# Staying ahead in the World Steel Cost Curve:

**S K Roy**

# Assumptions: FY'13

**Production volumes and operating parameters:**

- Actual FY'13 production volume and operating parameters applied where available, estimated values applied where specific information not available.

**Input costs:**

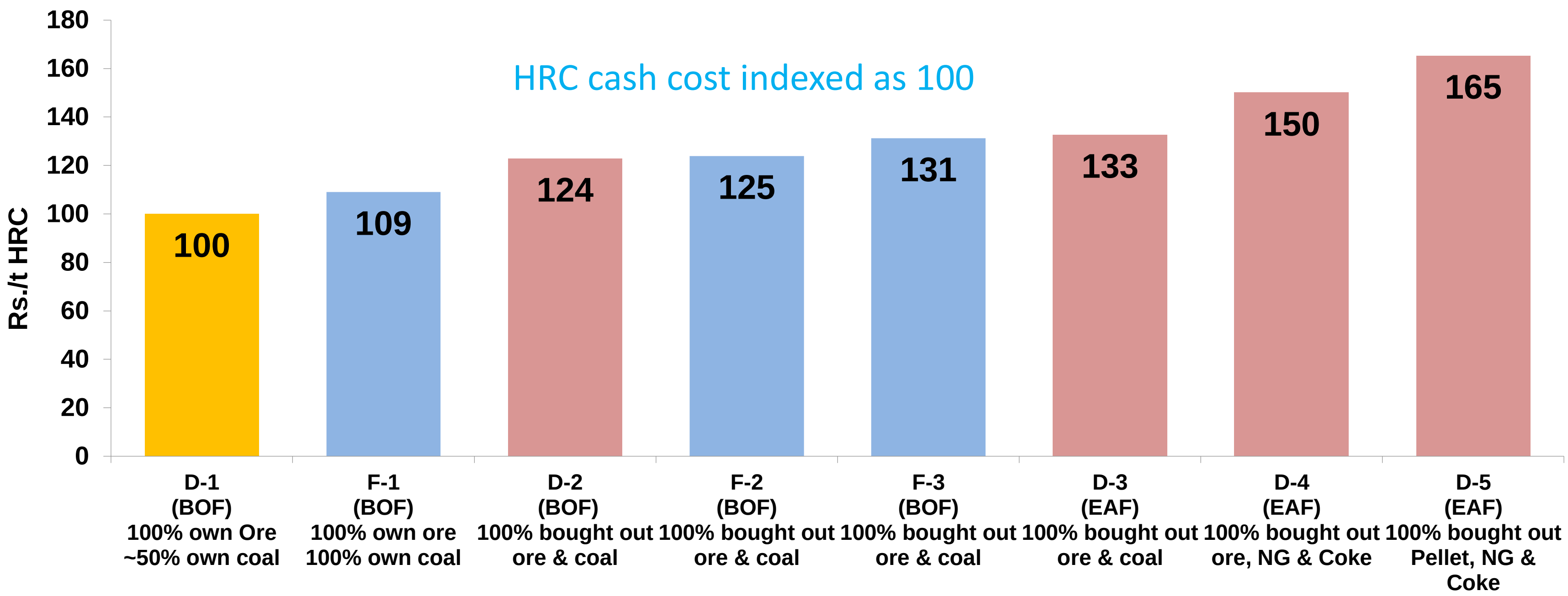
- Actual FY'13 data where available, estimated values applied where specific information not available

The **macro economic parameters** such as inflation, exchange rate & wage inflation are based on the actual data/ Annual Plan 2013-14 document

| | UOM | FY'13 |
|---|---|---|
| Inflation, WPI India | % | 7.36% |
| Salary & Wages escalation | % | Actual |
| HCC (FOB price) | $/t | 193 |
| Exchange Rate | Rs./$ | 54.37 |

