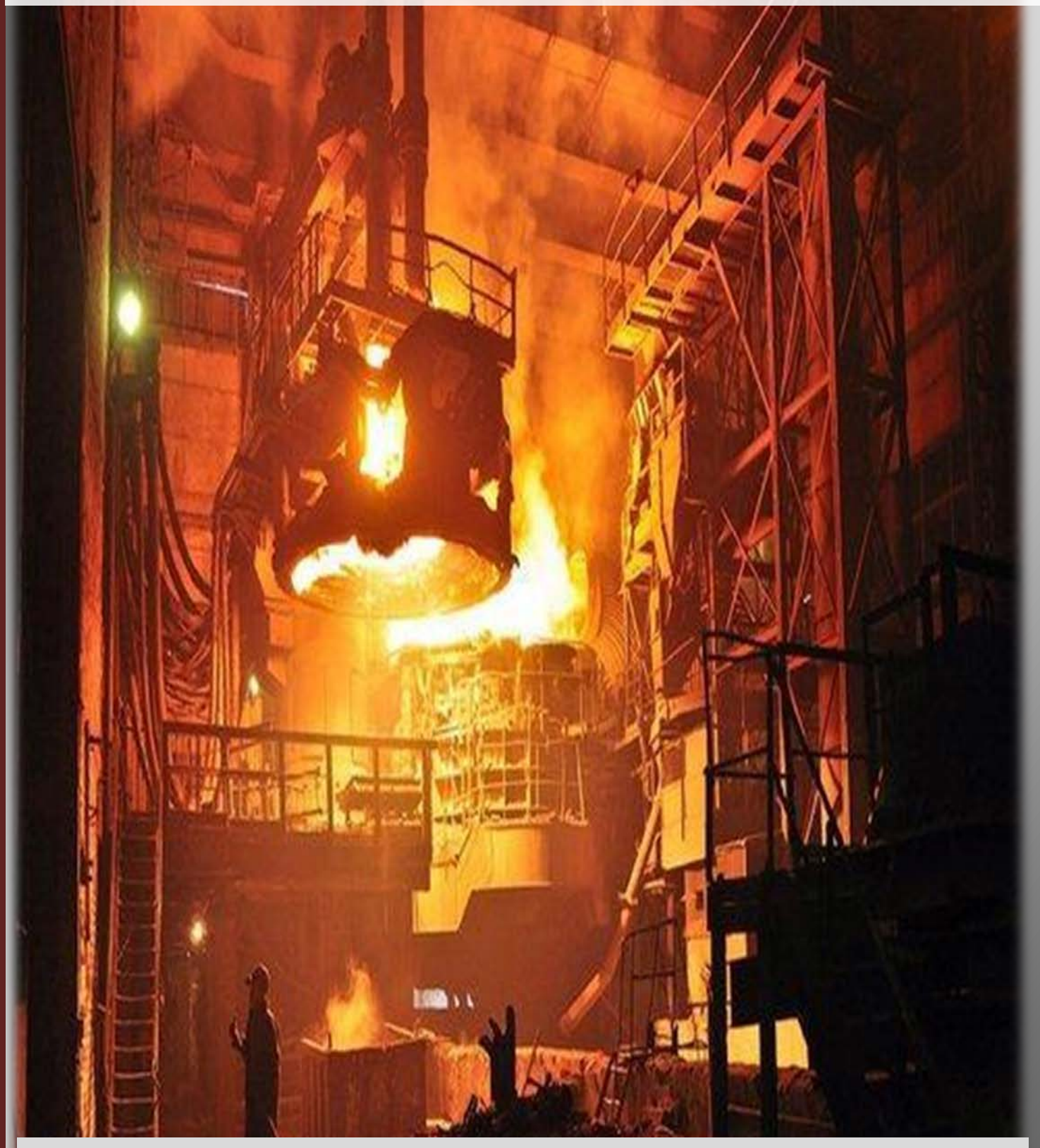
DRI UPDATE

SIMA
Sponge Iron Manufacturers Association
Indian voice for the ore based metallic & steel industry



MARCH | 2021

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Indian voice for the ore based metallic & steel industry

EDITORIAL

Dear Readers,

In last three editions I have been expressing my concern about the restricted availability of iron ore, its ever rising prices and their impact on the sponge iron and steel industry. During last two months situation is changing. Availability of iron ore particularly from Odisha segment is gradually increasing and the domestic prices o f iron ore have started coming down. This will definitely have a saluting impact on the financial performance of the Indian iron and steel industry.

Productions of sponge iron and sponge iron based steel plants are continuously increasing and we expect that in next two to three months we will come to pre-Covid 19 level. If we look into the JPC data from April – January, 2020, the production of sponge iron have shown negative growth of 12% as compared to the similar period of last year. We expect that sponge iron production in the current financial year should be around 35% million tonnes against 37.10 million tones of last year.

JPC under the aegis of Ministry of Steel had carried out a comprehensive survey in **Indian Sponge Iron Industry in association with SIMA**. In their report, JPC has acknowledged the contribution of SIMA. Highlights of the survey are on page no. 21 of this edition.

We wish our readers a very promising financial year ahead.

Deependra Kashiva

Executive Director

Carbon Neutral DRI/Steel Making - Beginning of A New Era?

Deependra Kashiva
Executive Director, Sponge Iron Manufacturers Association

1. Indian DRI Industry

Forty years old Indian DRI industry made a modest beginning when a demonstration plant was set up at Paloncha district, Khammam, Telengana to test the suitability of Indian iron ore and non coking coal based on Lurgi Technology, Germany. This was necessitated to conserve second highest foreign exchange outgo due to the import of steel melting scrap to meet the domestic metallic requirement. Thereafter, other coal based DRI plants like IPI Tata Steel, Bihar Sponge Iron Ltd, Odisha Sponge iron Ltd etc were set up. Major growth in coal based sector from 2003-04 to 2008-09.

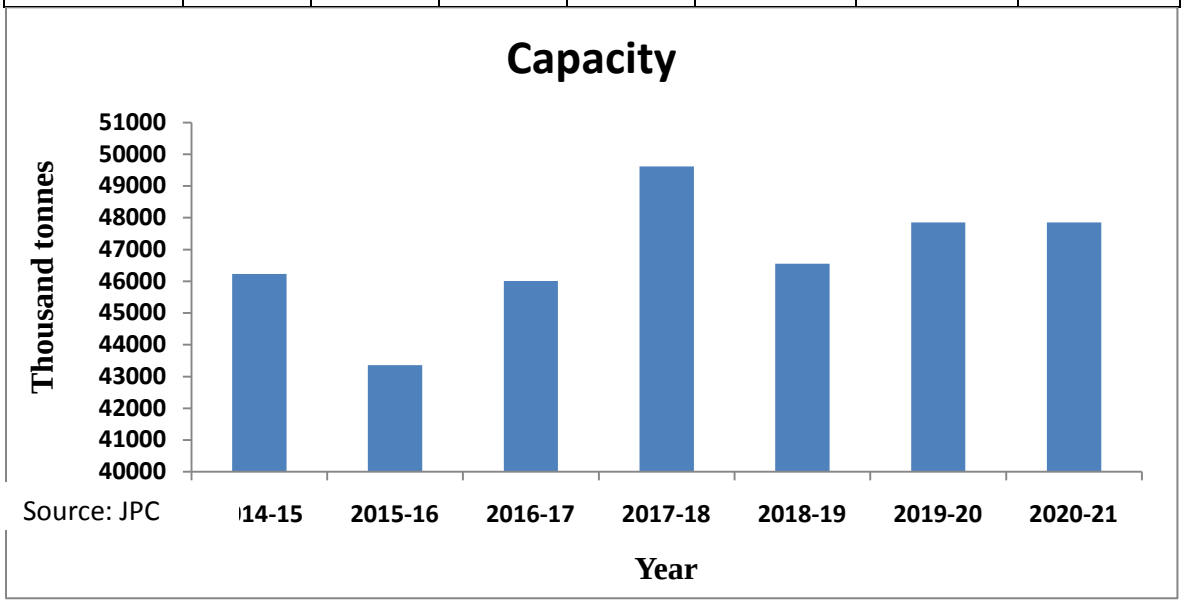
In early 90's three gas based DRI plants were set up in the west coast due to the availability of natural gas at that time. No Greenfield natural gas based DRI/HBI plant came up after 1994 (26 years) due to non-availability of natural gas. Subsequently, one syn gas based plant and one corex based plant were set up.

