.94	'06	7.81	6.75
'73	0.13	–	'90	1.46	1.71	'07	10.82	6.24
'74	0.26	–	'91	1.29	2.67	'08	8.01	5.99
'75	0.34	–	'92	1.45	2.71	'09	8.50	5.38
'76	0.37	–	'93	1.45	3.56	'10	8.42	5.60
'77	0.32	–	'94	2.44	3.93	'11	7.97	6.06
'78	0.28	0.11	'95	3.69	3.98	'12	8.17	6.58
'79	0.66	0.12	'96	3.58	3.20	'13	8.56	5.62
'80	0.81	0.25	'97	3.99	3.51	'14	7.70	5.17
'81	0.83	0.25	'98	4.24	3.00	'15	8.35	4.97
'82	0.80	0.18	'99	4.01	4.41	'16	8.79	4.70
'83	0.59	0.36	'00	4.54	5.02	'17	8.00	8.13
'84	0.83	0.39	'01	2.83	6.58			
'85	0.71	0.61	'02	4.85	6.45			
'86	0.89	0.73	'03	4.63	7.63			

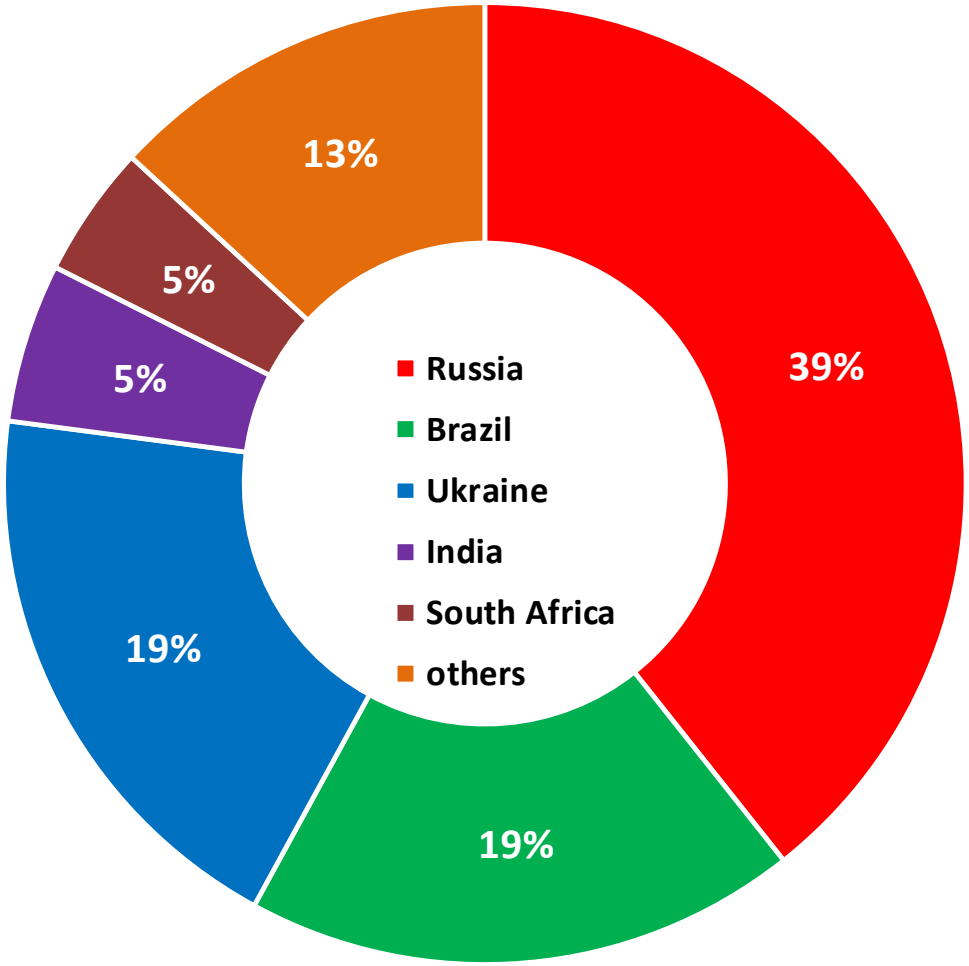


DRI/HBI exports 2017 - mt

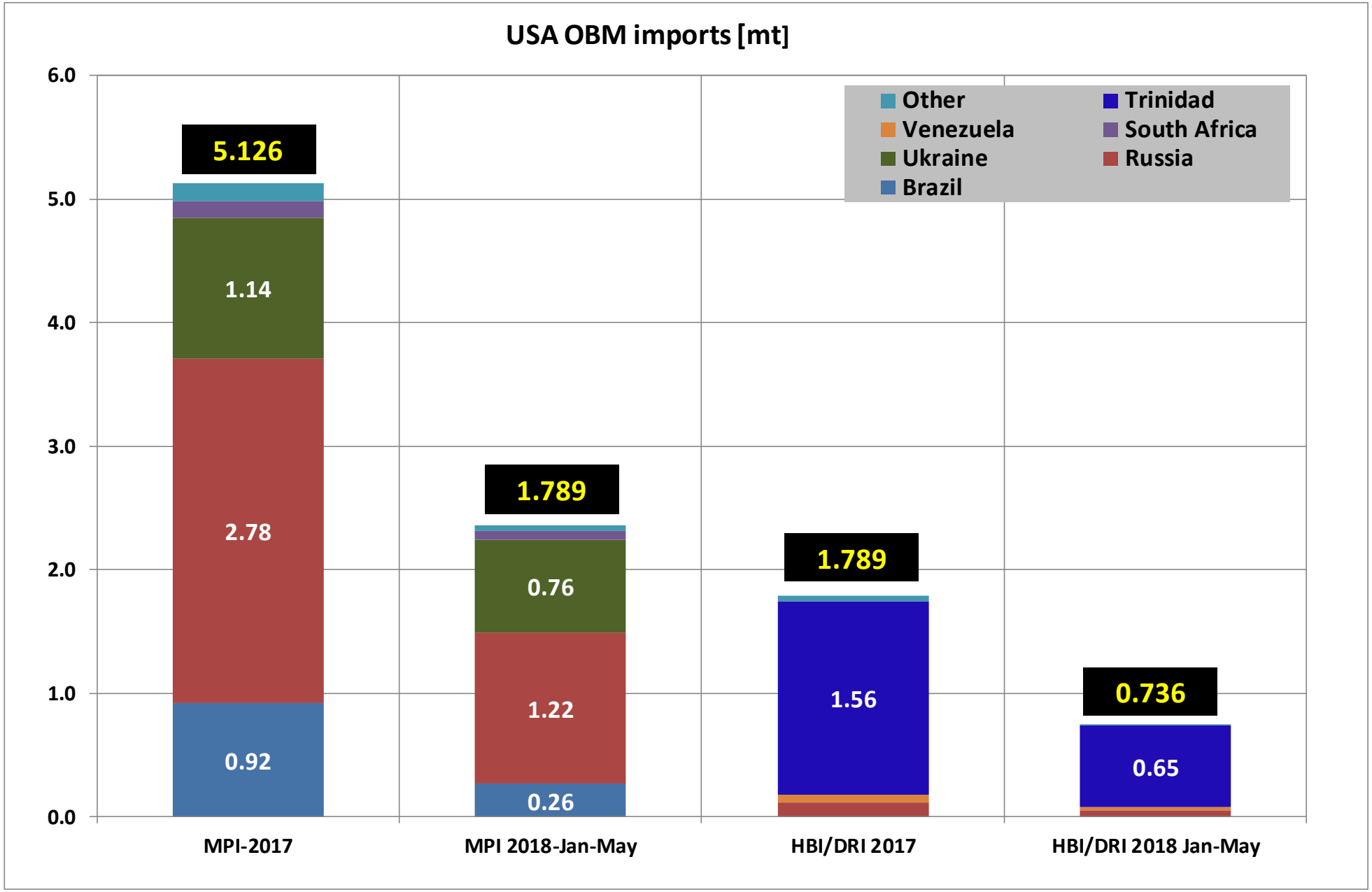


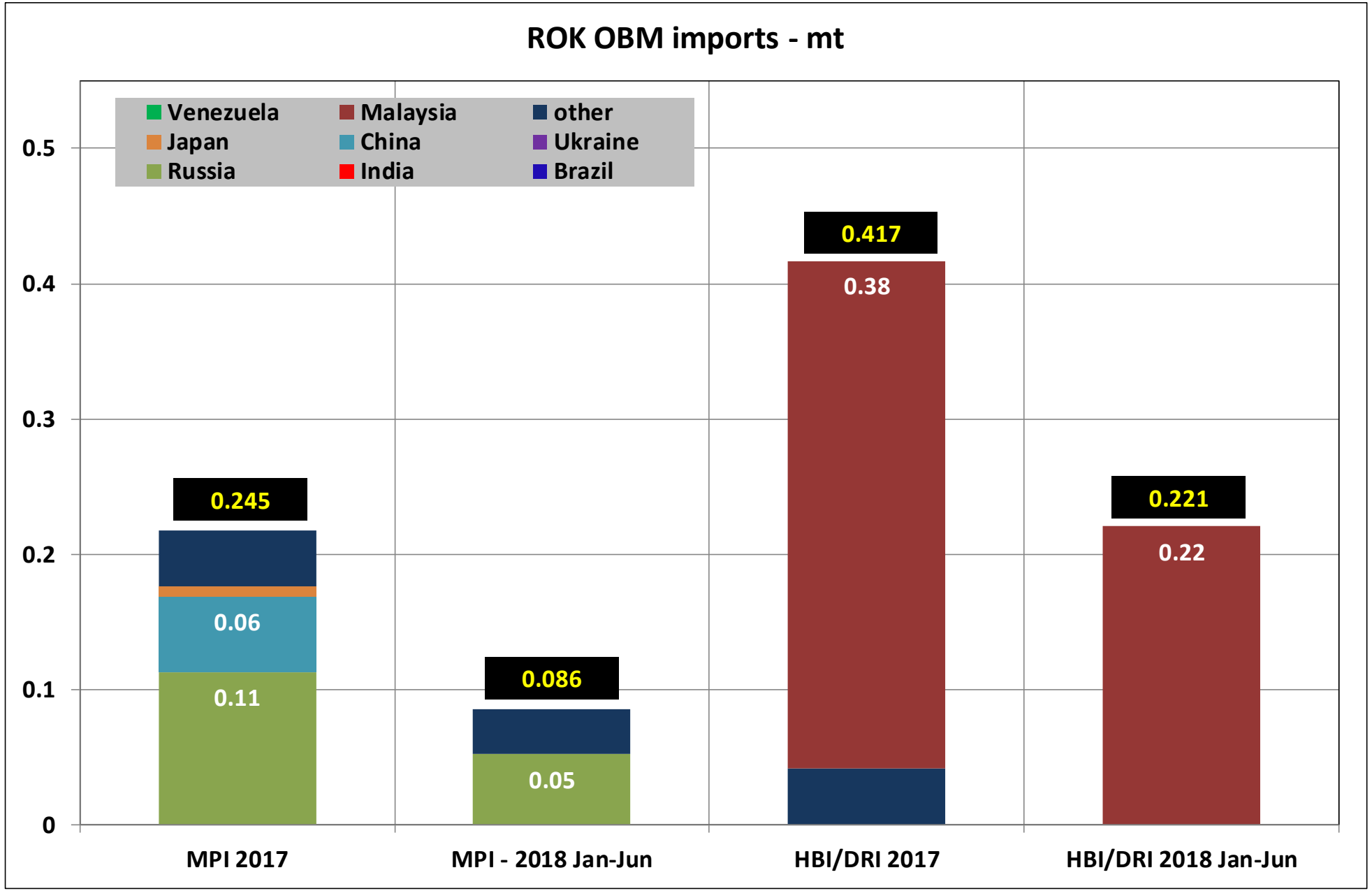
Total 9.113 mt (by deduction)