- Source: Annual reports / Internet /TSE AP 2012-13 document

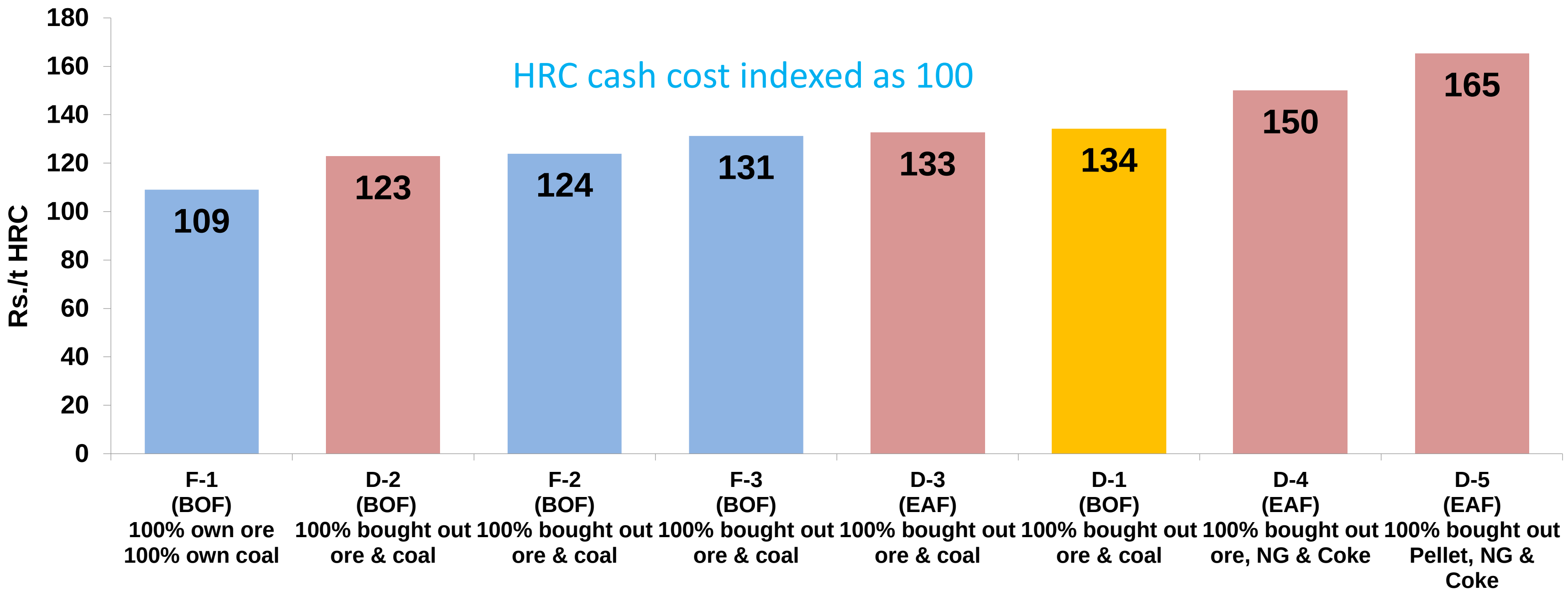
# lowest cost producer of HRC globally(FY'13)




Key Indian and most cost competitive Asian / Global players

- In FY'13, due to regulatory clamp down on iron ore mining in the states of Karnataka & Goa, India had to import 3.8 Mt of iron ore to supplement consumption requirement
- According to the order of the Supreme Court to stop all mining operations in Bellary District in Karnataka, activities from Thimmappanagudi Iron Ore Mines (TIOM) operated by VMPL was halted since July 2011
- One of the steel plant in India is correcting its business model by strengthening its upstream units (addition of new lime plant, coke ovens, pellet plant and on site electricity generation etc).

