CII 18th National Awards for Excellence in Energy Management 2017

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Premanand Rane
Ashish Dhanopia
Dhiraj Agarwal

VALUE ADDED BUSINESS
VISION, MISSION & VALUES

VISION
To be the highest value creator in the iron ore industry contributing to the growth of the nation

MISSION
- To continue to maintain our pre-eminent position in safety, environment and quality control management in the respective industry sectors.
- To maximise stakeholder wealth by exploiting core skills of iron ore mining, coke and iron making.
- To constantly seek high levels of productivity and technical efficiency; to maintain technological superiority over competitors.
- To aggressively seek additional resources.
- To maintain costs in the lowest decile globally.
- To be an organization with best-in-class people and a performance driven culture by attracting and retaining quality manpower.
- To contribute to the development of the communities that we operate in or have influence on our business activities.
1954
- starts a mining co

1992
- Commissioned Met coke plant

1994
- Commissioned first mini blast furnace in India

1995
- 1996
- 2000

1996
- Got OHSAS 18001 certification – first in the world for a mining co.

1994
- Commissioned Met coke plant

1995
- Commissioned 2nd Blast Furnace

1996
- First mining co. in the world to get ISO 14001

1998
- Develops own coking technology, applies for patents

1999
- 2000
- 2002

2000
- 2002
- 2013

2013
- Merger of Sesa Goa with Sterlize as Sesa Sterlize

2015
- Got EnMS 50001 certification

2016
- Acquisition of GEL & Commissioning of expansion project
- RBNQA – 2012 Assessment – only mining Company to receive commendation certificate

2017
- 2017

2018
- Excellence Journey continued

2018
- CII Industrial Innovation Award – Top 25 Innovative Organization in India.
- IMEA – 2016 Certificate of Gold
- 5 Star Rating for Sustainable Mining by MoM
- RBNQA- 2016 Certificate of Merit.
**INNOVATIONS & UNIQUE FEATURES**

**Highlights.**

- India’s largest merchant pig iron plant with production capacity of 0.7 MTPA, was first to introduce mini blast furnace concept in India

- Patented environment friendly heat recovery Coke making Technology

- First CDM project in Waste Heat recovery category.

- First to introduce ultra low S, SG grade Pig Iron in India, Development of special SG grade ultra low Mn & low Ti material for wind mills & special
Value Added Business Facility

PIG IRON PLANT I (PID I)

PIG IRON EXPANSION PLANT (BF #3)

SINTER PLANT (SP)

POWER PLANT (PP1, PP2)

COKE PLANT (MCD1, MCD 2)

- **BA - 280 K MT, NPC – 250 K MT**
- **BA - 424 *MU’s, NPC – 500 MU’s**
- **BA - 815* K MT, NPC – 778 K MT**
- **BA - Best achieved, NPC – Name Plate Capacity**
- **BA - 450* K MT, NPC – 375 K MT**
- **BA - 509*K MT, NPC – 522 K MT**
- **BA - 280 K MT, NPC – 250 K MT**
- **BA - 424 *MU’s, NPC – 500 MU’s**
- **BA - 815* K MT, NPC – 778 K MT**
- **BA - Best achieved, NPC – Name Plate Capacity**
- **BA - 450* K MT, NPC – 375 K MT**
- **BA - 509*K MT, NPC – 522 K MT**
The main sources of energy are coke, coal and electricity.
The total energy consumption of VAB for the FY 16-17 is around 35 Lakh MKCal.
Electricity Consumption at a Glance

Division wise break up %
- PID, 78%
- PP, 19%
- MCD, 3%

Plant Wise Break Up %
- BF 3, 34%
- Sinter, 19%
- PP-II, 10%
- PP-1, 9%
- PID-1, 17%
- O2N2, 7%
- MCD I, 3%
- MCD II, 1%

*As per power consumption data of FY’ 16-17
More than 15% of electrical energy consumption is of pollution control equipment.

Source: Benchmarking Visits and CRU Reports
Strategy To Reduce SPC

Details of Project identified

1. Cooling tower pump.
2. River water pump
3. GCS pump
1. Screening Dedusting Fan at Sinter Plant
2. Proportioning Dedusting fan at Sinter plant.
3. HBS CA Fan at Blast furnace 1 and 2.
4. PCI ID Fan at Blast furnace 3
1. Blower Motors at PID-I
1. Replacement of conventional lamp with LED lamps
1. Blow pipe modification to reduce compressed air usage.