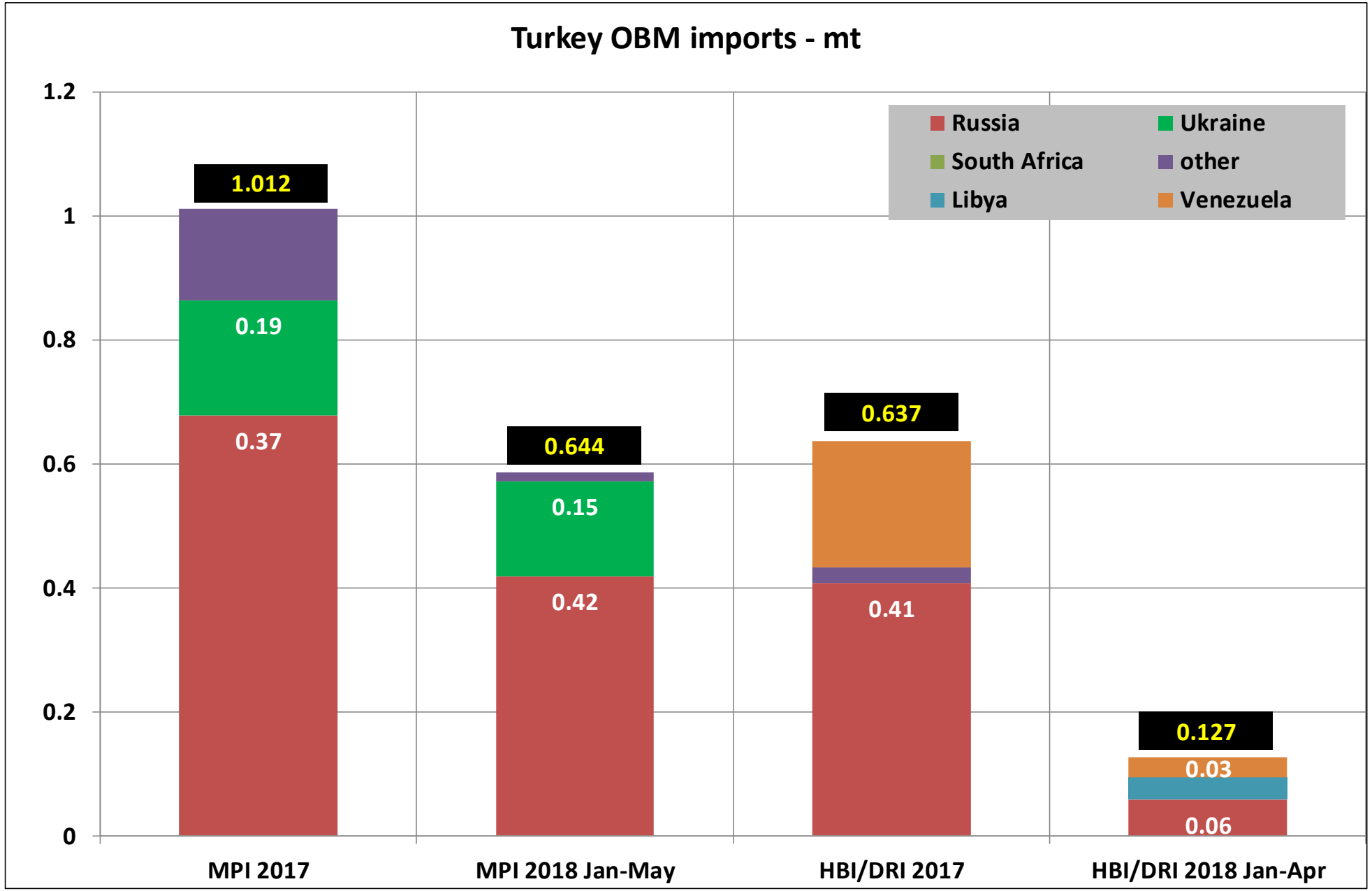
Merchant pig iron exports 2017 - total 12.2 mt