1.1 Capacity

The current operating capacity is 47.84 million tonnes per annum. The DRI operating capacity build up during 2014 - 15 to 2020-21 is as follows:

All figures are in '000 tonnes

Year	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Capacity	46234	43360	46007	49617	46556	47849	47849



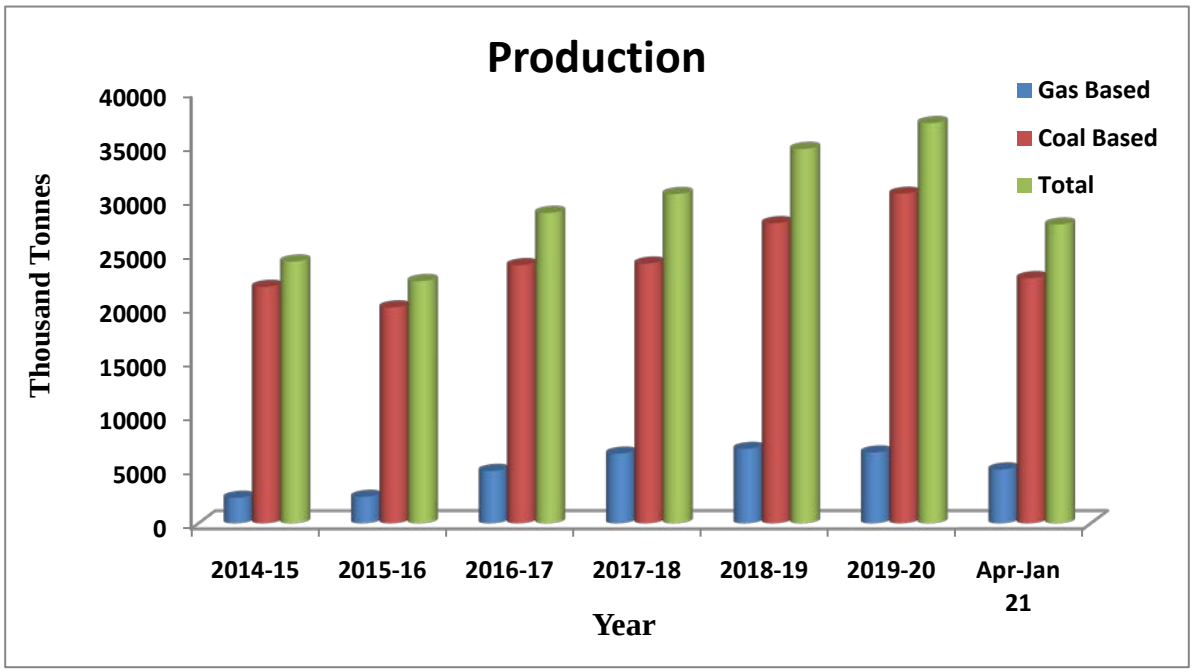
Source: JPC

1.2 Production

Route wise Production of the DRI from 2014 -15 to April-October'20 is as under:

All figures are in '000 tonnes

Production	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	Apr-Jan 21
Gas Based	2354	2440	4854	6458	6899	6564	4983
Coal Based	21889	19987	23908	24053	27806	30539	22700
Total	**24243**	**22427**	**28762**	**30511**	**34705**	**37102**	**27684**



Source: JPC

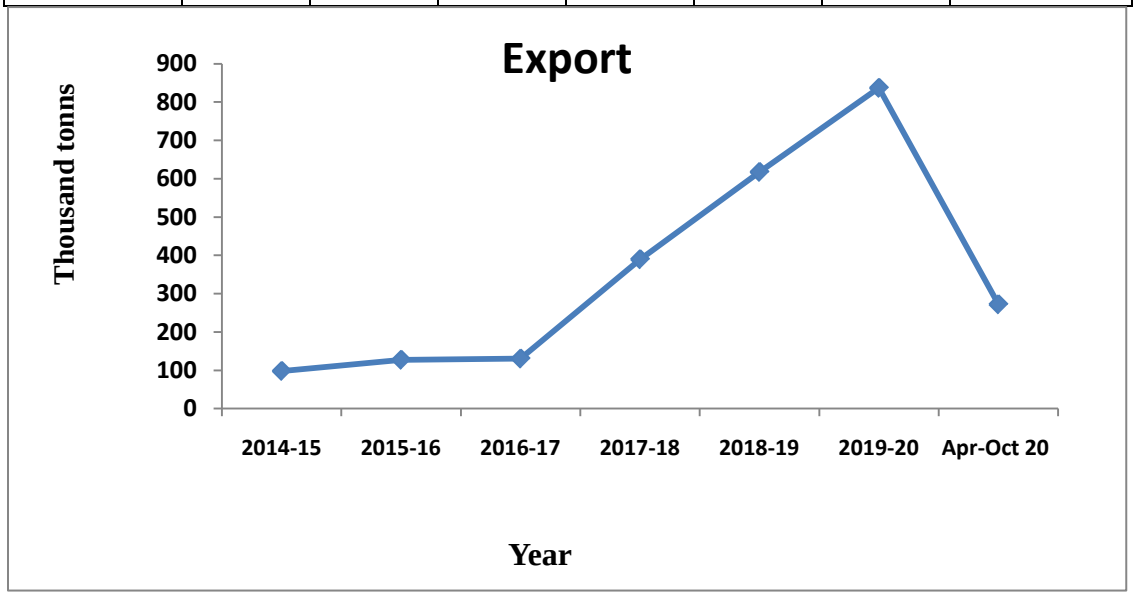
From the above, it can be seen that coal based DRI industry with a contribution of about 80% is dominating. **The total production of DRI in 2019- 2020 was 37.14 million tonnes.** In fact, Indian is the largest DRI producer in the world for the last 18 consecutive years and accounts about 30% of world production.

1.3 Export

Export of DRI is mainly consists of coal based DRI and it has exported to the neighboring countries. Details of which are as under:

All figures are in '000 tonnes

Year	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	Apr-Oct 20
Export	98	127	130	390	618	837	272



Source: JPC

1.4 Technological Profile

To increase the DRI production from the current level of 37.14 million tonnes to 80 million tonnes by 2030-31, as envisages in the **National Steel Policy 2017,** the industry has following options:

I. Coal based DRI production
II. Natural gas based production
III. Natural Gas + Coke oven gas
IV. Syn Gas +Coke oven gas
V. Corex gas based production

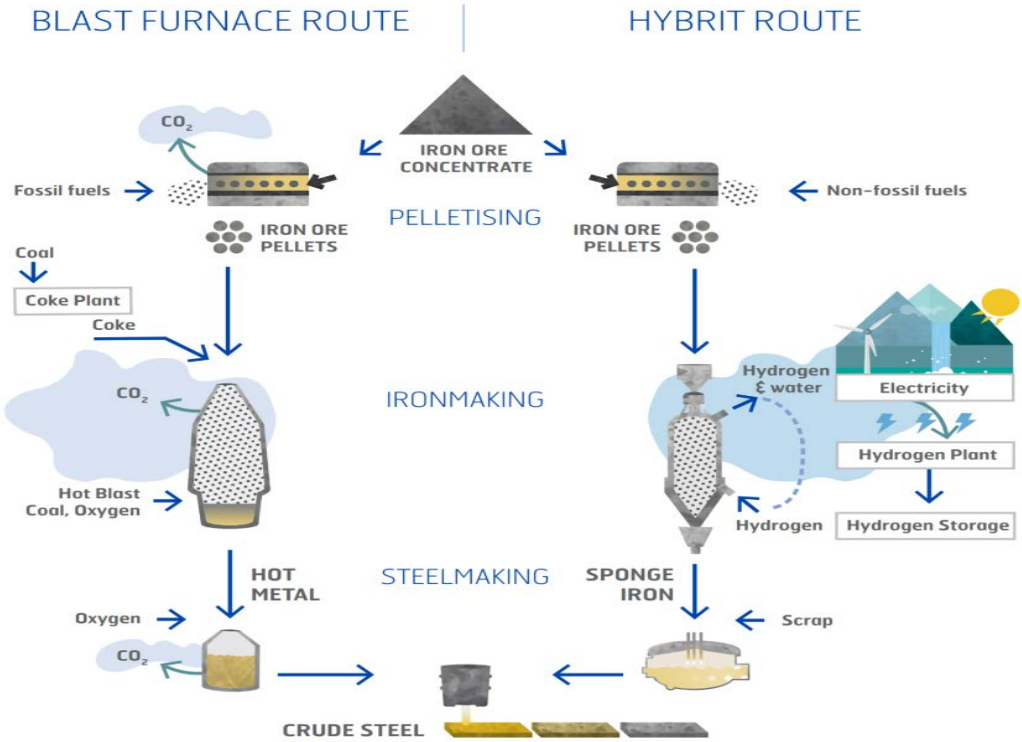
From the above, it can be noticed that Indian DRI industry uses various reductant namely non coking coal, producer gas, natural gas, syn gas, corex gas, coke oven gas etc. All these fuels / reductant have carbon footprints. Coal based route has higher CO_2 emissions compared to other above mentioned routes. Natural gas based route is much cleaner routes. Following global natural gas prices offer a good opportunity for India to expand natural gas based production. However, there is element of its uncertainty on continuous basis. Syn gas based route offers another good opportunity but the capital expenditure on production of syn gas and its transportation are currently to deterrents.

2. Low Carbon Hydrogen / Carbon Neutral DRI World Scenario

There is growing concern about the GHG emissions and need to reduce it drastically. Therefore, many advanced countries are **contemplating to opt for low carbon hydrogen based DRI / Steel production**. Many of them have already declared to be carbon neutral by 2050. We, in India have to start thinking in this direction also.