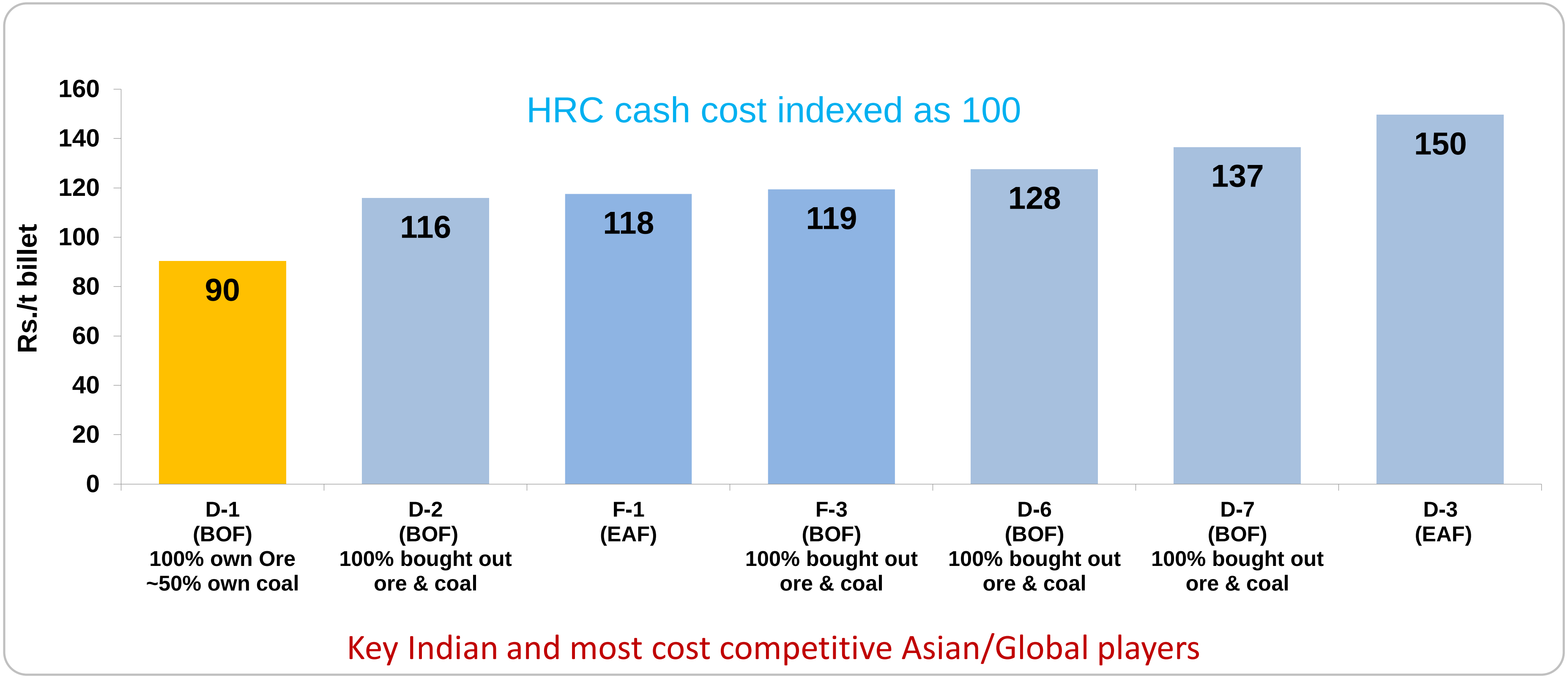
# HRC Cost with bought out Raw Material




Key Indian and most cost competitive Asian / Global players

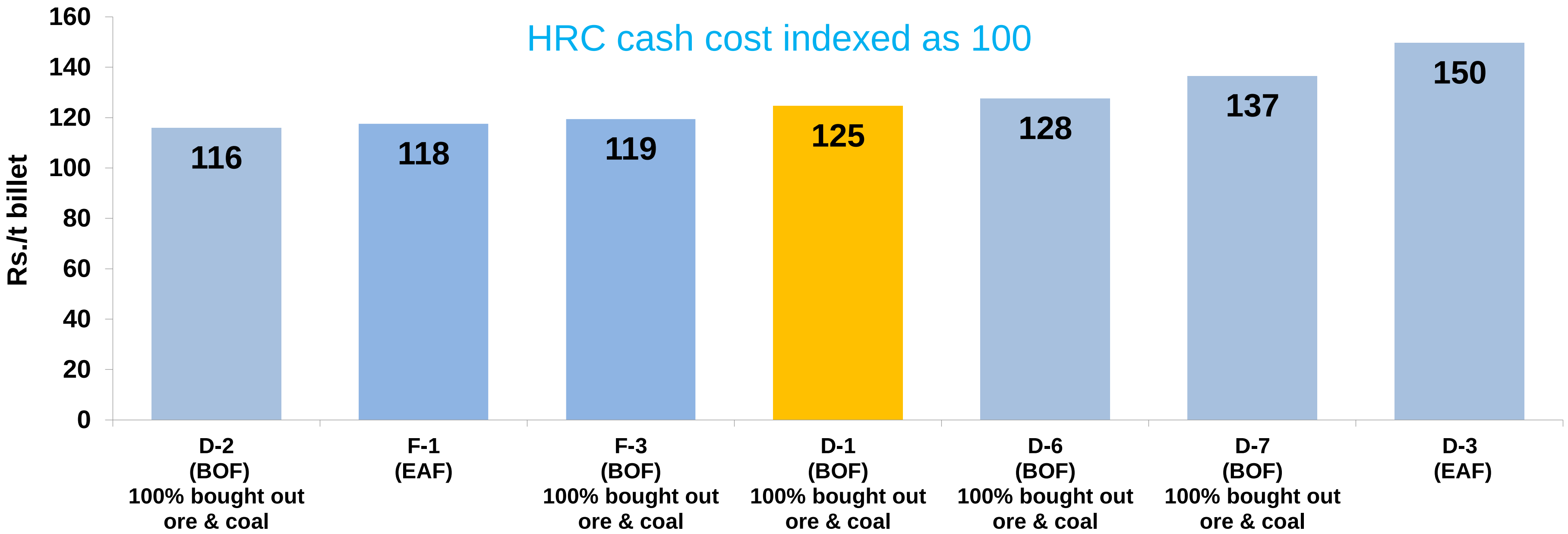
D-1 looses the cost-leadership

# Lowest cost producer of Billet globally'(FY'13)




- D7 billet cost is higher due to two stage conversion ( bloom-billet), however THE PROCESS enables to produce higher grade/special steel products
- D3 billet is through DRI-IF-EAF route (0.3Mt billet capacity)

# Billet Cost with bought out Raw Material in FY'13




Key Indian and most cost competitive Asian/Global players

D-1looses the cost-leadership

# Operating Efficiencies in Iron & Steel making operations

| KPIs | UOM | BOF route | | | | | | EAF route | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FP & LP | FP& LP | LP | FP | FP&LP | FP | FP | FP | FP | LP |
| **BF Iron making** | | | | | | | | | | | |
| Fuel rate | kg/thm | 589 | 562 | 555 | 480 | 494 | 506 | 535 | 570 | 709 | 506 |
| Injection rate (overall) | kg/thm | 111 | 96 | - | 200 | 181 | 88 | 150 | 58 | 133 | 88 |
| Injection rate (bigger fce) | kg/thm | 141 | 100 | - | 200 | 200 | 74 | 150 | 58 | 133 | 74 |