Energy Efficiency improvement in fans: 4.8
Energy Efficiency improvement in pumps: 1.8
Energy Efficiency improvement in motors: 1.0
Energy efficiency improvement by LED Lighting: 5.3
Improvement in energy efficiency in compressed air system: 2.7
Strategy To Reduce Specific thermal energy

Specific Thermal energy reduction waterfall (in KJ/THM)

<table>
<thead>
<tr>
<th>Description</th>
<th>(KJ/THM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEC in 2016-17</td>
<td>19.2</td>
</tr>
<tr>
<td>Production of foundry grade iron outside the BF.</td>
<td>0.2</td>
</tr>
<tr>
<td>Reduction in coke breeze by using BF dust.</td>
<td>0.1</td>
</tr>
<tr>
<td>Reduction in coke breeze by using oxygen enrichment.</td>
<td>0.1</td>
</tr>
<tr>
<td>Reduction in GUTKO time from 70 mins to 50 mins.</td>
<td>0.1</td>
</tr>
<tr>
<td>Modifying the shutdown burden of blast furnace.</td>
<td>0.1</td>
</tr>
<tr>
<td>Targeted SPC in FY 19-20</td>
<td>18.6</td>
</tr>
</tbody>
</table>
Energy Conservation Projects
IMPLEMENTED ENERGY SAVING PROJECTS IN LAST 3 YEARS

Energy Saving in M Kcal - YoY

Total Energy saving potential in M Kcal

Total Energy Saving in M KCal - Category Wise

Total Saving potential of Rs. 99 Millions/year
Total Power saving of 13 Million Units/year,
Total Thermal energy saving of 42560 M Kcal/year
<table>
<thead>
<tr>
<th>Year of Implementation</th>
<th>CATEGORY</th>
<th>Title of Energy saving Project Implemented</th>
<th>Total Annual Savings</th>
<th>Investment Made</th>
<th>Payback in Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014-15</td>
<td></td>
<td>Installation of APH and GPH in blast furnace.</td>
<td>21.0</td>
<td>14.4</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Starter modification (delta/star) for CB-1 and cooling tower fan no.3 at BF#3</td>
<td>0.15</td>
<td>0.07</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elimination of coke fines conveyor at BF#3.</td>
<td>0.08</td>
<td>1.18</td>
<td>177</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elimination of C1 and C2 conveyor in sinter plant by providing by pass chute.</td>
<td>0.06</td>
<td>0.18</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Optimization of oxygen compressor loading through logic modification at O2N2 plant</td>
<td>1.26</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
## IMPLEMENTED ENERGY SAVING PROJECTS

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>Title of Energy saving Project Implemented</th>
<th>Total Annual Savings</th>
<th>Investment Made</th>
<th>Payback in Months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Elimination of BF1 venturi pump operation by tapping the pipeline from GCS line.</td>
<td>0.20</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2014-15</td>
<td>Optimizing the voltage of distribution transformers secondary to 410V.</td>
<td>0.10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Switching off of 2 nos. under loaded transformers in sinter plant.</td>
<td>0.09</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Automation of C4 conveyor to start/Stop through gate valve logic automation.</td>
<td>0.09</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Eliminated Ore Fines conveyor at BF3 by taking it directly to the bunker</td>
<td>0.09</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Total energy saving is 2497 M Kcal
<table>
<thead>
<tr>
<th>Year of Implementation</th>
<th>CATEGORY</th>
<th>Title of Energy saving Project Implemented</th>
<th>Total Annual Savings</th>
<th>Investment Made</th>
<th>Payback in Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015-16</td>
<td></td>
<td>Sinter bed height extension by 100mm from 650mm to 750mm</td>
<td>40.33</td>
<td>3.80</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diverting partial quantity of furnace cooling water directly to cooling tower basin.</td>
<td>0.37</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delta/ Star starter for underloaded drives</td>
<td>0.08</td>
<td>0.02</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eliminated BF-2 venturi pump operation by tapping the pipeline from GCS water line.</td>
<td>0.02</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Retrofitting 6.5 MW rotor impeller with energy efficient one.</td>
<td>15.11</td>
<td>12.77</td>
<td>10</td>
</tr>
<tr>
<td>Year of Implementation</td>
<td>CATEGORY</td>
<td>Title of Energy saving Project Implemented</td>
<td>Total Annual Savings</td>
<td>Investment Made</td>
<td>Payback in Months</td>
</tr>
<tr>
<td>------------------------</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rs. Millions</td>
<td>Rs Millions</td>
<td></td>
</tr>
<tr>
<td>2015-16</td>
<td></td>
<td>Replaced BFG blower with energy efficient blower</td>
<td>2.20</td>
<td>4.48</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Installed energy efficient cooling water pump</td>
<td>1.90</td>
<td>0.50</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arresting compressed air leakage (PID-1)</td>
<td>1.53</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduction in coke breeze consumption in sinter plant.</td>
<td>0.75</td>
<td>2.00</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Installed voltage controller for high mast tower (5 nos.)</td>
<td>0.02</td>
<td>0.02</td>
<td>10</td>
</tr>
</tbody>
</table>