Many producers in Europe have made announcements to scale –up hydrogen direct reduction technology which include ThyssenKrupp, Voestalpine and Salzgitter. It is a matter of great satisfaction that one **Hybrit project** has already started to use green hydrogen for the production of 0.2 MTPA DRI. This project also aims to tackle emissions all the way along the supply chain. Details of the project are as under:

Hybrit (Hydrogen Breakthrough Iron making Technology) is a joint venture between Swedish companies, SSAB, LKAB and Vattenfall, aiming to replace coal with hydrogen in steelmaking process. In this process, iron metal is produced by using hydrogen gas as the main reductant. The production route is similar to existing DR processes, except for CO_2emissions.Hydrogen reacts with iron oxides to form water instead of carbon dioxide. In the demonstration project in Sweden, hydrogen will be produced by electrolysis of water using fossil-free electricity.



Apart from this technology, there is existing Midrex® Process and HYL ENERGIRON technologies but all they have some amount of carbon footprints.

Further to the above, as per the **press release dated Feb. 28, 2021** Mikhailovsky HBI, which was jointly established by USM and Mikhailovsky GOK (part of Metalloinvest), signed a contract with Primetals Technologies and consortium partner Midrex Technologies, Inc. to supply a new Hot Briquetted Iron (HBI) Plant in Zheleznogorsk, Kursk region, Russia. The plant is designed to produce 2.08 million metric tons of HBI per year. Latest design features ensure reduced energy consumption and environmental impact. The contract includes engineering, supplies and advisory services. Startup is expected in the first half of 2024. This initially would be on grey hydrogen and have the provision to subsequently switch over to green hydrogen.

2.1 Indian Scenario

In India, substantial amount of hydrogen is being already used for the production of DRI/ HBI. One gas based DRI plant is using hydrogen 75% and another syn gas based plant is using 60% hydrogen. To be completely carbon neutral, we have to opt some other reductant. Hydrogen production through electrolysis process using some renewal energy offers such options as demonstrated in the Hybrit. It is imperative to produce the hydrogen at a competitive cost which can be subsequently used in the vertical shaft reactor to produce the DRI / HBI. This metallics can subsequently be used for steel production either in the Electric arc furnace or in the Basic oxygen furnaces. India is emerging as the lowest renewable energy (RE) producer in the world.

For the hydrogen route, gas based capacity could be build up in the 2020's using natural gas for which infrastructure for transportation is being set up and its prices have reduced substantially. Alternatively, coal based syn gas, which is being promoted presently by the Government of India, can also be another option. Subsequently, this could be switched to low carbon hydrogen over a period of time which would lead reduction in emissions.

There are also specific issues about the use of hydrogen some of which are listed as under:

i. Hydrogen has a high energy density by weight, but a low energy density by volume when not compressed or liquefied. Thus, the cost of infrastructure for storing and transporting hydrogen can be a major obstacle in its development.

ii. Hydrogen purity, material compatibility, and concerns for safety.

iii. Production of DRI through the hydrogen route will have 0% carbon with pure hydrogen. The majority of DRI has to be used in induction furnaces of electric arc furnaces which need carbon in the charge materials for proper metallization and to generate the heat for faster melting. Therefore, it will be needed to add some hydro carbons to achieve the desired carbon level.

iv. Main barrier is low cost of hydrogen and access to renewable energy. It is understood that main cost component in the electrolysis process, the cost of electrolyte is about US $ 1000 per piece. Today cost of electrolytic hydrogen is about US$ 8/Kg. To be cost competitive, it should be between US$ 2 - 4/ Kg. Therefore, it is imperative to produce the hydrogen at the minimum cost.

2.2 National Research & Development Project

To resolve the above mentioned issues and other related issues, it will be appropriate to have a **National Demonstration Project** to establish the techno economic parameters. For this there is a need to have R&D project which can be funded from the R&D mechanism in vogue in Ministry of Steel and supported by BEE, GIZ, and International Funding Organization(s). There will also be need to have foreign collaboration for carrying out the R&D activity to conclude its logical conclusion and its suitability under the Indian conditions. As per the various TERI's studies, India will have initially need to go in big way for grey hydrogen based DRI / steel production and subsequently to green hydrogen based DRI / steel production and have to phase out coal based DRI route by 2050. This would be necessitated to reduce carbon footprints and to fall in line with the world trend in spite of the fact that the production cost through this route would be initially higher than the conventional BF-BOF route. A carbon price is a well understood policy lever to motivate a switch to cleaner fuels across a number of sectors. Many companies already apply an internal carbon price to aid investments decisions thus reducing stranded asset risk. For the steel sector, where steel is globally traded, a carbon border adjustment would be required to limit dirtier steel being imported at lower costs. This is currently being taken forward by the EU under their 'Green New Deal'.

2.3Latest developments

While presenting Union Budget 2021, Finance Minister, Mrs. Nirmala Sitharaman announced the **National Hydrogen Mission.** This new initiative will benefit the domestic companies**.** Experts are of the opinion that the need of the hour is a collision of stake holders like the Hydrogen Council or the European Hydrogen Coalition. Some of the experts are of the opinion that India has the potential to be the one of the world leader in the hydrogen driven economy.

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Prospects in DRI production and cost

D.P. Deshpande, Ex-MD, Tata Sponge Iron Ltd.

The DRI kiln operations have to compete with other iron ore reduction processes such as blast furnace, to survive in the long run, rather than competing amongst themselves. The cost advantage in logistics would be limited to a point. Rotary kilns are intrinsically low productivity equipments when compared to the BFs. But they can compete well in carbon rates and therefore cost, given a little more effort and insights.

Currently, the Indian DRI kilns operate with South African Coal and produce at a rate of 100+% of capacity. The feed rates of iron ore/pellets when South African coal is used are much higher than what they would be when Indian high ash coals were used. When the feed rates of iron ore or pellets are high, it means in other words that the coal rate is low and other contents of the kiln such as coal ash, or dolochar are also low.

This point provides further insights into the process of coal based Sponge Iron.

Basics of Iron ore reduction

Let us look at the stoichiometric requirement of coal and the heat; for DRI manufacture.
For a complete and stoichiometric reduction of
Magnetite , Fe_3O_4..... 24/168= 0.143 t of carbon per tonne of Fe.

$$Fe_3O_4 + 2\,C = 3\,Fe + 2\,CO_2$$
$$(3*56+4*16) + 2*12 = 3*56 + (2*12+4*16)$$

Hematite, Fe_2O_3 .....36/224= 0. 16 t of carbon per tonne of Fe

$$2\,Fe_2O_3 + 3\,C = 4\,Fe + 3\,CO_2$$
$$(4*56 + 6*16) + 3*12 = 4*56 + (3*12 + 6*16)$$

Reduction is an endothermic process and requires heat. This heat is supplied by the coal when it oxidises in the kiln. Stoichimetrically, the net effect of reaction with carbon is 758 kcal of heat generation per Kg of DRI. The VM associated with fixed carbon also burns and gives 1300 kcalof heat per kg of Fe . DRI process at stoichiometric level gives a heat of about 2060 kcal per kg of Fe. But the sensible heats of reactants, products , demoisturisation etc consumes about 1800 kcal/kg of Fe, leaving a net surplus of only 250 kcal/kg of Fe. (0.09 MW for 1 tph of DRI production @ 30% energy conversion in the power plant)

The kilns usually operate at a C/ Fe ratio of 0.45 or so (for a stoichiometric ratio of 0.16) If the Fixed carbon in the coal is 55%, the coal per tonne of DRI gets to 0.82 or so. This means that there is a significant excess coal is being used in the kiln normally, and it leads to more power generation. If there is an excess of 0.29 kg (0.45-0.16) of carbon per Kg of Fe, all this carbon and its associated VM will deliver about 3600 kcal/kg of Fe.

Production at 110 +% of Capacity

When the production rates are high, it is usually associated with lower coal rates. Which means the process moves closer to stoichiometry. A rotary kiln can be fed volumetrically only to the extent of about 30% by a mix of coal and iron ore/pellets. The higher coal content in the feed material means limitation to metallic feed. In other words, lower feeding of coal means that much extra opportunity for ferrous material to be fed. And feed rates for iron ore and pellets shall go up accordingly. Higher the feed rate, higher is the production rate. The lower the coal rate, the lower is the air requirement and lower is the waste gas volume, and even specific power generation. These things can also be quantified as per computations made above

One aspect that also needs attention is that usually high FC coals leave quite a lot of un reacted FC in the char. At the discharge end of the kiln, the FC runs into an oxygen deficiency zone and therefore FC goes unreacted, because most of the iron ore has got reduced and source of oxygen is only the air from the blowers that will get into the bed. This loss of carbon often goes as unavoidable and can be expensive. In other words, it presents an opportunity to drop the variable costs by fine tuning the kilns or by use of lower graded coal. The trick is to reduce the FC loss to the char which would reduce the setting of C/Fe ratio.

Possibilities to **reduce cost.**

Once we see a high loss of FC to the char, one starts to look at creating more opportunity for increasing iron ore feed rate further. Or vice a versa, an opportunity to use cheaper lower FC coal, when you want to drop the variable cost, let production rate drop for overall profitability.
Let me take the second argument and explore the opportunity to reduce variable cost of DRI.
When the ash goes up by 10% or VM goes up by 10%, the fixed carbon shall drop as much and for the same C/ Fe ratio, the coal rate will go up about 20 %.(0.55/(0.55-0.1)) The coal rate will change from 0.88 to about 1.06, and feed rate or production rate would come down also by about 20%. If the high VM or high ash coal is cheaper in percent cost, by more than the percentage drop in FC, the it will lead to a drop in variable cost.