| Agglomerate | % | 73% | 86% | 77% | 95% | 77% | 98% | 75% | 84% | 91% | 98% |
| **BOF/EAF Steelmaking** | | BOF | BOF | BOF | BOF | BOF | BOF | EAF | EAF | EAF | EAF |
| Gross Metallic Charge (HM+Scrap+Ore+Alloys) | kg/tcs | 1170 | 1172 | 1227 | 1096 | 1073 | 1191 | 1205 | 1200 | 1206 | 1211 |
| Scrap rate (scrap only) | % | 5.6% | 5.9% | 7.5% | 7.5% | 13.8% | 24.0% | 4% | 6.5% | 4.5% | 85.8% |
| DRI rate | % | - | - | - | - | 2.8% | - | 41% | 43% | 43.70% | - |
| Flux rate | kg/tcs | 94 | 71 | 80 | 64 | 61 | 64 | 46 | 50 | 42 | 46 |

Source: Annual reports / Internet search /Site Visit reports/ TSE Library services

# Shougang, installed two world-class, large-sized, modern Blast Furnaces in China - Their achievements

1 The Blast Furnaces' Major Technical Features

Constructed & **innovated** independently by Shougang

- Two world class super-sized modern blast furnaces in China
- Equipped with advanced and practical processes, mature and reliable equipment, and energy-saving and environmental protection technologies
- The technologies incorporated offer **valuable reference for future super-sized blast furnace projects**