Total energy saving is 17,125 M Kcal
<table>
<thead>
<tr>
<th>Year of Implementation</th>
<th>CATEGORY</th>
<th>Title of Energy saving Project Implemented</th>
<th>Total Annual Savings</th>
<th>Investment Made</th>
<th>Payback in Months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rs. Millions</td>
<td>Rs Millions</td>
<td></td>
</tr>
<tr>
<td>2016-17</td>
<td>Production of foundry grade iron outside the furnace.</td>
<td>41.2</td>
<td>0.1</td>
<td>-</td>
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<tr>
<td></td>
<td>Up gradation of ID fan for blast furnace 1 and 2.</td>
<td>5.12</td>
<td>4.86</td>
<td>11</td>
<td></td>
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<tr>
<td></td>
<td>Replacement of 2 hot well pumps with energy efficient pumps.</td>
<td>1.71</td>
<td>1.50</td>
<td>11</td>
<td></td>
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<tr>
<td></td>
<td>Sinter plant operation in 2 nos. of chill fan</td>
<td>2.82</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Installation of voltage controllers for lighting feeders</td>
<td>0.28</td>
<td>1.80</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>Year of Implementation</td>
<td>CATEGORY</td>
<td>Title of Energy saving Project Implemented</td>
<td>Total Annual Savings</td>
<td>Investment Made</td>
<td>Payback in Months</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------</td>
<td>------------------------------------------</td>
<td>----------------------</td>
<td>-----------------</td>
<td>------------------</td>
</tr>
<tr>
<td>2016-17</td>
<td></td>
<td>Optimization of Fuel and Flux fan.</td>
<td>0.54</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capacitor bank installation in sinter plant</td>
<td>0.06</td>
<td>0.10</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Impeller trimming of cooling tower pump</td>
<td>0.06</td>
<td>0.01</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stock house DD fan automation</td>
<td>0.55</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Automation of river water pump</td>
<td>0.02</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Total energy saving is 34,121 M Kcal
Green House Gases- Inventory
**Green House Gas Emission**

**Total CO2e MT (in Lakh)**

<table>
<thead>
<tr>
<th>Year</th>
<th>FY 15-16</th>
<th>FY 16-17</th>
<th>FY 17-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission (MT)</td>
<td>1.82</td>
<td>1.90</td>
<td>0.86</td>
</tr>
</tbody>
</table>

**GHG Emission Per THM (tCO2/THM)**

<table>
<thead>
<tr>
<th>Year</th>
<th>FY 15-16</th>
<th>FY 16-17</th>
<th>FY 17-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emit.</td>
<td>2.74</td>
<td>2.65</td>
<td>2.62</td>
</tr>
</tbody>
</table>

- **Pulv. coal injection to reduce GHG emission**
- **APH and GPH to reduce GHG emission.**
- **Continuous plantation Drive**

*GHG Emission Apr’17 - July’17*
INNOVATION
### Project Selection

#### 200 Ideas

- **50 shortlisted**
- **7 Prioritized**
- **Top 3**

<table>
<thead>
<tr>
<th>Idea Description</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>P6</th>
<th>P7</th>
<th>Total Points</th>
<th>Maximum Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundry grade production outside Blast Furnace</td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Additional SG Grade Production</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>45</td>
<td>70</td>
</tr>
<tr>
<td>Upgradation of blowers and HBS ID</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>51</td>
<td>70</td>
</tr>
<tr>
<td>Stack Bottom Tapping</td>
<td>9</td>
<td>8</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>9</td>
<td>62</td>
<td>70</td>
</tr>
<tr>
<td>Reduction in Coke/PCI consumption</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>47</td>
<td>70</td>
</tr>
<tr>
<td>Coke rate reduction by increasing sinter bed height from 650mm to 750mm.</td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Reduction in Coke Breeze Consumption through Steam Injection in SMD</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>41</td>
<td>70</td>
</tr>
</tbody>
</table>

**Improvement in Waste heat utilization by Stack Bottom Tapping**

**Coke rate reduction by increasing sinter bed height from 650mm to 750mm.**

**Foundry grade production outside Blast Furnace to reduce thermal energy consumption.**
Innovative Projects

Improvement in Waste heat utilization by Stack Bottom Tapping

- Foundry grade iron production outside blast furnace.
- Increase in sinter bed height from 650 mm to 750 mm
- Steam Injection at Sinter Plant in Secondary mixing drum
- Savings in coke due to Iron Ore addition in Ladle.
- Introduction of Air Pre-Heater & Gas Pre-Heater.
WASTE HEAT RECOVERY - POWER GENERATION

Process Flow

CHIMNEY
FROM CONDENSATE AND DM WATER
DEAERATOR
BOILER FEED PUMP
WASTE HEAT RECOVERY BOILER
COKE OVEN
COFG
Combustor
BF GAS
STEAM
CW INLET
CW OUTLET
TO DEAERATOR
Electric generator
Electricity
Cooling tower
DEAERATOR
WASTE HEAT RECOVERY
POWER GENERATION
Project Area

Project Area
Temp of COFG is 1100-1150 °C
Heat loss 62 M Kcal/Hr.