What are the associated effects of such actions ?

The waste gas volume per tonne of DRI would go up, if the VM is allowed to go up by almost the same percentage as the drop in FC . The waste gas system.....the boiler, the ID fan and the ESP..... should be able to handle it.

Even though the increase in coal rate is 1.2 times the percentage drop in FC at a drop level of 10%; the ratio will increase faster beyond that level. May be to 1.3 times, if the FC drops by 15%.

The rate of combustion of VM is different from that of FC. So if FC is substituted by VM, the overall combustion rates would go up. The temperature profile would undergo a change as a result. In order to contain the wasteful burning away of coal, the air adjustment becomes necessary to maintain the required temperature profile.

Usually, with increase in VM, the inherent moisture would also go up. It has its own impact on the temperature profile and causes a delay in combustion. All these effects can be visualized against a standard temperature profile and air adjustment planned.

The key to change the production or the variable cost level thus stays with ensuring that the wasteful coal burning or loss of fixed carbon to char is reduced. The burning of coal is facilitated or impeded by availability of air/O2. So air adjustment becomes a good tool to operationalise the idea; a model for air adjustment needs to be developed. The installation should have the capability to alter air flows as needed, even if we have a model to do so.

Reducing CO2 emission

Going by the stoichiometric requirements, it becomes clear that reduction of iron ore would require the same tonnage of carbon, irrespective of the fact whether the reduction is in the BF or DRI kiln. In reality, both the routes are non stoichiometric, for reasons of economics. It would be obvious that the process which runs closer to the stoichiometry would have the least carbon consumption. The BFs have a fuel rate of about 525 kg/t, which also works out to 450 kg of carbon per t of hot metal, almost the same as that of DRI kilns. But BFs score over the fact they deliver liquid iron for the same carbon rate. DRI process is just about that much more expensive and also generates that much extra CO2.

The process needs to be pushed closer to stoichiometric levels by studying and modeling internal dynamics. Also the sensible heat from the products needs to be recovered to preheat the air. (compare the BF operations). Preheated air shall reduce the total heat requirement of the process, even reduce the unburnt fixed carbon at the discharge.

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D.R.I - Developed Through Research and Innovation

Vivek Agrawal, COO, Godawari Power & Ispat Ltd.

Abstract:-

India is largest DRI producer in the world with a total capacity of 46.56 mn tonnes/yr, with coal based units accounting for a share of approx. 80% (37.25 mn tonnes). In January –December 2019, producing 36.86 million tonnes sponge iron with 80% efficiency and growth rate 7.7% over the corresponding year. While only coal based DRI production has been only 28 mn tonnes (75% capacity). Today we are operating at very low capacity the major reasons are raw material, machinery and most important cause is innovative minds , I strongly feel that no process or plant can deliver and sustain peak performance even with best input and machines until, unless innovations are being done .Godawari power & Ispat ltd is a perfect example where we achieved not only turnaround performance rather excellence through innovative and creative thinking and had been able to save huge costs as such we redefined D.R.I as Developed Through Research and Innovation. Here an effort had been put to highlight some key areas of cost reduction through innovations.

Company Profile:

GODAWARI POWER & ISPAT Ltd (GPIL) located in Raipur- Chhattisgarh is first generation BSE/NSE listed company of Raipur based HIRA group. Company started its operations in Raipur-Chhattisgarh as a sponge iron manufacturer and later progressively expanded operations across a significant part of the value chain of the iron and steel industry, eventually covering Iron ore Mining , pellet, Sponge Iron, Steel, Ferro Alloy, Wires , & Power segments by venturing into green field Projects. RR Ispat Limited which is engaged in the operation of Rolling Mill (primarily based on Billets produced in GPIL) is a GPIL promoted company.

GPIL is the first company in Chhattisgarh to be awarded with ISO.9001;2015 For QMS, ISO 14001:2015 for environment management system and OHSAS ISO 45001 ; 2018 For occupational health and safety.

Production Profile:

FACILITY	INSTALLED CAPACITY
Captive iron ore	2.10 MTPA
Iron ore Pellets	2.10 MTPA
Sponge Iron (DRI)	4,95,000 TPA
Steel Billets	4,00,000 TPA
Ferro Alloys	16,500 TPA
Rolled Product (TMT+ Wire Rod)	6,14,000 TPA
HB Wires	1,50,000 TPA
Power	73.00 MW

DRI Through coal based route:-

In Indian context still coal based DRI making is best technology and process due to less cost of project and cost of production, if it is properly operated and innovations are being done. In DRI process we not only make DRI rather also make highly important electricity from heat of flue gases through WHRB route.

No process of plant can deliver peak performance in absence of innovations. Innovative and creative working are the secret of success of any plant. All of us can put best technology and use best raw material , but having innovative and creative minds at work place are the biggest assets. At GPIL the team under the dynamic leadership of MD Sh B.L.Agrawal and ED Abhishek Agrawal always think in innovative way , as a result this less known company had done so well in last 5-6 years and had emerged as one of the most efficiently operating plant in its profile of operation.

"All we need is 'Vision, Passion' and Authority to do"

DRI: A NERVE CENTRE FOR STEEL MAKING IN INDIA

- India is the largest producer of DRI/SI in the world.
- 1/3 of total steel production is by DRI route.
- Search for alternate routes based on non-coking coal and iron ore / ore fines resulting in growth of DRI and other hybrid routes.
- Played the role of catalyst - in Steel Industry Growth in recent years by providing big impetus to Secondary Sector.
- Technological improvements favor enhanced usage of sponge iron in all the routes of steel making on economic and environmental grounds.
- Substantial Value-Addition.
- Relatively low cost of investment.
- Ease of setting up of a sponge iron plant.
- Clear-cut technology of direct reduction.

The areas where Innovations are required:-

- **SAFETY& ETHICS**
- **ENVIRONMENT. CLEAN AND GREEN WORKING.**
- **AVAILAIBILITY OF THE PRODUCTION PLANTS-SHUTDOWN STRATEGY**
- **PREVENTIVE AND PREDICTIVE MAINTENANCE- VIBRATION REPORTS**
- **MANPOWER OPTIMISATION AND PRODUCTIVITY**
- **CONSERVATION OF NATURAL RESOURCES- COAL-ENERGY EFFICIENCY**
- **REFRACTORY.**
- **STEAM AND POWER MAXIMISATION FROM WHRB.**
- **STRIVING FOR PEAK PRODUCTION & STORE COST/INVENTORY.**
- **WASTE AS A RESOURCE (BEST FROM WASTE).**

Safety is never costly, no safely is more costlier

Safety & Ethics:-

Safety is the back bone of any company , it had been experienced that most of the DRI plant/steel plant had seen accidents due to various reasons.

When some body focus on human values, performance is maximised and profit generates naturally, Prime concern for any company should be safety. Because of injury and lack of safety every 100 days -2 days are lost, safety is the biggest innovation and profit in any company, safe culture develop feeling that some one at top is concerned about human assets. safe culture improves commitment, cost goes down and profit multiplies. There are profits in values, safety is love and commitment that makes environment healthy. If we have heart the heart should speak and we should listen it. Safety culture starts from the top. Safety is everything.

ENVIRONMENT:- CLEAN AND GREEN WORKING:-

Labour capital is an essential element in every nation's economy. human capital increases productivity and economic growth. While health is increasingly seen as an important part of human capital, environmental protection, which typically promotes health, has notbeen viewed through this lens. Indeed, such interventions are typically cast as a burden on producers and consumers, and thus a drag on the labour market and the economy in general. it seems likely that efforts to reduce pollution could in fact also be viewed as an investment in human capital, and thus a tool for promoting, rather than retarding, economic growth.

Pollution is also likely to have productivity impacts on the intensive margin, even in cases where labour supply remains unaffected. Since worker productivity is more difficult to monitor than labour supply. Hence if we had to achieve peak performance than working environment had to be clean and green, this shall help in direct cost reduction significantly.