**Design Parameters of Blast Furnaces No.1 & No.2**

| Parameter | UOM | Factor |
|---|---|---|
| Effective inner volume | m3 | 5500 |
| Productivity | t/m3/d | 2.3 |
| Annual production capacity | Mt | 8.98 |
| Coke rate | kg/t | 290 |
| Coal injection rate | kg/t | 200 |
| Fuel rate | kg/t | 490 |
| Agglomerate | % | 90 |
| Slag ratio | kg/t | 250 |
| Oxygen enrichment ratio | % | 3.5 |
| TRT power generation | kWh/t | 45 |
| One generation campaign life | years | 25 |

2 Operating Performance

No.1 BF and No.2 BF were blown in successfully on 21 May 2009 and 26 June 2010, respectively

- Since blast furnaces successful blow-ins, all the technical and economic parameters have been **steadily and stably advancing**
- The blast furnaces have achieved large-scale operation with high efficiency, modernized, environmental performance and aim for long campaign lives

**No.1 BF Key Technical Index Since Blow-In**

| Date | Producti vity | Coke rate | Fuel Rate |
|---|---|---|---|
| | t/m3/d | kg/t | kg/t |
| May 09 | 0.851 | 551 | 634 |
| Jun 09 | 1.39 | 503 | 565 |
| Jul 09 | 1.447 | 483 | 532 |
| Augt 09 | 1.948 | 372 | 481 |
| Sept 09 | 2.117 | 354 | 483 |
| Oct 09 | 2.216 | 340 | 489 |
| Nov 09 | 2.273 | 300 | 484 |
| Dec 09 | 2.308 | 288 | 480 |
| Jan 10 | 2.302 | 307 | 483 |
| Feb 10 | 2.336 | 287 | 482 |
| Mar 10 | 2.370 | 270 | 481 |

- Source: Feature article from AIST.org through TSE library services

# POSCO (Pohang) challenging newer cost levers

1 Volume

Facility expansions at Pohang

- BF#4 catches up with bigger size blast furnaces. Improved productivity
- Construction of new steel making plant. Achieved early regular-operation (Target 57 days, actual 29)

| Parameter | UOM | 2010 | 2011 |
|---|---|---|---|
| Increase in the inner volume of Blast Fce#4 | m3 | 3795 | 5600 |
| Increase in Crude steel production | Mt | 12.4 | 14.4 |

2 KPI

Improvement in the KPIs e.g :

- Increase in coal injection rate at BF#4
- Lower gaseous fuel consumption at the sinter plant
- Increase in metallic yield at the BOF shop #2

| Parameter | UOM | 2010 | 2011 |
|---|---|---|---|
| Coke rate | kg/t | 315 | 293 |
| Coal injection rate | kg/t | 180 | 200 |
| BF Fuel rate | kg/t | 495 | 493 |
| Sinter Plant gaseous fuel rate | Kcal / t Sinter | 10210 | 7840 |
| BOF metallic yield | % | 94.8 | 95.9 |

3 Technology

Improved productivity and profitability through recycling byproduct(dust, sludge containing Fe)

- Rotary Hearth Furnace: 140 kt/yr capacity HBI plant
- FINEX: 0.6 & 1.5 Mt capacity plant
- Use of HBI in the BOF shop