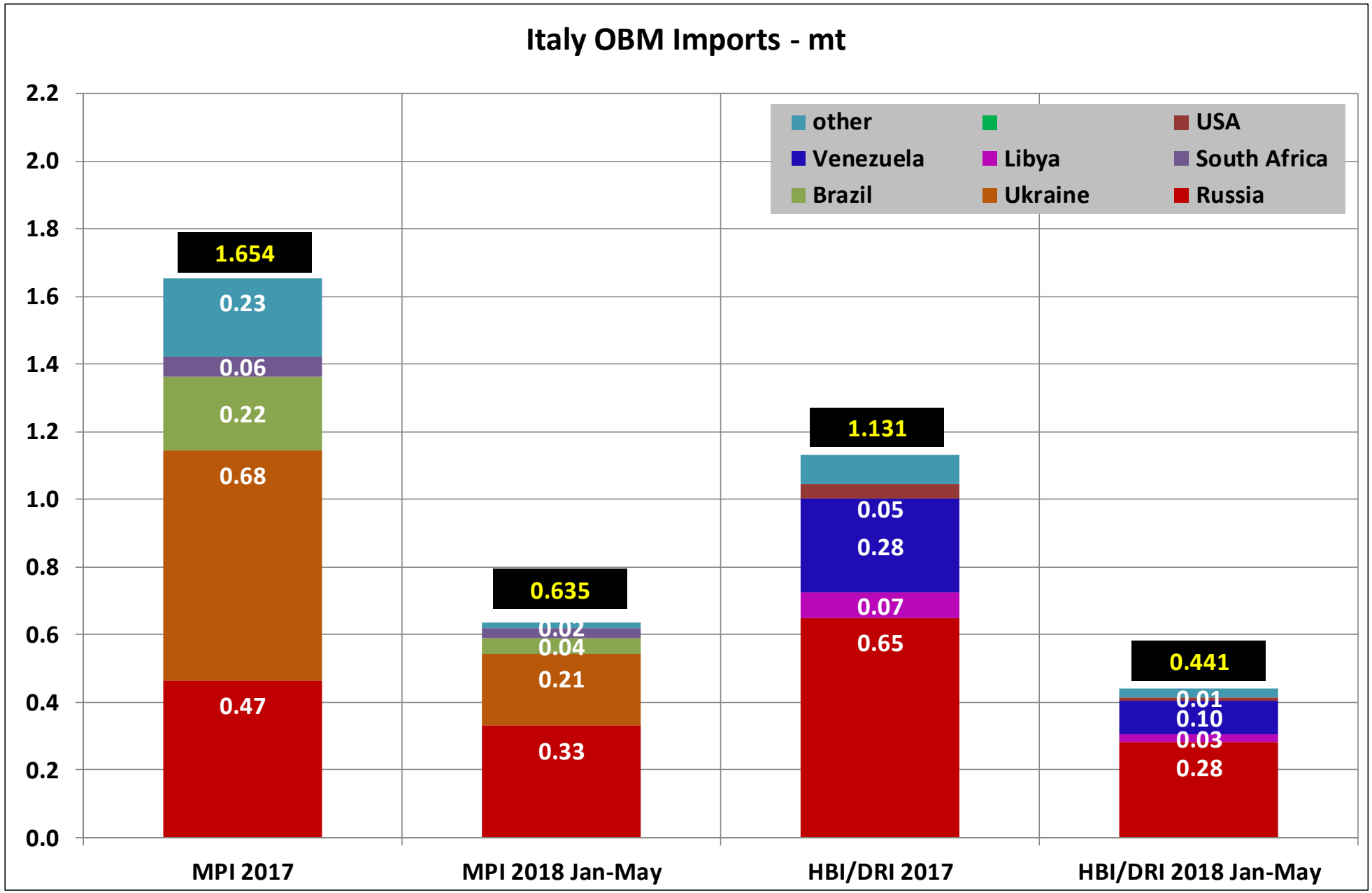


Total 12.25 mt

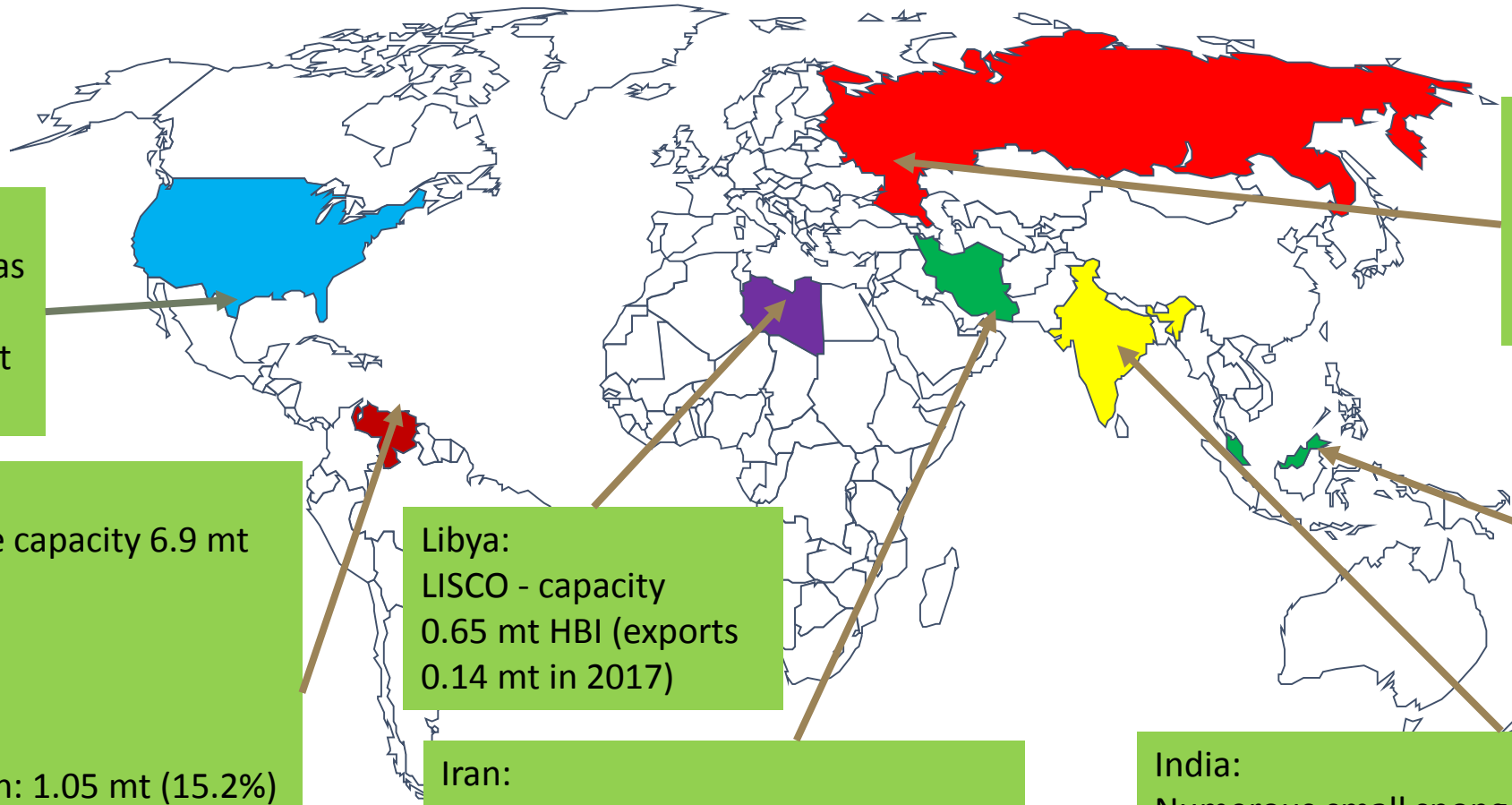

USA OBM imports [mt]
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Other
Trinidad
Venezuela
South Africa
Ukraine
Russia
Brazil
5.126
1.14
2.78
0.92
1.789
0.76
1.22
0.26
1.789
1.56
0.736
0.65
MPI-2017
MPI 2018-Jan-May
HBI/DRI 2017
HBI/DRI 2018 Jan-May


ROK OBM imports - mt
Venezuela
Malaysia
other
Japan
China
Ukraine
Russia
India
Brazil
0.5
0.4
0.3
0.2
0.1
0
0.245
0.06
0.11
0.086
0.05
0.417
0.38
0.221
0.22
MPI 2017
MPI - 2018 Jan-Jun
HBI/DRI 2017
HBI/DRI 2018 Jan-Jun


Turkey OBM imports - mt
1.2
1
0.8
0.6
0.4
0.2
0
Russia
Ukraine
South Africa
other
Libya
Venezuela
1.012
0.19
0.37
0.644
0.15
0.42
0.637
0.41
0.127
0.03
0.06
MPI 2017
MPI 2018 Jan-May
HBI/DRI 2017
HBI/DRI 2018 Jan-Apr


Italy OBM Imports - mt
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
other
USA
Venezuela
Libya
South Africa
Brazil
Ukraine
Russia
1.654
0.23
0.06
0.22
0.68
0.47
0.635
0.02
0.04
0.21
0.33
1.131
0.05
0.28
0.07
0.65
0.441
0.01
0.10
0.03
0.28
MPI 2017
MPI 2018 Jan-May
HBI/DRI 2017
HBI/DRI 2018 Jan-May

Global merchant DRI/HBI supply



USA:
voestalpine Texas
2.0 mt HBI
(exports ±1.0 mt
in 2017)

Russia:
Metalloinvest
Lebedinsky GOK
Capacity 4.5 mt HBI
(2017 exports 2.8 mt)

Venezuela:
Total HBI nameplate capacity 6.9 mt
FMO 1.0 mt
Comsigua 1.3 mt
Briqven 1.5 mt
Bricar 0.9 mt
Bricor 2.2 mt
2017 HBI production: 1.05 mt (15.2%)
2017 DRI production 0.44 mt (9.2%)
2017 DRI/HBI exports 1.25 mt

Libya:
LISCO - capacity
0.65 mt HBI (exports
0.14 mt in 2017)

Malaysia:
Antara Steel Mills
(Labuan plant)
Capacity 0.7 mt HBI
2017 exports ±0.55 mt

Iran:
Various steel mills exporting surplus DRI /HBI to regional markets (0.6 mt In 2017)

India:
Numerous small sponge iron plants small volume exports to nearby markets (0.55 mt in 2017)

Mt = million tonnes

DRI and HBI supply-side developments

- LebGOK HBI #3 module started up in March 2017, adding at least 1.8 mt to global HBI capacity
- voestalpine Texas HBI plant started up in October 2016, adding 2.0 mt to global HBI supply (about 50% to be consumed in own blast furnaces in Austria)
- DRI/HBI production in Venezuela is severely constrained by lack of pellet supply, maintenance and spare parts, etc.
- Nucor Louisiana DRI production has been constrained by plant/equipment issues (captive supply to own mini-mills)
- Iranian exports are growing: 0.7 mt exports in 2017/18, reported to reach about 1 mt in 2018/19
- Indian sponge iron production grew significantly in 2017 with exports to nearby markets, notably Bangladesh

New sources of DRI/HBI, actual and potential

- Cleveland Cliffs' 1.6 mt Midrex HBI plant at Toledo, OH, scheduled for start of commercial production in mid-2020, to be supplied with DR grade iron oxide pellets from captive North Shore operation
- Chippewa Capital Partners plans 1.8-2.0 mt Energiron DRI/HBI plant as part of plan to revive the Essar Minnesota/Mesabi Metallics project at Nashwauk, MN. Under the bankruptcy agreement, construction of the DR plant must be completed by end 2021.
- IMC (International Metallics Corp (Canada), Ltd.) plans 2 mt Midrex HBI plant at Bécancour, Quebec (project is at study stage)
- Ex ArcelorMittal Point Lisas DR plant (Trinidad) could be partially restarted under new management