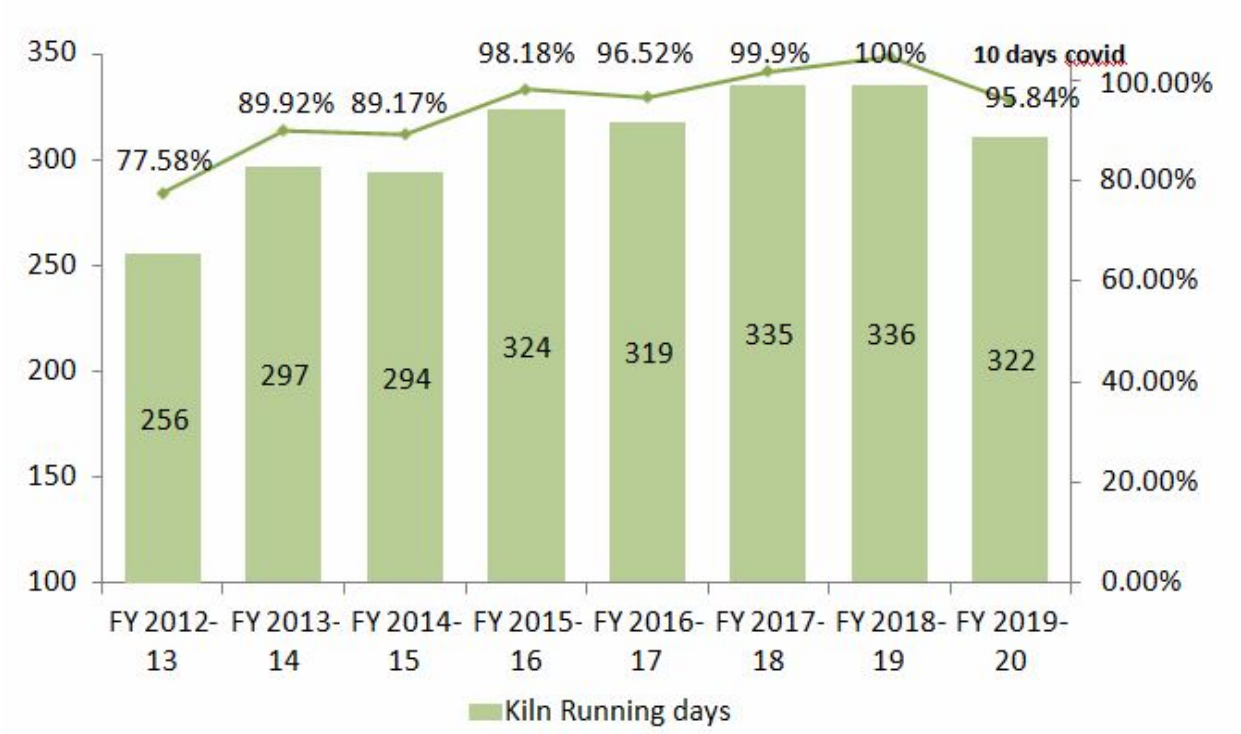
HUMAN ASSET IS THE BIGGEST ASSET OF ANYH COMPANY

AVAILAIBILITY OF THE PRODUCTION PLANTS- SHUTDOWN STRATEGY:-

In GPIL we follow a unique and all together different strategy of **FILL IT, SHUT IT, FORGET IT**.

Means During shutdown we do very minute, meticulous and strategic planning to attend and address each and every corner of the plant and left no area un-attended even at the cost of more days and production loss, we are kind enough of the Top mgt for never ever asking us for reduction in shut down days, at times we had taken even 30 days shutdown but after this we had been confident for 300-400 days where no breakdown/shutdown had happened and our kilns had given as high as 99.8% availability. All this had helped in uninterrupted operation and saved huge losses due to idle coal, quality loss and production loss. Our operating days and availability trend is followed in coming slides.

Trend of Running days at a glance:



Enhancement in steam generation:-

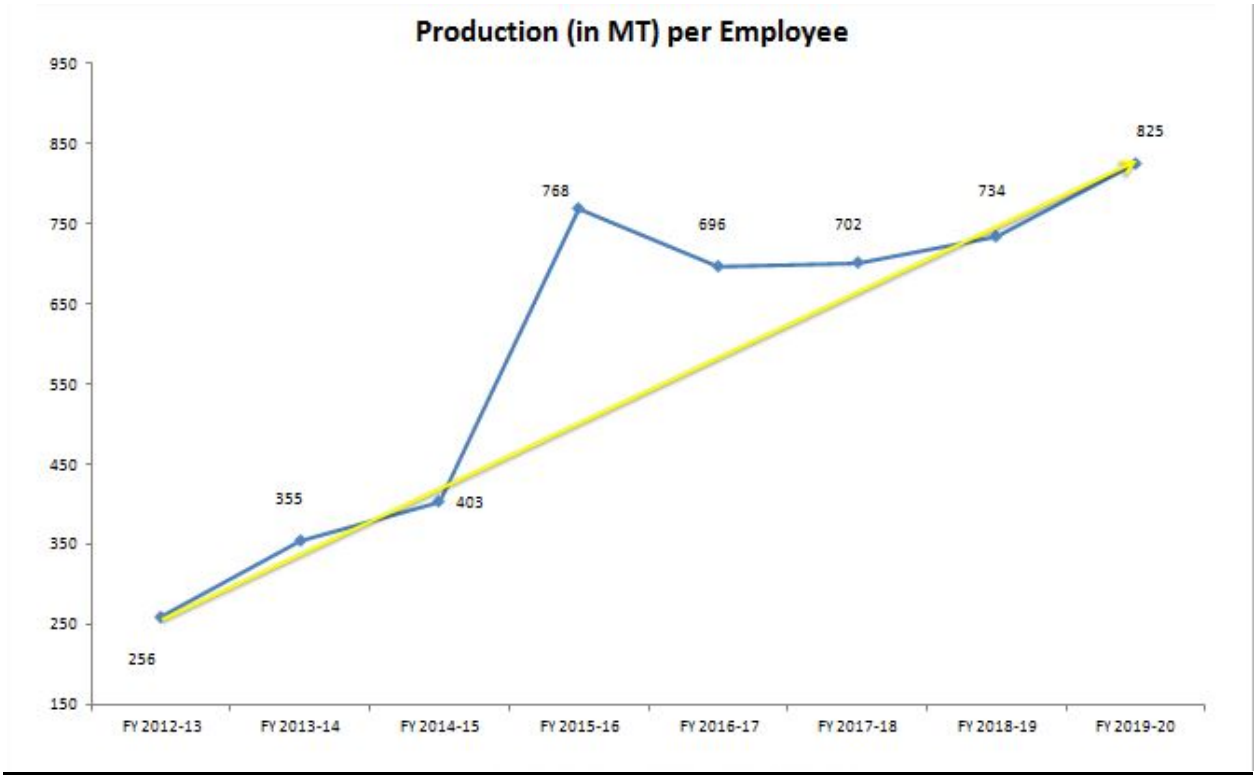
Thermal efficiency of merely 51.3% in coal based DRI kilns may seem low, but since the reduction reactions require such high temperature energy losses are inevitable. A material and energy balance around the kiln indicates that due to chemical reactions and combustion, heatgenerated inside the kiln is 272 GJ/h, which is the total theoretical energy required for the kiln. However, the actual energy consumption in a conventional plant in the kiln comes out to be 498 GJ/h. This value is 45.2% more than the theoretical energy consumption. The above departure in energy consumption figures decreases efficiency of the kiln.

WHRB is highly successful in Indian conditions . If proper combustion is done then we can maximise steam generation, in GPIL with lot of innovative work in combustion we had increased 10-15 tonnes steam generation which accounts for 3-4 mw power generation /hr or cost reduction of 200-225 Rs per mt tonne of DRI.

MANPOWER OPTIMISATION AND PRODUCTIVITY MAXIMISATION

At GPIL we had constantly, consistently and continuously worked on Innovative ways of optimization of manpower, multiskilling , mechanisation, simplification, highest level of workmanship, housekeeping safe and clean environment. These are the mantras for running plant at peak with optimum manpower. Our productivity had been multiplied 4 times in last on 5-6 years due to these success mantras.

Productivity Per Head



Conservation of natural resources:-Yield maximization and carbon reduction:-

Pellet ore yield maximised to 71.5

In any DRI plant 75-85% cost goes to raw material hence efficient use of raw material is most important, Ideally yield of pellet had to be 71-72 while safe carbon consumption should be below 400 kg Gpil operates its kiln through pre-heater route , due to pre-heaters our fines generation and fly-ash fet was very high and yield was low we did number of innovative solutions in pre-heaters and addressed all losses and made process world class as a result we are getting 71-72 yield with pellets and our carbon consumption is 395 kg considering all losses, by doing small small-small innovative things in process control, design modification, quality stabilisation and peak production, we had been able to save substantially in pellet and coal.

GPIL IS THE ONLY PLANT WHERE 400 TPD KILNS ARE RUNNING THROUGH PREHEATERS AND MAKING 500 TPD.

Conservation of natural resource- Coal Energy Efficient operation:-

Elimination of domestic coal and use of imported coal:-

Benefits of Imported Coal :-

- Coal loading Reduced by 50%
- Specific Air Requirement Reduced 30%
- Approx 30% Load Reduced on SAF,FD Fan & ID Fan Dolachar and char Generation Reduced by 50%
- Kiln Main Drive & Cooler Main Drive RPM Reduced by 50%,
- Resulting reduction in Power Consumption and higher feed rates by 10-20%.
- Overall production increased by 20%. Accretion reduced to almost negligible.
- Campaign life gone up to 300-400 days.
- Cost of coal remains same (as compared to domestic coal).
- Variable and Fixed cost reduced significantly, due to higher production, less shut down , less store costs and higher yields.