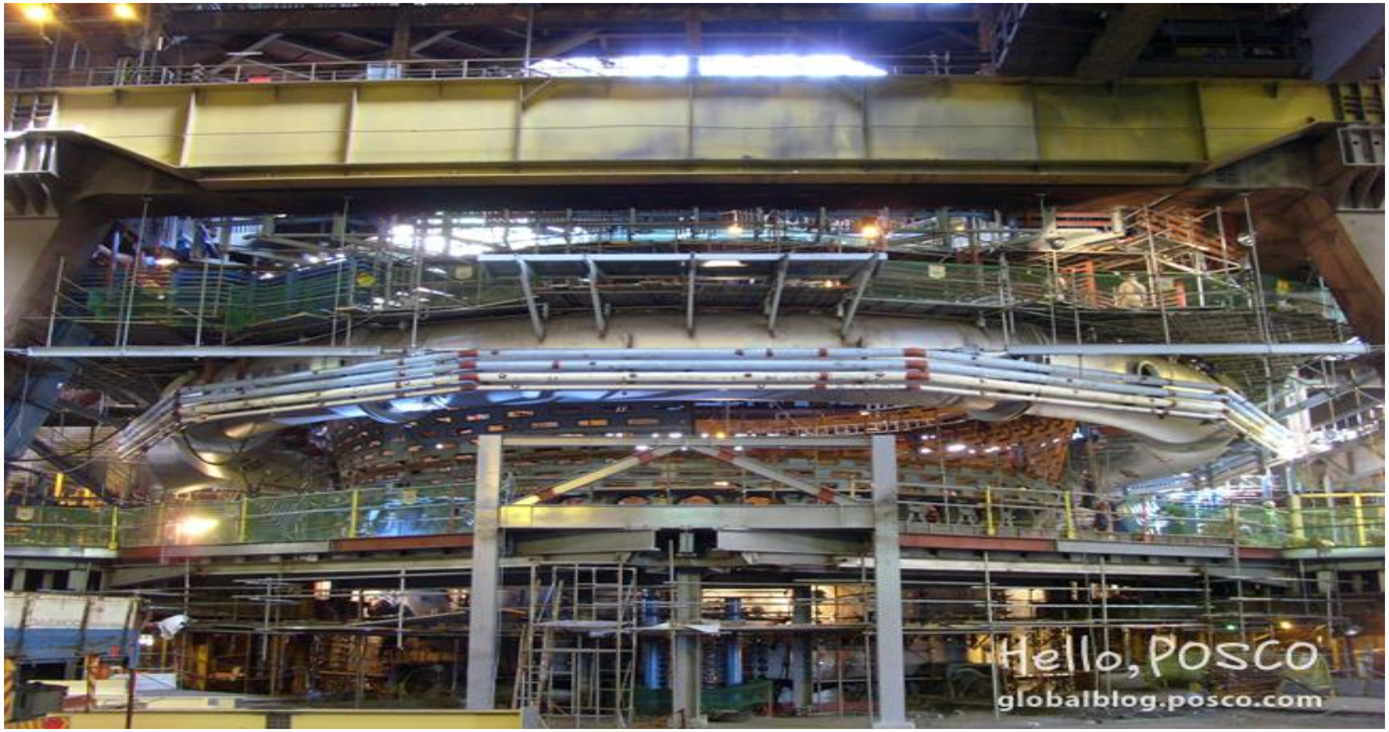
**BOF Shop No.2 (HM+Scrap +HBI consumption)**

| Parameter | UOM | 2010 | 2011 |
|---|---|---|---|
| Scrap | kg/tls | 109 | 144 |
| Hot metal (including pig iron) | kg/tls | 891 | 856 |
| HBI | kg/tls | 27 | 29 |

Source: POSCO analyst meet presentations/ POSCO-Tata technical exchange data

# POSCO (Pohang) challenging newer cost levers

Facility expansions at GwangyangBF#1 has been renovated to 6000M3 volume in 108 days in June 2016 from a volume of 3950 M3.The original volume was 3800 M3 built in April 1987




Posco used a new cooling system to minimise the damage s on the furnace during repair.

Cutting edge technology emdedded to enable introduction of more reducing gas into the furnace

Dry based dust collector used to enhance the recovery of energy

Non steam quenched blast equipment to cool down slag- -less electricity,water,unpleasant smell and dusts

# : Potential if operates at benchmark level > Rs. ~2,500 Crs. (Gross potential)

| Parameters | UOM | POSCO (As Is) | POSCO (Normalised for INDIAN condition) | Typical Indian Plant | Rough Gap Rs. Crores | Rationale/comments |
|---|---|---|---|---|---|---|
| **Solid Fuel Consumption** | kg/t net sinter | 64 | | 80 | 166 | Benchmark indicating gap of ~16 kg / t net sinter without normalising ; ~Rs. 13,543/t anthracite coal cost ; 7.34 Mt of net sinter production |
| **Fuel Rate** | kg/thm | 491 | 574 | 589 | 295 | Benchmark indicating gap of ~15 kg/thm after normalising for agglomerate %, sinter RDI, coke ash, coke CSR, & slag rate ; ~Rs. 22,400/t imported coke cost ; 8.86 Mt of HM production |
| **Labour productivity** | tcs/m/yr | 2364 | | 513 | 1247 | Benchmark indicating gap of ~1851 tcs/m/yr without normalising for mechanisation ;~Rs. 10 lac/man/yr; average salary; 8.13 Mt of crude steel |

** FY 12 figures*

Of course this would have meant CAPEX for correction of technology & quality such as CDQ, sinter alumina etc.