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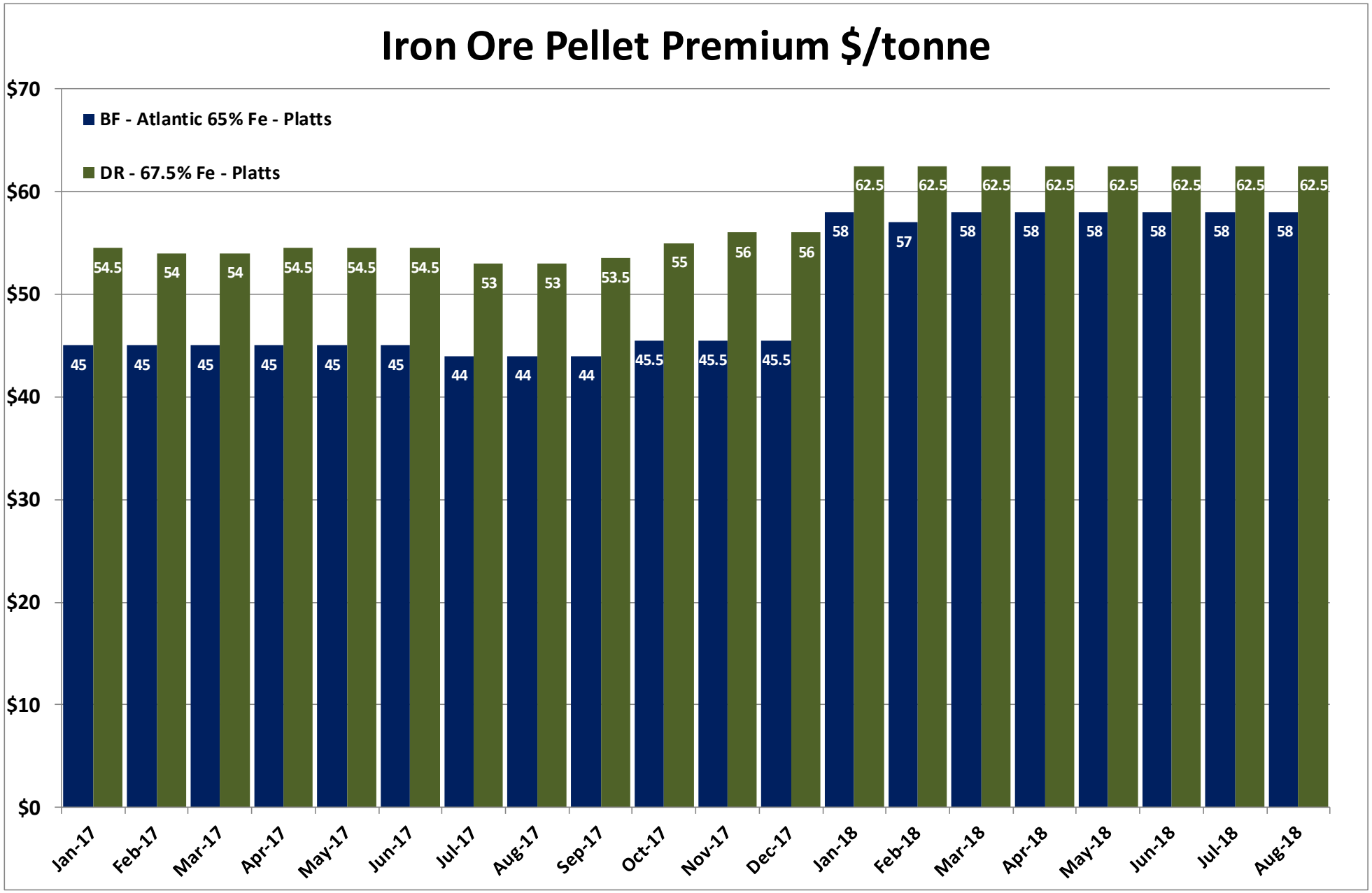
Iron Ore Pellet Premium $/tonne



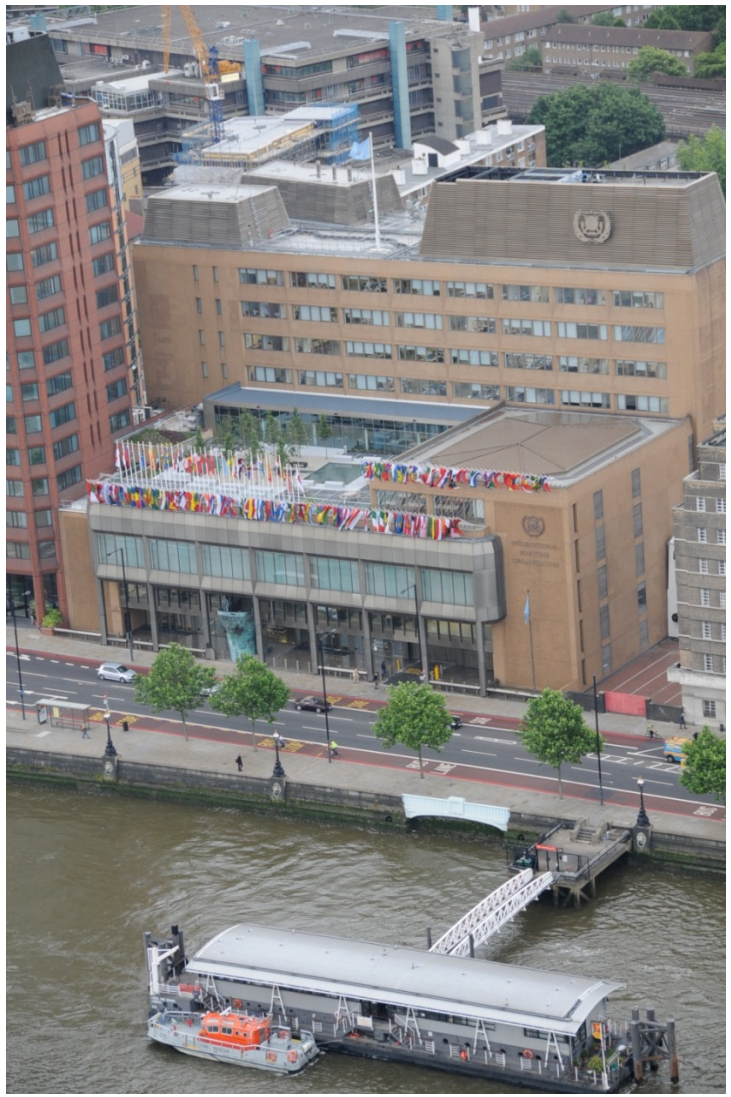
Iron ore pellet supply

- **Samarco remains shut down**
  - no definitive date for restart
- **IOC strike cost about 1 mt pellet production in 2018**
  - 2018 guidance 9-10 mt pellets + concentrates
- **Anglo American's Minas Rio operation shut down in March 2018 for pipeline repairs, expected to be completed in Q4 2018**
  - 2018 guidance 3.0 mt concentrate (based on production prior to shutdown)
- **Bahrain Steel production constrained by pellet feed supply**
  - suspension of contract with Anglo American (Minas Rio)