Refractory:-

Refractory is the most vital part of any DRI Kiln. No kiln had to be operated with any hot spot as losses due to hot spots are much more then what we see, any small refractory problem may spoil the show and may lead to shutdown of the plant and huge losses, As per my experience followingare the important areas for refractory. Strength and Porosity plays major role in refractory, higher alumina leads to more heat loss and increased conductivity,

Important areas of refractory are:

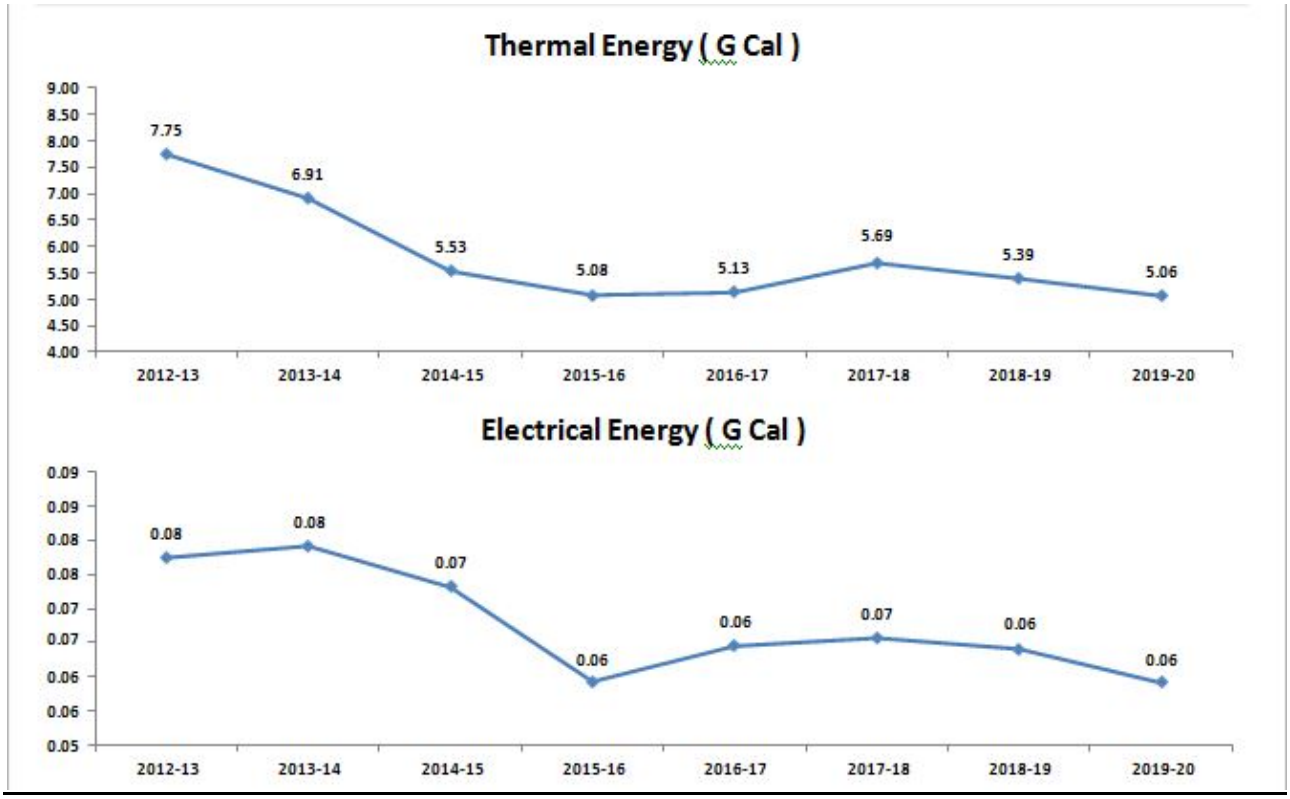
1. Selection
2. Application and Installation
3. Utilization

Proper selection, installation and utilization reduces

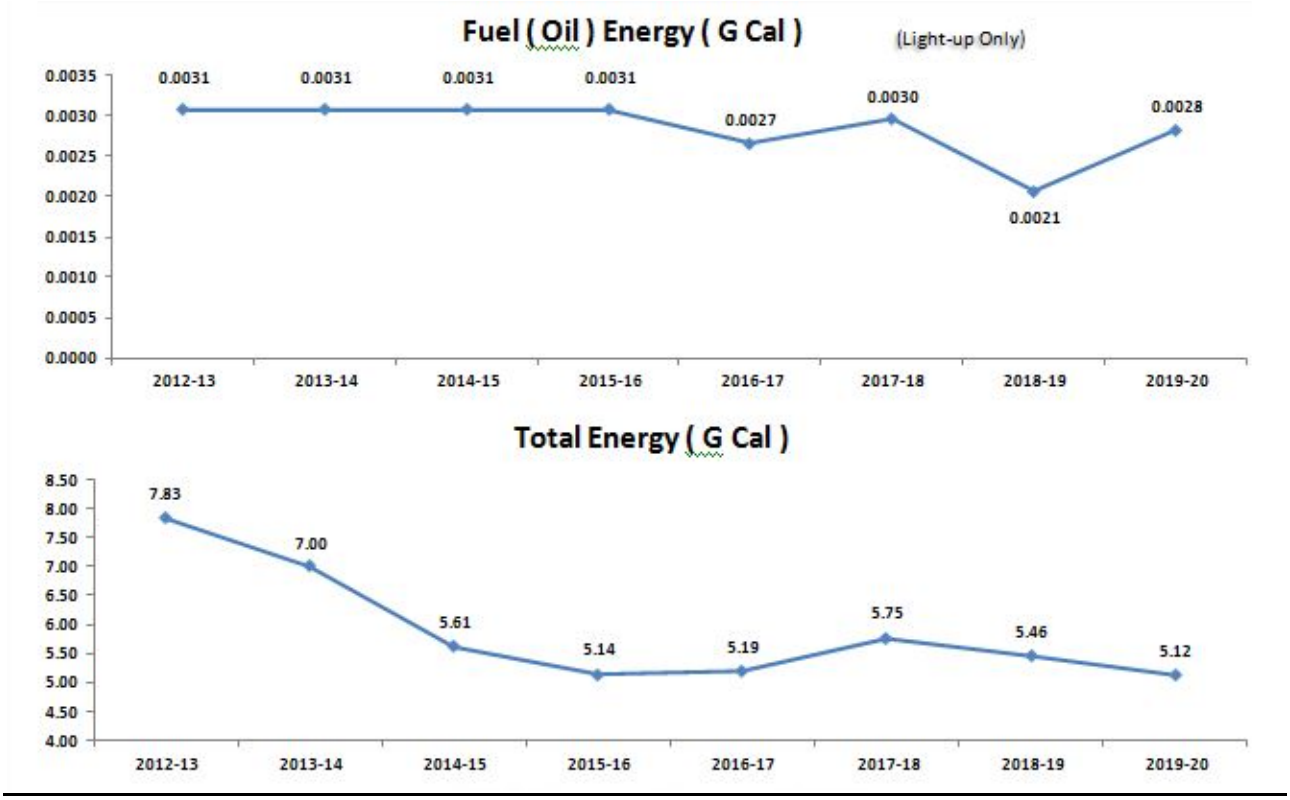
1. Shell temperature.
2. Total weight.
3. Heat loss.
4. Coal consumption.
5. Power consumption.

Use of MPB (Micro porous board) and proper thickness of castable to retain heat inside kiln and minimise energy loss from shell of kiln by reduction of shell temp 20-25* C and sp.coal by 15-25 kg.