# Cost of Poor Quality > ~Rs. 1,000 Crs.

| | UOM | Typical Domestic Unit | Overseas Unit | Difference | Impact Rs Crores | Rationale/Comments |
|---|---|---|---|---|---|---|
| COKE Ash ↓ | % | 15.3 | 11.4 | 4 | ~620 | For every 1% increase in coke ash, coke rate increases by 8 kg |
| Coke CSR ↑ | point | 64.5 | 65.9 | -1 | ~57 | For every 1 point decrease in coke CSR, coke rate decreases by 2 kg |
| Sinter RDI ↑ | point | 29.8 | 31.2 | -1 | ~69 | For every 1 point decrease in sinter RDI, coke rate decreases by 2.5 kg |
| Hot metal Silicon ↓ | % | 0.86 | 0.51 | 0.35 | ~70 | For every 0.1% increase in HM Si hot metal charge increases by 2.5 kg |
| | | | | | ~146 | For every 0.1% increase in HM Si lime consumption increases by 8.1 kg/tls |
| Hot metal Sulphur ↓ | % | 0.05 | 0.03 | 0.02 | ~100 | For every 0.01% increase in HM Sulphur DS compound increases by 0.8 kg/tls |

- Of course this would have meant CAPEX for correction of technology & quality
- There could be some degree of overlap between the cost of not operating at benchmark level (slide#9) and cost of poor quality

# Potential savings of ~Rs. 50 crores for every 1 unit of improvement in key cost levers

| Parameters | UOM | Domestic Unit | Improvement of 1 unit | Potential (Rs. Crs.) | Assumptions/comments |
|---|---|---|---|---|---|
| **Solid Fuel Consumption** | kg/t net sinter | 80 | 79 | 10 | ~Rs.X /t anthracite coal cost ; T1 Mt of net sinter production |
| **Fuel Rate** | kg/thm | 589 | 588 | 20 | ~Rs.Y /t imported coke cost; T2 Mt of HM production. Considering replacement of purchase coke. |
| **Labour productivity*** | tcs/m/yr | 513 | 514 | 3 | ~Rs. 10 lac/man/yr average salary. |
| **HM+Scrap** | kg/tcs | 1112 | 1111 | 19 | Based on increased throughput. ~Rs.Z /t NR from sale of prime billet; T3 Mt of crude steel production. |

Gross Potential = 52

# Inputs for thought

*Trend in steel industry*

Strategy to secure future RM through vertical integration and long term commitments.

Investment in specific equipment and process control to counter raw materials price increase and grade decline

# Future RM volumes are secured through vertical integration and long term commitments

| | Level of integration / commitments | Assets | Company |
|---|---|---|---|
| Vertical Integration | Increase further vertical integration<br>▪ Iron Ore: 50% up to 70%<br>▪ Coal: to 20% | ▪ Iron Ore: Canada (QCM), Brazil, Liberia, Algeria, Baffinland, Bosnia, CIS (Ukraine, Kazachstan), Mauretania<br>▪ Coal: US, Russia | ArcelorMittal |
| | Increase further vertical integration<br>▪ Iron Ore (group-wide: up to 50-70%) | ▪ Iron Ore: Canada (New Millennium)<br>▪ Coal: Mozambique | TATA<br>TATA STEEL |
| | Current vertical integration level of ~25% for iron ore, no further integration plans announced | ▪ Iron Ore: Austria (Erzberg) | voestalpine |
| Long term contracts | 80-85% of iron ore volume covered under long term contracts | | ThyssenKrupp |