Temp of COFG is 1250-1300 °C

Increased generation of 1.8 MW

COFG inlet to WHRB

Before

32m

After
Before
• Energy loss of 62 M Kcal/hr due to temp. loss of about 150 C.

After
• Recovery of heat to generate additional power of 1.8 MW.

Daily Benefit
• Profit of Rs. 98 K per day due to 1.8 MW excess power generation.

Annual Benefits
• Profit of Rs 3.41 Cr/ annum.
• Utilization of 62 M Kcal /hr heat of waste gases.
• Investment 7 Cr, Payback 2 years
Innovative Projects

- Improvement in Waste heat utilization by Stack Bottom Tapping
- **Foundry grade iron production outside blast furnace.**
- Increase in sinter bed height from 650 mm to 750mm
- Steam Injection at Sinter Plant in Secondary mixing drum.
- Savings in coke due to Iron Ore addition in Ladle.
- Introduction of Air Pre-Heater & Gas Pre-Heater.
Foundry grade iron production by Outside Blast Furnace.

Productivity:
- Basic grade: 3.80 T/m³/hr.
- Foundry grade: 3.40 T/m³/hr.

Fuel Consumption (Coke rate):
40 Kgs/THM increases in Foundry grade production.

Addition of additives to convert Basic Grade to Foundry Grade PI

Total Quantity produced by Fe-Si addition FY 16-17 165K MT.
Total thermal energy saving 28875 M Kcal

Total Saving FY 16-17 41.2 Million/year
Innovative Projects

- Improvement in Waste heat utilization by Stack Bottom Tapping
- Foundry grade iron production by Ferro- silicon addition.
- **Increase in sinter bed height from 650 mm to 750mm**
- Introduction of Air Pre-Heater & Gas Pre-Heater.
- Savings in coke due to Iron Ore addition in Ladle.
- Steam Injection at Sinter Plant in Secondary mixing drum.
Increase in Sinter Bed Height

Need for the Project:
In the Pig Iron Manufacturing, Sinter plays a vital role as it helps in better productivity and also reduce coke rate in Blast furnace. This project helped us to increase Sinter production by 250t to 300t/day to meet the requirement of all the three Blast furnaces.

Innovation in the Approach:
- Internal study of the equipment was done to check the suitability.
- Study of design & modification was done internally.
- Modification of sinter machine pallet car (height extension by 100mm) done internally.
- Reengineering of Sinter Plant process parameters to ease operation.

Benefits & Savings:
Sinter Plant productivity increased to 1.50t/m2/hr from 1.31t/m2/hr (average daily increase in sinter production is 250t)

- CII Industrial Innovation Award – Top 25 Innovative Organization
- Saving of coke rate resulting in energy saving of 8900 M Kcal/year
- Side wall to be increased by 100mm
1. Interconnecting BF gas pipeline from Power Plant II to Power Plant I for utilization of excess BFG. (Increase in Power generation by 3 MW)

2. Reduction in coke breeze consumption of sinter plant by using BF dust, and oxygen enrichment. (Reduction in Thermal energy by 31220 M Kcal/Year)


4. Reduction in coke rate at Blast Furnace by increase in oxygen enrichment.

5. Reduction in thermal energy consumption by using pulverized coal injection in PID-1.
Pareto analysis for factors influencing coke breeze consumption

Co-relation between specific Coke breeze consumption and BFG dust.

Chemical Analysis of Iron Ore fines & Flux

<table>
<thead>
<tr>
<th>Component s</th>
<th>IOF</th>
<th>Dolomite</th>
<th>Limestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe</td>
<td>58.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mn</td>
<td>0.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SiO2</td>
<td>4.83</td>
<td>5.60</td>
<td>6.02</td>
</tr>
<tr>
<td>Al2O3</td>
<td>2.97</td>
<td>0.86</td>
<td>0.95</td>
</tr>
<tr>
<td>P</td>
<td>0.05</td>
<td>0.03</td>
<td>0.044</td>
</tr>
<tr>
<td>LOI</td>
<td>6.17</td>
<td>40.15</td>
<td>42.13</td>
</tr>
<tr>
<td>CaO</td>
<td>29.02</td>
<td>48.60</td>
<td></td>
</tr>
<tr>
<td>MgO</td>
<td>19.23</td>
<td>1.76</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Analysis of Blast Furnace Gas Dust