Iron ore pellet supply

- Vale's 2017 pellet production was 50.3 mt
  - 41.1 mt in Brazil
  - 9.2 mt in Oman
- Vale plans to increase pellet production by about 5 mt in 2018.
  - Tubarão #2 line was restarted in January 2018
  - Tubarão #1 line was restarted in May 2018
  - São Luis plant scheduled for re-start in Q3 2018, adding 7 mt capacity of BF pellets
  - Operational capacity addition in 2018 will be about 13 mt
  - 2018 production guidance about 55 mt
  - Scope for >60 mt production post 2018

International Maritime Organisation



IMO is an intergovernmental body that deals with matters on sea transport, which are referred to it by its Member Governments.

IMO is mainly involved in development of international regulations, on the basis of proposals by Member Governments.

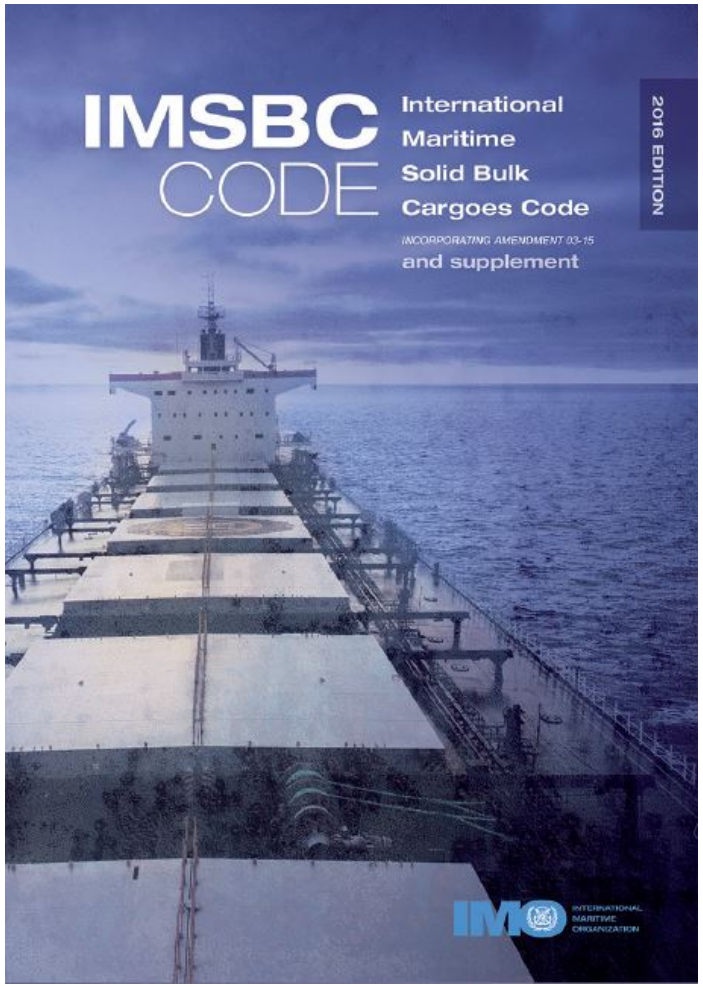
The practical design and application is the responsibility of the maritime Administrations concerned

IMSBC Code

Provisions facilitate the safe stowage and shipment of solid bulk cargoes,

Updated every two years

Sub-committee on Carriage of Cargoes & Containers and its associated Editorial and Technical Group deal with amendments to the IMSBC Code



IMSBC Code hazard classification

- **Group A: cargoes which may liquify**
- **Group B: cargoes with chemical hazard**
  - Class 4.1: Flammable solids
  - Class 4.2: Substances liable to spontaneous combustion
  - Class 4.3: Substances which, in contact with water, emit flammable gases
  - Class 5.1: Oxidizing substances
  - Class 6.1: Toxic substances
  - Class 7: Radioactive materials
  - Class 8: Corrosive substances
  - Class 9: Miscellaneous dangerous substances and articles.
- **Group C: cargoes which are neither liable to liquefy nor possess chemical hazards**
- **Materials Hazardous only in Bulk (MHB)**
  - Combustible solids (CB)
  - Self-heating solids (SH)
  - Solids that evolve flammable gas when wet (WF)
  - Solids that evolve toxic gas when wet (WT)
  - Toxic solids (TX)
  - Corrosive solids (CR)
  - Other hazards (OH)

IMSBC Code schedules for direct reduced iron

- **Direct Reduced Iron (A) - briquettes, hot-moulded = HBI**
  - **MHB, Class B (self-heating, evolution of H_2 when in contact with water)**
  - **Surface ventilation, natural or mechanical, as necessary during voyage**
- **Direct Reduced Iron (B) - lumps, pellets, cold-moulded briquettes = DRI**
  - **MHB, Class B (self-heating, evolution of H_2 when in contact with water)**
  - **Shipped under inert atmosphere**
- **Direct Reduced Iron (C) - by-product fines**
  - **MHB, Class B (self-heating, evolution of H_2 when in contact with water)**
  - **Shipped under inert atmosphere**
  - **Maximum moisture 0.3%**
  - **Average particle size <6.35 mm**
  - **No particles > 12 mm**

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DIRECT REDUCED IRON (A)
Briquettes, hot-moulded

Description

Direct reduced iron (A) is a metallic grey material, moulded in a briquette form, emanating from a densification process whereby the direct reduced iron (DRI) feed material is moulded at a temperature greater than 650°C and has a density greater than 5,000 kg/m^3. Fines and small particles (under 6.35 mm) shall not exceed 5% by weight.