## Steelmakers are investing in specific equipment and process control to counter raw materials price increase and grade decline

| Challenge | Options | | Observed investments / actions |
| --- | --- | --- | --- |
| High coking coal price | Increase PCI level | | ▪ Invest in additional PCI facilities<br>▪ Improve process control to allow BF operation with high slag volume while trying to increase PCI rate<br>▪ Beneficiation of ore to reduce gangue level<br>▪ To work on coal blend to improve coke quality. |
| | Increase use of non coking coal in blend | | ▪ Switch over to stamp charging<br>▪ Coal dryer to increase share of non-coking (USS)<br>▪ Invest in briquetting equipment to increase share of non coking coal (NS) |

## Steelmakers are investing in specific equipment and process control to counter raw materials price increase and grade decline *contd….*

| Challenge | Options | Issues | Observed investments / actions |
|---|---|---|---|
| High Pellet price | Increase sinter productivity | Decreasing iron ore size | ▪ Install slit wires, to increase permeability on the sinter strand by pre segregating the charge<br>▪ Install vertical / horizontal rigs to create a more permeable load on the sinter strand |
| | Maintain sinter quality | Deteriorating chemical quality of natural iron ore. | ▪ Maintain RDI level even with high Al2O3 level by spraying Cacl2.<br>▪ Go for multilevel bedding & blending facilities to homogenise the plant reverts from deferent sources. |

# Steelmakers are investing in specific equipment and process control to counter raw materials price increase and grade decline *contd….*

| Challenge | Options | Issues | Observed investments / actions |
|---|---|---|---|
| High Raw Material Price and Volatility | Increase the portfolio of sintering fuel | Cheaper sintering fuels have higher %S & %N leads to higher emission rates | ▪ Invest in waste gas circulation<br>▪ Install MERON *(Maximised emission reduction of sintering)*<br>▪ Install EPS *(Electrostatic Precipitator)* |
| | Create flexibility on RM burden | ▪ Plant faces storage constraints<br>▪ Less expensive raw material is associated with quality issues | ▪ Invest in extra bunker storage capacity. This will help in shielding raw material from rain.<br>▪ Optimise blending of good and inferior quality raw material to arrive at an acceptable range<br>▪ Optimise the use of plant internal reverts |

## Steelmakers are investing in specific equipment and process control to counter raw materials price increase and grade decline contd…

| Challenge | Options | Issues | Observed investments / actions |
|---|---|---|---|
| Volatile steel demand leading to regular adjustment of Pig Iron supply | Create flexibility in hot metal productivity | Adjusting the outputs makes the blast furnace process less stable | ▪ Invest in process knowledge to optimize the BF process under a wider productivity range (a.o., $O_2$ input), taking into account maximum flexibility at the steel shop.<br>▪ Design the BF process to maximise productivity and utilise the excess Hot Metal profitably.<br>▪ Optimize scrap proportion in the charge at the steel melting shop |

## SOME KNOWN FACTS:

- Blast Furnace performance level improves with improvement in raw material quality.
- With increase in BF size, raw material quality requirement becomes stringent and productivity takes a dip with the same quality level.
- Improved quality level is associated with increase in cost
- The cost of steel manufactured goes up and bottom line is impacted.

## WHAT SHOULD THE BF OPERATOR DO?

- One needs to weigh the option between local optima and global optima and decide action plan.
- In the larger interest, it is important to find one's own way to beneficiate the domestic raw material to improve its quality and work on one's processes to find ways and means to put this raw material to profitable use.

**Let us make an attempt to understand the reasons for the gap and their contribution:-**

## Raw material front

| **Reason** | Contribution range |
| --- | --- |
| **Poor quality of raw material** | 40-45 |
| **Poor quality of Sinter & pellet** | 45-50 |
| **Lower level of PCI injection** | 10-15 |

## Facility Hardware

| **Reason** | **Contribution range** |
| --- | --- |
| **Poor PCI capacity** | 25-30 |
| **Inadequate Instrumentation** | 10-15 |

## System and Skill

| | |
| --- | --- |
| Judgment ,control action etc. | 15-20 |

## To improve productivity and maximise energy utilisation ( key for sustainability ) one needs to Work on:-

- Burden Quality Improvement.
- Increment in prepared Burden.
- Increment in PCI rate.
- Implementation of Torpedo covers.
- Replacement of Coke / PCI by C B M or C N G.

# Thank You.