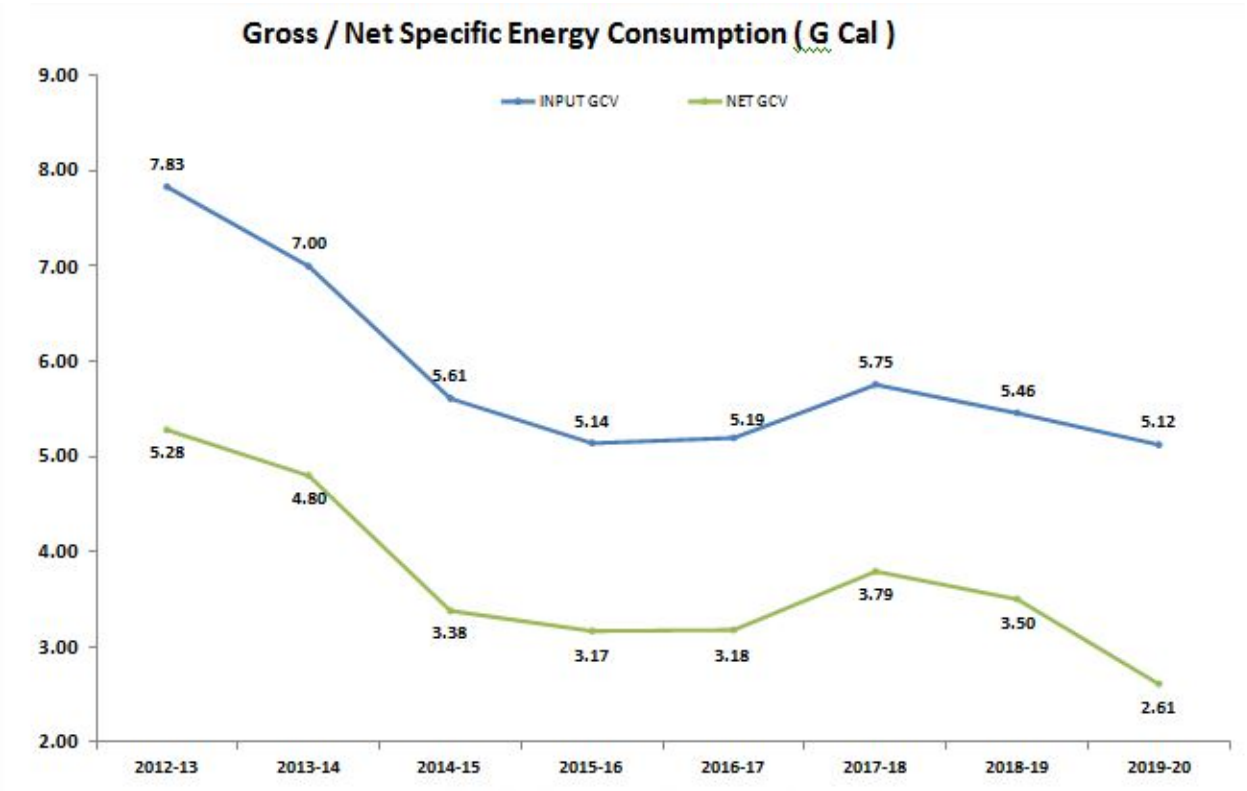
Trend of Specific Energy Consumption



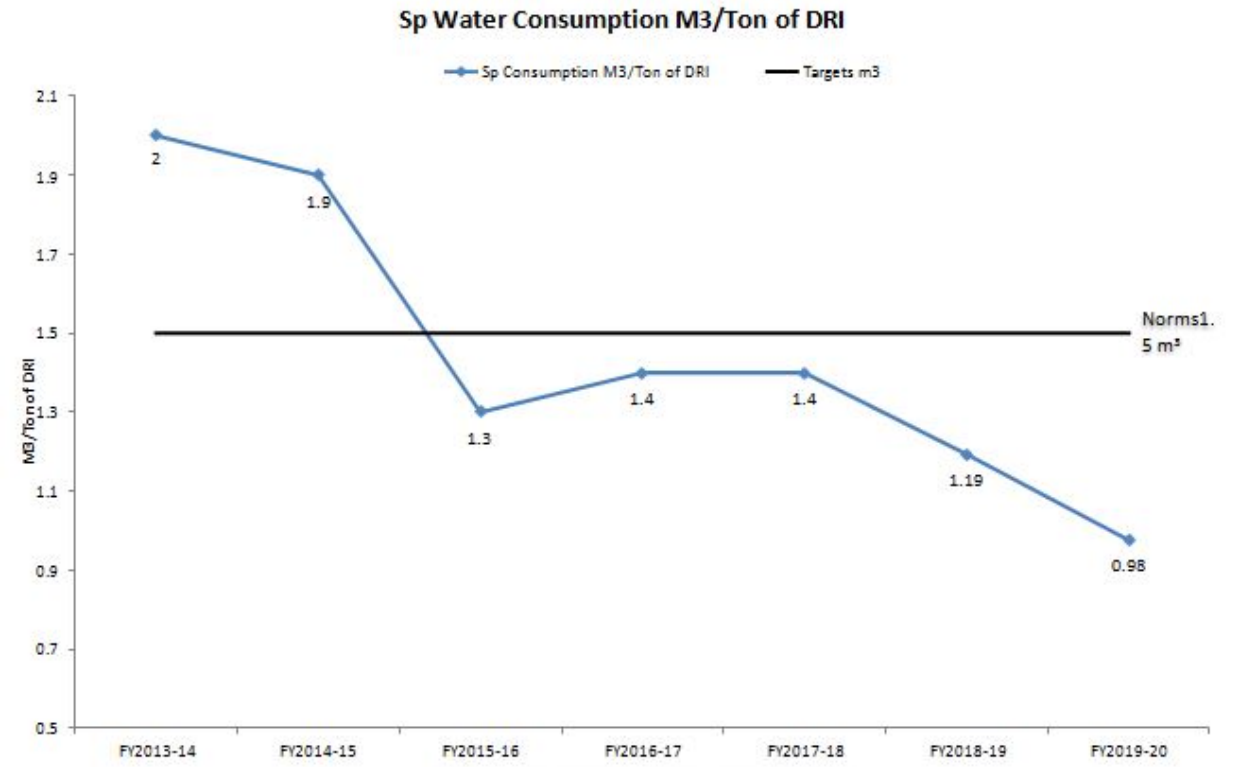
Trend of Specific Energy Consumption



Trend of Specific Energy Consumption



Sp. Water Consumption

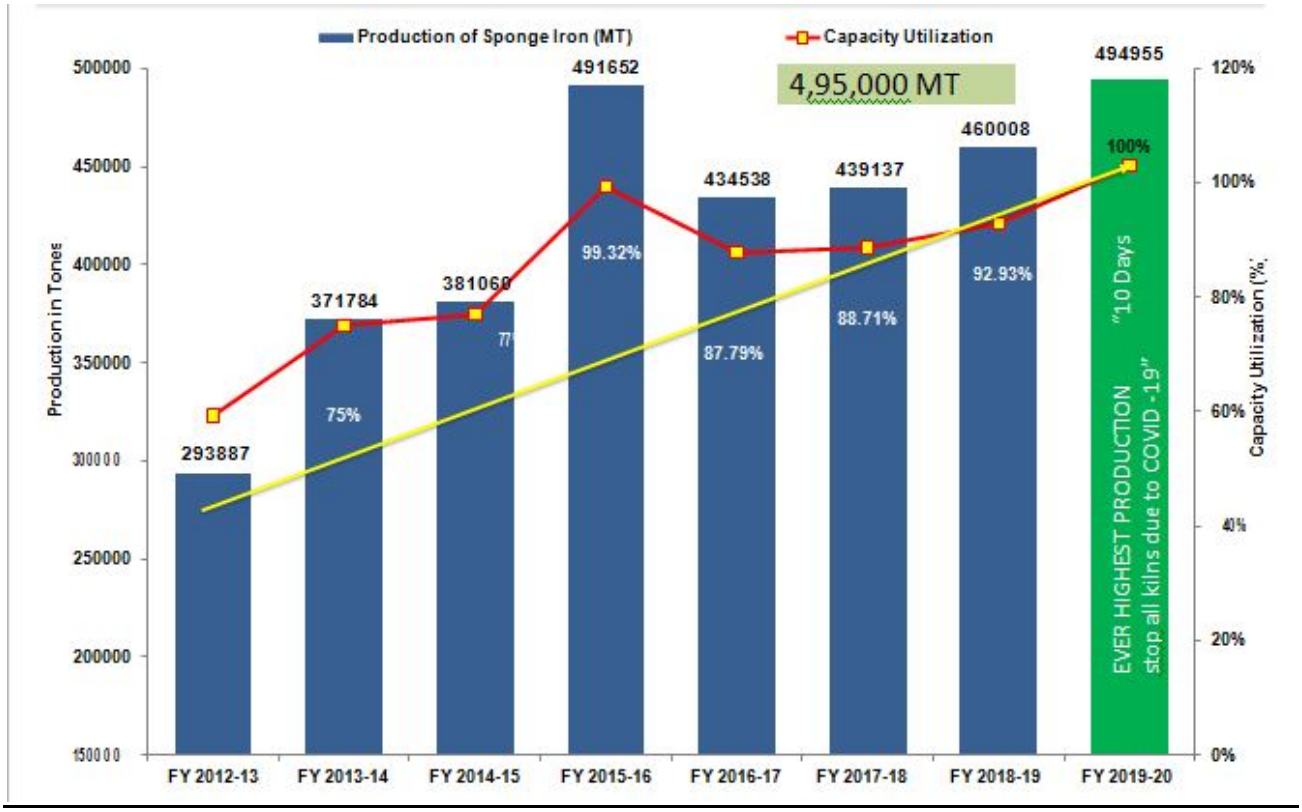


Striving for peak Production and maintenance cost reduction

If we do all preparation for a smooth run after thorough predictive, preventive maintenance, then no one can stop us in achieving and sustaining peak performance. Achieving production at optimum cost is always the outcome of meticulous planning and fine working, at GPIL our team had adopted same concept and did record performance year on year basis. Achieving peak performance and sustaining at peak always bring down cost significantly.

SPECIFIC COST OF MAINTENANCE AND INVENTORY COST IS ALSO ONE GREY AREA FOR COST OPTIMISATION, OVER A PERIOD OF TIME WE HAD STANDARISED MOST OF THE CONSUMABLES AND HAD TRIED TO KEEP ONLY CRITICAL INVENTORY WITH QUALITY SPARES , THIS HAD HELPED US IN SAVING MAINTENANCE COST SIGNIFICANTLY AND ALSO HELPED IN COST REDUCTION DUE TO CARRYING OF INVENTORY.

DRI Production at a Glance



Best from waste:-

As the coal based DRI process generates valuable bye products, the company has adopted several measures to adopt proficient waste management practices and become zero waste company.

Waste is not waste if it is converted to useful resources. In Godawari power we had worked on following waste generation areas.

1. Accretion: - After change in raw material and much better controlon process, accretion generation is almost negligible; accretion is also having good mkt and is a saleable waste.
2. Refractory:-Used refractory is sold in the market.
3. Bag filter dust is fired in ABC and steam generation is maximized, increased steam 1.5-2 tons per hour per kiln.
4. ABC & DSC dust is also having good mkt.
5. All back flow is rescreened and used as raw material while its fines is sold in the mkt.
6. All the above waste had been converted to resource and GPIL is 'zero waste' discharging company.