Characteristics

Angle of repose	Bulk density (kg/m^3)	Stowage factor (m^3/t)
Not applicable	2500 to 3300	0.3 to 0.4 To be verified by the shipper
Size	**Class**	**Group**
Approximate size: Length 50 mm to 140 mm Width 40 mm to 100 mm Thickness 20 mm to 50 mm Briquette weight 0.2 to 3.0 kg Fines and small particles: under 6.35 mm	MHB	B

Hazard

Temporary increase in temperature of about 30°C due to self-heating may be expected after material handling in bulk. The material may slowly evolve hydrogen after contact with water (notably saline water). Hydrogen is a flammable gas that can form an explosive mixture when mixed with air in concentration above 4% by volume. It is liable to cause oxygen depletion in cargo spaces. This cargo is non-combustible or has a low fire-risk.

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DIRECT REDUCED IRON (B)
Lumps, pellets, cold-moulded briquettes

Description

Direct reduced iron (DRI) (B) is a highly porous, black/grey metallic material formed by the reduction (removal of oxygen) of iron oxide at temperatures below the fusion point of iron. Cold-moulded briquettes are defined as those which have been moulded at a temperature less than 650°C or which have a density of less than 5,000 kg/m^3. Fines and small particles under 6.35 mm in size shall not exceed 5% by weight.

Characteristics

Angle of repose	Bulk density (kg/m^3)	Stowage factor (m^3/t)
Not applicable	1750 to 2000	0.5 to 0.57
Size	**Class**	**Group**
Lumps and pellets: Average particle size 6.35 mm to 25 mm. Cold-moulded briquettes: Approximate maximum dimensions 35 mm to 40 mm. Fines and small particles under 6.35 mm up to 5% by weight.	MHB	B

Hazard

Temporary increase in temperature of about 30°C due to self-heating may be expected after material handling in bulk.

There is a risk of overheating, fire and explosion during transport. This cargo reacts with air and with fresh water or seawater to produce heat and hydrogen. Hydrogen is a flammable gas that can form an explosive mixture when mixed with air in concentrations above 4% by volume. The reactivity of this cargo depends upon the origin of the ore, the process and temperature of reduction, and the subsequent ageing procedures. Cargo heating may generate very high temperatures that are sufficient to ignite the cargo. Build-up of fines may also lead to self-heating, auto-ignition and explosion. Oxygen in cargo spaces and enclosed spaces may be depleted.

DIRECT REDUCED IRON (C)
(By-product fines)

Description

Direct reduced iron (DRI) (C) is a porous, black/grey metallic material generated as a by-product of the manufacturing and handling processes of DRI (A) and/or DRI (B). The density of DRI (C) is less than 5,000 kg/m^3.

Characteristics

Angle of repose	Bulk density (kg/m^3)	Stowage factor (m^3/t)
Not applicable	1850 to 3300	0.30 to 0.54
Size	**Class**	**Group**
Fines and small particles with an average size less than 6.35 mm, no particles to exceed 12 mm	MHB	B

The cargo shall not be accepted for loading when its temperature is in excess of 65°C or if its moisture content is in excess of 0.3%.

Hazard

Temporary increase in temperature of about 30°C due to self-heating may be expected after material handling in bulk.

There is a risk of overheating, fire and explosion during transport. This cargo reacts with air and with fresh water or seawater, to produce hydrogen and heat. Hydrogen is a flammable gas that can form an explosive mixture when mixed with air in concentrations above 4% by volume. Cargo heating may generate very high temperatures that are sufficient to lead to self-heating, auto-ignition and explosion.

Oxygen in cargo spaces and in enclosed adjacent spaces may be depleted. Flammable gas may also build up in these spaces. All precautions shall be taken when entering cargo and enclosed adjacent spaces.

The reactivity of this cargo is extremely difficult to assess due to the nature of the material that can be included in the category. A worst case scenario should therefore be assumed at all times.

What's wrong with the DRI(C) schedule?

Direct Reduced Iron (C) - by-product fines

- **MHB, Class B (self-heating, evolution of H_2 when in contact with water) - should also be Class A, cargoes which may liquefy if shipped at a moisture content above their Transportable Moisture Limit.**
- **Shipped under inert atmosphere - experience has shown that mechanical ventilation is more effective for fines**
- **Maximum moisture 0.3% - such a material does not exist in the commercial world**
- **No particles > 12 mm - with screening at 9.5 mm there is some carryover of oversize - aim is max 5% +12.5 mm**

Proposed DRI (D) description

IIMA believes that it is essential that there be a mandatory instrument governing shipment of DRI Fines to replace the current practice of shipping under exemptions to the IMSBC Code. IIMA is working towards a new schedule for "real world" DRI Fines - DRI (D).

Description

Direct reduced iron (DRI) (D) is a porous, black/grey odourless metallic material generated as a by-product of the manufacturing and handling processes of DRI (A) and/or DRI (B) which has been aged for at least 30 days prior to loading. The density of direct reduced iron (DRI) (D) is less than 5,000 kg/m³.

Characteristics

Angle of repose	Bulk density (kg/m^3)	Stowage factor (m^3/t)
Not applicable	1,850 to 3,300	0.30 to 0.54
Size	Class	Group
Fines and small particles with an average size less than 6.35 mm, particles larger than 12.5 mm not to exceed 5% by weight	MHB (WF), (OH)	A and B

Hazard

There is a risk of explosion during loading, transport and discharge due to the fact that this cargo reacts with moisture/water and especially seawater, to produce hydrogen and heat. Hydrogen is a flammable gas that can form an explosive mixture in combination with air in concentrations above 4% by volume.

Contact Information

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