<table>
<thead>
<tr>
<th>Components</th>
<th>GCP (Gas cleaning plant)dust</th>
<th>Blast Furnace Dust catcher dust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe</td>
<td>30.90</td>
<td>38.35</td>
</tr>
<tr>
<td>SiO2</td>
<td>9.48</td>
<td>8.06</td>
</tr>
<tr>
<td>Al2O3</td>
<td>5.90</td>
<td>5.32</td>
</tr>
<tr>
<td>MnO</td>
<td>0.88</td>
<td>0.82</td>
</tr>
<tr>
<td>CaO</td>
<td>6.36</td>
<td>4.78</td>
</tr>
<tr>
<td>MgO</td>
<td>3.22</td>
<td>2.32</td>
</tr>
<tr>
<td>P</td>
<td>0.07</td>
<td>0.05</td>
</tr>
<tr>
<td>LOI</td>
<td>28.09</td>
<td>21.88</td>
</tr>
<tr>
<td>CARBON</td>
<td>23.58</td>
<td>20.32</td>
</tr>
</tbody>
</table>

Initiative taken to reduce Coke breeze consumption at sinter plant
Monitoring & Reporting System
REPORTING & MONITORING SYSTEM

**FREQUENCY**

**REPORT/SYSTEM**

**RESPONSIBILITY**

**DAILY**

- Separate report on energy and water consumption.
- Monitoring energy consumption on daily basis in WAR Rooms and Tracking in MIS.
- Reporting the major variances to the management.
- Review of concerns raised in daily morning meetings.

**FREQUENCY**

**REPORT/SYSTEM**

**RESPONSIBILITY**

**MONTHLY**

- MIS reporting for energy consumption for the whole plant.
- Review on projects related to reduction in specific energy consumption.
- Variance analysis with respect to budgeted fig.
- Monthly review on specific energy consumption.
### DAILY SEC DEVIATION - ANALYSIS

#### Specific Power Consumption (KWH/THM)

<table>
<thead>
<tr>
<th>DATE</th>
<th>PRODUCTION</th>
<th>BLOWER</th>
<th>STOCK HOUSE</th>
<th>CAST HOUSE</th>
<th>RF ACCESSORIES &amp; HHS</th>
<th>PCI</th>
<th>CWPS &amp; COMPRESSOR</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>01-08-17</td>
<td>1342</td>
<td>96</td>
<td>8.2</td>
<td>4.5</td>
<td>7.9</td>
<td>2.4</td>
<td>26.5</td>
<td>150</td>
</tr>
<tr>
<td>02-08-17</td>
<td>1337</td>
<td>96</td>
<td>11.3</td>
<td>48</td>
<td>8.1</td>
<td>2.7</td>
<td>27.5</td>
<td>154</td>
</tr>
<tr>
<td>03-08-17</td>
<td>1338</td>
<td>92</td>
<td>5.1</td>
<td>49</td>
<td>7.8</td>
<td>2.5</td>
<td>25.6</td>
<td>145</td>
</tr>
<tr>
<td>04-08-17</td>
<td>1390</td>
<td>92</td>
<td>8.0</td>
<td>50</td>
<td>7.6</td>
<td>2.6</td>
<td>26.6</td>
<td>146</td>
</tr>
<tr>
<td>05-08-17</td>
<td>1373</td>
<td>94</td>
<td>8.4</td>
<td>50</td>
<td>7.7</td>
<td>2.6</td>
<td>27.3</td>
<td>150</td>
</tr>
<tr>
<td>06-08-17</td>
<td>1394</td>
<td>94</td>
<td>8.2</td>
<td>50</td>
<td>7.5</td>
<td>2.6</td>
<td>27.3</td>
<td>149</td>
</tr>
<tr>
<td>07-08-17</td>
<td>1455</td>
<td>89</td>
<td>7.8</td>
<td>5.1</td>
<td>7.2</td>
<td>2.6</td>
<td>25.7</td>
<td>142</td>
</tr>
</tbody>
</table>

#### DAILY SEC DEVIATION - ANALYSIS

Following are run hrs. deviation. Excess power consumed FTD: 2430 KWh due to extra run hrs.

**Specific energy FTD: 152KWH/THM**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>KW</th>
<th>Benchmark run hrs</th>
<th>Actual</th>
<th>Deviation</th>
<th>Excess KWh consumed</th>
<th>Impact on sp. consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan well pumps</td>
<td>54</td>
<td>42.00</td>
<td>48.00</td>
<td>6</td>
<td>3.34</td>
<td>0.13</td>
</tr>
<tr>
<td>Compressors (BF)</td>
<td>108</td>
<td>48.00</td>
<td>60.02</td>
<td>12</td>
<td>12.16</td>
<td>0.95</td>
</tr>
<tr>
<td>Compressors (PCI)</td>
<td>49</td>
<td>24.00</td>
<td>36.45</td>
<td>12</td>
<td>10.45</td>
<td>0.44</td>
</tr>
<tr>
<td>Jockey Pump</td>
<td>11</td>
<td>6.00</td>
<td>24.00</td>
<td>18</td>
<td>18.00</td>
<td>0.14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>0.00</td>
<td>18</td>
<td>2430.21</td>
<td>1.77</td>
</tr>
</tbody>
</table>