Outcomes of Innovations

1. **Ever Highest yield (Iron ore + Pellet) of 71.69 % (1.395 Mt).**
2. **Lowest Specific Carbon consumption from 610 Kg ↓ 396 Kg.**
3. **Lowest Specific Energy (Gross) from 7.83 G Cal ↓ of 5.12 G Cal**
4. **Lowest Specific Energy (Net) from 5.28 G Cal ↓ of 2.61 G Cal**
5. **Highest Man power Productivity from 256 Mt/ Head ↑ 825 Mt/ Head**
6. **Highest specific productivity 0.46 mt/m3 (This is a new concept)**
7. **Zero waste generation**

GPIL Glimpses

And the results of our vision and passion is100 to 500

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STATISTICS

Item	Performance of Indian Steel Industry		
	April-Jan 2020-21*(mt)	April-Jan 2019-20(mt)	% Changes*
Crude Steel Production	83.307	91.604	-9.1
Hot Metal Production	56.074	60.776	-7.7
Pig Iron Production	3.827	4.725	-19.0
Sponge Iron Production	27.684	31.444	-12.0
Total Finished Steel (alloy/stainless + non-alloy)			
Production	76.408	91.604	-12.0
Import	3.792	5.991	-36.7
Export	8.837	7.213	22.5
Consumption	74.941	85.409	-12.3
Source: JPC; *provisional; mt=million tones			

Details of the JPC survey of Indian sponge iron industry

JPC under Ministry of Steel carried out a survey of Indian sponge iron units in association with the SIMA. The report also carries two articles from Chairman and ED, SIMA

Highlight of the report are as under:

Parameter	Survey Finding: Ref Year: 2019-20
Number of working /operational units	285
Number of units in coal based route	282
Number of units in gas based route	3
Year of Commissioning	90% of units commissioned after 2002
Annual Capacity	47.85 million tonnes
Production	37.102 million tons
Share of Coal Based Route	82%
Exports	0.836 million tonnes
Employment	84,632
Source of Power	• Grid (102 units) • Captive (48 units) • Both (135 units)
Pollution Control Measure	• Air type (24 units) • Water type (6 units) • Both (255 units)
Testing Facilities	• Chemical (242 units) • Physical (251 units) • Spectography (76 units) • Metallography (64 units)
Number of units with Forward Integration	116
Number of units with Backward Integration	23
Number of units under expansion	20
Capacity under expansion	5.3 million tonnes

NEWS ITEM

Primetals Technologies and Midrex Technologies sign contract with Mikhailovsky HBI for world´s largest HBI plant

- **Plant will produce 2.08 million metric tons of hot briquetted iron (HBI) per year**
- **Latest design features reduce energy consumption and environmental impact**
- **Contract includes engineering, supplies and advisory services**
- **Startup of the plant is expected in the first half of 2024**

Dubai, United Arab Emirates, February 28, 2021 - Mikhailovsky HBI, which was jointly established by USM and Mikhailovsky GOK (part of Metalloinvest), signed a contract with Primetals Technologies and consortium partner Midrex Technologies, Inc. to supply a new Hot Briquetted Iron (HBI) Plant in Zheleznogorsk, Kursk region, Russia. The plant is designed to produce 2.08 million metric tons of HBI per year. Latest design features ensure reduced energy consumption and environmental impact. The contract includes engineering, supplies and advisory services. Startup is expected in the first half of 2024.

The agreement was signed by Pavel Mitrofanov, Deputy CEO of USM; Stephen Montague, President and CEO of Midrex; Etsuro Hirai, Chief Technology Officer of Primetals Technologies and CEO of Primetals Technologies Austria; and Aashish Gupta, Executive Vice President and Head of Global Business Unit – Upstream.

Ivan Streshinsky, CEO of USM, said: “This is the start of an important project for the Russian metals and mining industry that will further strengthen our country's leadership in the global market for hot briquetted iron (HBI), the base product for the green metallurgy of the future. One of the world's largest HBI plants will be built and commissioned in close technological cooperation with Metalloinvest.”

“Mikhailovsky HBI project will help fill the growing demand for low CO2 metallics that our industry desperately needs,” Stephen Montague, President and CEO of Midrex said. “We are proud of our Contribution in development of HBI production and the role that Midrex plays in helping steelmakers to decarbonize.”

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“Previously we have successfully completed HBI 2 and HBI 3 at Lebedinsky GOK. That Primetals Technologies and Midrex have been selected by Mikhailovsky HBI as the technology supplier underscores trust in expertise of our specialists and in our solutions,” Etsuro Hirai, CEO of Primetals Technologies Austria said. “This project will include all the latest technological features and will be one of the largest and most modern HBI plants in the world.”

Nazim Efendiev, CEO of Management Company Metalloinvest, said: "Metalloinvest is the world leader in the market for merchant HBI. In 2020, almost 4.8 million metric tons of briquettes were shipped from Lebedinsky GOK. The Company will bring its accumulated experience in organising HBI production processes to ensure successful implementation of the project. Andrey Varichev Mikhailovsky GOK will be a supplier of high-quality iron ore for the new plant. It is vital that the new plant is designed based on the principles of carbon-free metallurgy, with the prospect of fully transitioning to the use of "green" hydrogen as a reducing agent. This project creates strong basis for further development of “green” metallurgy and active implementation of eco technologies of steel production in the industry”.

The new contract once again proves Midrex-based direct reduction technology as the leading technology in the market with a market share of 80%.

The new plant will be the largest HBI plant in the world and is equipped with the latest design features. The plant includes a 7.15m diameter Midrex shaft furnace, a 19-bay reformer with 280mm MA-1 reformer tubes and low NOx burners for NOx reduction. An increased top gas pressure ensures higher furnace productivity and reduced power consumption. A flue gas hot fan additionally reduces electric power consumption. Also, a hot fines recycling system will be included. The level 1 and level 2 automation systems, including the DRIpax expert system, are also part of the project.

Midrex and Primetals Technologies will be responsible for engineering and supply of mechanical and electrical equipment, steel structure, piping, ductwork, as well as for training and advisory services.

The Midrex plant produces high-quality HBI from iron ore pellets using the natural gas-based Midrex Direct Reduction Process (Midrex NG) - the most environmentally friendly technology for ore-based ironmaking. Compared to traditional ironmaking technologies, the carbon footprint of a Midrex NG plant is reduced by more than 50% compared with blast furnace ironmaking. By replacing natural gas with green hydrogen there is potential to further decrease carbon emissions in the future. The contracted plant is capable of being converted in the future to use up to 100% hydrogen as a reducing agent. The feed for the new HBI plant consists of pellets produced from Mikhailovsky GOK iron ore.

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Investment in the construction of the plant is estimated at over 40 bn roubles excluding VAT. The project will create around 400 highly qualified jobs in Zheleznogorsk. Mikhailovsky HBI (55% owned by USM, 45% by Mikhailovsky GOK) will implement the project based on the principles of project financing.

MIDREX is a registered trademark of Kobe Steel, Ltd.

MIDREX NG is a trademark of Midrex Technologies Inc.

Midrex plant LGOK III at Lebedinsky GOK. A comparable plant will be built in Zheleznogorsk

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Metalloinvest is a leading global iron ore and merchant HBI producer and supplier, and one of the regional producers of high-quality Steel . The Company has the world's second-largest measured iron ore reserve base and is one of the lowest-cost iron ore producers. Metalloinvest is wholly owned by Holding Company USM LLC. Alisher Usmanov is the major beneficiary of Holding Company USM LLC (49%).

Midrex is the world leader for direct reduction ironmaking technology and aftermarket solutions for the steel industry. As the technology provider of the MIDREX® Process for 50-plus years, Midrex designs, builds and services Direct Reduced Iron (DRI) plants.
The MIDREX Process fits the need of steelmakers seeking a dependable and clean source of iron. Each year, MIDREX Plants produce more than 60% of the world's DRI in its three forms: cold DRI (CDRI), hot DRI (HDRI), and hot briquetted iron (HBI). The MIDREX Process is unsurpassed in the industry in terms of production and process flexibility.

The company's headquarters and research and technology development center are located in Charlotte, NC, USA. Midrex Technologies also has offices in the United Kingdom, China, India, and Dubai, and will execute this project through its wholly owned subsidiary Midrex UK Limited. For more information, please visit www.midrex.com .

Primetals Technologies, Limited, headquartered in London, United Kingdom, is a pioneer and world leader in the fields of engineering, plant building, and the provision of lifecycle services for the metals industry. The company offers a complete technology, product, and services portfolio that includes integrated electrics and automation, digitalization, and environmental solutions. This covers every step of the iron and steel production chain—from the raw materials to the finished product—and includes the latest rolling solutions for the nonferrous metals sector. Primetals Technologies is a joint venture of Mitsubishi Heavy Industries and partners, with around 7,000 employees worldwide. To learn more about Primetals Technologies, visit the company website www.primetals.com.

USM is a diversified Russian holding company with significant interests across the metals and mining, telecommunications, technology and Internet sectors. The group's assets include industry leaders such as Metalloinvest, Udokan Copper, MegaFon and ICS Holding. USM is a shareholder of the Centre for Research in Perspective Technologies and an indirect shareholder of Mail.ru Group. USM is registered in Russia. Its key shareholders are Alisher Usmanov, Vladimir Skoch, Farhad Moshiri and Ivan Streshinsky.

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