#### Run Hours monitoring

##### Specific Power Consumption (KWH)

<table>
<thead>
<tr>
<th>DRIVES</th>
<th>BLOWER</th>
<th>STOCK HOUSE</th>
<th>CAST HOUSE</th>
<th>RF ACCESSORIES &amp; HHS</th>
<th>PCI</th>
<th>CWPS &amp; COMPRESSOR</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER</td>
<td>127655.00</td>
<td>11409.00</td>
<td>8060.00</td>
<td>9981.00</td>
<td>3349.00</td>
<td>37851</td>
<td>268962.00</td>
</tr>
<tr>
<td>BENCHMARK</td>
<td>12910.00</td>
<td>10000</td>
<td>7781.00</td>
<td>11217.00</td>
<td>3448</td>
<td>37633</td>
<td>207576</td>
</tr>
<tr>
<td>SPECIFIC</td>
<td>92.99</td>
<td>8.37</td>
<td>5.87</td>
<td>7.27</td>
<td>2.44</td>
<td>28</td>
<td>152</td>
</tr>
<tr>
<td>BENCHMARK</td>
<td>88.8487</td>
<td>5.5274</td>
<td>5.3281</td>
<td>7.6827</td>
<td>2.3614</td>
<td>25.7762</td>
<td>142.1752</td>
</tr>
<tr>
<td>% Deviation</td>
<td>4.67%</td>
<td>11.19%</td>
<td>10.18%</td>
<td>-5.36%</td>
<td>3.32%</td>
<td>6.97%</td>
<td>7.07%</td>
</tr>
</tbody>
</table>

#### Deviation monitoring

1. (+3.6KWH/T) is due to less production
2. (-1.3KWH/T) is due to less consumption by BLOWER due to low wind

#### Reasons for Deviation

1. (+1.6KWH/T) is due to less production
2. (+0.8KWH/T) is due to excess consumption by stock house dusting fan. BENCHMARK is 5205 and actual is 5290. Also, jockey pump has consumed more power due to excess run hours by CHDO fan
Continual Improvement - Energy Management System

**MANAGERIAL**

**PLAN:**
- Policy/goals/targets
- Resources

**DO:**
- Training
- Communication
- Control equipment systems & processes

**CHECK:**
- Corrective/preventive action
- Internal audits

**ACT:**
- Management review

**TECHNICAL**

**PLAN:**
- Energy data management
- Assessments

**DO:**
- Energy purchasing
- Design
- Projects
- Verification

**CHECK:**
- Monitoring
- Measurement

**ACT:**
- System performance
ENERGY AND CARBON POLICY

We at Vedanta Limited - Iron Ore Business, acknowledge the sustainable global action towards reduction in the scale and severity of the problem of climate change. We are committed to this effort through progressive energy and carbon programme that forms an integral part of our sustainable development and business goals.

We shall strive to:

- Adopt, implement and maintain best in class technology, processes and practices for carbon and energy management and minimize greenhouse gas emissions across all our activities and services.
- Monitor and improve our energy usage and carbon emissions from all our activities and operations, optimise energy consumption through adoption of energy efficient, innovative techniques and minimise carbon emissions. Report carbon emissions in conformance with the International Reporting Standards.
- Enhance energy efficiency as a factor in process, operations and facility design.
- Explore opportunities for adoption and implementation of renewable energy sources.
- Create awareness among employees and stakeholders on energy conservation and minimisation of greenhouse gas emissions.

This policy shall be implemented throughout the Iron Ore Business. We will measure progress against this policy and improve performance on a periodic basis, to enable ongoing management of energy and carbon efficiency.

Chief Executive Officer,

Jawahar Kumpat,

Date: 07th July, 2013

ENERGY CONSERVATION CELL

Encon spent 23 Cr

Turnover 1629 Cr

EBITA 245 Cr

ISO 50001:2011

FY 2016-17

ISO 9001:2015

ISO 14001:2015

OHSAS 18001:2007
Green Supply Chain
Vedanta operations shall identify material supplies/suppliers in terms of sustainability impact and consider how they can work with the key suppliers to reduce sustainability impacts. This include identifying raw material products with the most significant impact and determining risk reduction methods in collaboration with the supplier, such as energy efficiency programs, raw material substitution, alternate packaging strategies including take-back, alternate transport strategies etc.

Technical Standard – Supplier and Contractor Management

4.11. Supply chain

a) Vedanta operations shall identify material supplies/suppliers in terms of sustainability impact and consider how they can work with the key suppliers to reduce sustainability impacts. This may include identifying raw material products with the most significant impact and determining risk reduction methods in collaboration with the supplier, such as energy efficiency programmes, raw material substitution, alternate packaging strategies including take-back, alternate transport strategies etc.

b) In accordance with IFC Performance Standard 2, Vedanta operations shall monitor their primary supply chain on an ongoing basis in order to identify any significant changes in its supply chain and if new risks of child and/or forced labour are identified, Vedanta shall take appropriate steps to remedy them.

c) In accordance with IFC Performance Standard 2, where there is a high risk of significant issues related to workers employed by a primary supplier, Vedanta operations will introduce procedures and mitigation measures to ensure that primary suppliers within the supply chain are taking steps to prevent or to correct life-threatening situations.
Sustainable Development
- Stake Holders are Encouraged toward Green Energy.

Reward & Recognition
- Organizing Energy idea mela and energy conservation day and rewarding employees, workmen and contractors.

Training & Awareness
- Regular Training and Awareness on Sustainable Energy Conservation
- Progress monitoring, reporting & Help to Improve

Green Supply Chain

Policy
- Priority to the Energy Efficient Products in the negotiations

Vendor Partnership
- Involve in energy reduction programs.

Implementing Projects
- Organizing Projects on Energy
- Result Tracking and Sustain the KPIs
Green Supply Chain

Paperless Invoicing
It’s the faster, easier and more convenient way to receive invoices via e-mail.
- Faster: Get your Grainger invoice the day after your order ships.
- Easier: Electronic sharing saves time and reduces paper routing.
- Greener: Less paper helps reduce recycling costs and frees up storage space.

PR to Payment – Paperless office

Raw material transport- By Conveyors

Procurement of equipment of highest efficiency

Clean Energy to state electricity board
Waste Heat Utilization

COKE PLANT

WASTE HEAT RECOVERY
POWER PLANT

PIG IRON PLANT
Waste heat Utilization

Power Generation – Waste Heat

**Power Generation**

<table>
<thead>
<tr>
<th>Year</th>
<th>Power Generation (Million KWH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY13</td>
<td>183</td>
</tr>
<tr>
<td>FY14</td>
<td>263</td>
</tr>
<tr>
<td>FY15</td>
<td>368</td>
</tr>
<tr>
<td>FY16</td>
<td>415</td>
</tr>
<tr>
<td>FY17</td>
<td>404</td>
</tr>
</tbody>
</table>

- Utilized more than 56 L million Kcal of energy.
- 1187 Million units (KWH) generated in last 3 years
- Eliminated usage of diesel in slag drier plant by waste heat.
- Waste gases used in Pulverized coal injection plant and sinter plant.
- Steps identified and initiated to increase the power generation from 58 MW to 65 MW by utilizing waste gases.

**Waste Heat Utilization- Optimization Plan**

<table>
<thead>
<tr>
<th>Component</th>
<th>MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Generation FY-17</td>
<td>58</td>
</tr>
<tr>
<td>Interconnecting BFG line from PP2 to PP1</td>
<td>3</td>
</tr>
<tr>
<td>Gas volume increase from BF and CO due to increase in Prod.</td>
<td>3</td>
</tr>
<tr>
<td>Utilization of heat of common flue tunnel</td>
<td>1</td>
</tr>
<tr>
<td>Targeted generation FY 18</td>
<td>65</td>
</tr>
</tbody>
</table>

www.sesagoironore.com
## WASTE MANAGEMENT

### Hazardous wastes

<table>
<thead>
<tr>
<th>Sr.no</th>
<th>Type of wastes</th>
<th>Mode of disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Used / spent oil</td>
<td>Sold to recycler registered with CPCB &amp; having valid authorization of SPCB.</td>
</tr>
<tr>
<td>2</td>
<td>Waste residue containing oil</td>
<td>Incinerated in coke oven plant</td>
</tr>
<tr>
<td>3</td>
<td>Empty / discarded paint tins</td>
<td>To recycler registered with CPCB and having valid authorization of SPCB</td>
</tr>
</tbody>
</table>

### Non Hazardous Wastes

<table>
<thead>
<tr>
<th>Sr.no</th>
<th>Type of wastes</th>
<th>Mode of disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slag</td>
<td>Used in manufacturing of cement</td>
</tr>
</tbody>
</table>
Utilization of Renewable Energy Sources

- Proposed to set up solar plant to meet the power requirement at our employee township.
- Supplied 197 M units clean power to state electricity board.
- Daylight utilization using transparent Roof sheets
- Usage of Turbo Ventilator
Rain Water Harvesting

Rainwater Harvesting and reuse.

Rain Water Harvesting

• Collection of rainwater for reuse in plants as a replacement for fresh water
• Three no of storm water ponds developed of total 25000 M3 capacity to collect rainwater runoff. - 3.5 Lakh m3/Year
• Rain Water collected in Mining Pits and used for Process - 4 Lakh m3/year
• Rain Water Harvesting roof – 22000 m2, Collection of water - 0.5 Lakh m3 / Year

8 Lakh m3/Year

Storm Water Harvesting Ponds

Roof rain Water harvesting
Thank You !
## Benchmarking Data – Blast Furnace

<table>
<thead>
<tr>
<th></th>
<th>UOM</th>
<th>TATA - Jamshedpur</th>
<th>ESSAR - Hazira</th>
<th>JSW - Vijayanagar</th>
<th>Nippon Steel - Japan</th>
<th>Chelyabinsk - Russia</th>
<th>POSCO - S.Korea</th>
<th>Vedanta</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production</strong></td>
<td>Mt</td>
<td>9.97</td>
<td>1.39</td>
<td>7.8</td>
<td>9.2</td>
<td>3.9</td>
<td>14.22</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>Mt</td>
<td>10.55</td>
<td>1.73</td>
<td>8.15</td>
<td>11.84</td>
<td>4.5</td>
<td>14</td>
<td>0.625</td>
</tr>
<tr>
<td><strong>Number of furnaces</strong></td>
<td>Nos</td>
<td>7</td>
<td>9</td>
<td>7</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total equivalent coke rate</strong></td>
<td>kg/thm</td>
<td>546</td>
<td>523</td>
<td>535</td>
<td>530</td>
<td>466</td>
<td>489</td>
<td>578</td>
</tr>
<tr>
<td><strong>PCI</strong></td>
<td>kg/thm</td>
<td>145</td>
<td>120</td>
<td>120</td>
<td>179</td>
<td>-</td>
<td>167</td>
<td>111</td>
</tr>
<tr>
<td><strong>Fe content in Hot Metal</strong></td>
<td>%</td>
<td>94.3</td>
<td>90.3</td>
<td>94.5</td>
<td>94.3</td>
<td>94.4</td>
<td>94.5</td>
<td>93</td>
</tr>
<tr>
<td><strong>Inputs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pellets</strong></td>
<td>kg/thm</td>
<td>594</td>
<td>886</td>
<td>481</td>
<td>150</td>
<td>331</td>
<td>131</td>
<td>7</td>
</tr>
<tr>
<td><strong>Sinter</strong></td>
<td>kg/thm</td>
<td>569</td>
<td>644</td>
<td>1135</td>
<td>1200</td>
<td>1268</td>
<td>1205</td>
<td>1028</td>
</tr>
<tr>
<td><strong>Lump Ore</strong></td>
<td>kg/thm</td>
<td>395</td>
<td>50</td>
<td>43.91</td>
<td>238</td>
<td>4</td>
<td>277</td>
<td>620</td>
</tr>
<tr>
<td><strong>Scrap</strong></td>
<td>kg/thm</td>
<td>10</td>
<td>-</td>
<td>5</td>
<td>41</td>
<td>4</td>
<td>277</td>
<td>620</td>
</tr>
<tr>
<td><strong>Limestone / Dolomite</strong></td>
<td>kg/thm</td>
<td>19.86</td>
<td>2</td>
<td>4</td>
<td>4.5</td>
<td>36</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td><strong>Bf Coke</strong></td>
<td>kg/thm</td>
<td>385</td>
<td>390</td>
<td>402</td>
<td>332</td>
<td>457</td>
<td>304</td>
<td>464</td>
</tr>
<tr>
<td><strong>PCI</strong></td>
<td>kg/thm</td>
<td>145</td>
<td>120</td>
<td>120</td>
<td>179</td>
<td>-</td>
<td>167</td>
<td>111</td>
</tr>
<tr>
<td><strong>Coke Oven Gas / BF Gas</strong></td>
<td>GJ/thm</td>
<td>0.55</td>
<td>-</td>
<td>0.25</td>
<td>-</td>
<td>1.65</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td><strong>Natural Gas</strong></td>
<td>GJ/thm</td>
<td>1.28</td>
<td>2.55</td>
<td>1.39</td>
<td>-</td>
<td>1.65</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td><strong>Oxygen</strong></td>
<td>Nm3/thm</td>
<td>54</td>
<td>35</td>
<td>35</td>
<td>47.9</td>
<td>96</td>
<td>78</td>
<td>53</td>
</tr>
<tr>
<td><strong>Skull</strong></td>
<td>%</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4.8</td>
</tr>
<tr>
<td><strong>BF Slag</strong></td>
<td>kg/thm</td>
<td>233.62</td>
<td>125</td>
<td>249</td>
<td>292</td>
<td>337</td>
<td>240</td>
<td>362</td>
</tr>
<tr>
<td>PARAMETERS</td>
<td>UNITS</td>
<td>JSW Bellary</td>
<td>Salem</td>
<td>Dolvi</td>
<td>NINL</td>
<td>Tata Steel Jamshedpur</td>
<td>JSPL</td>
<td>Vedanta</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-------</td>
<td>-------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-----------------------</td>
<td>------</td>
<td>---------</td>
</tr>
<tr>
<td>Capacity of Plant</td>
<td>MT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Productivity</td>
<td>(t/m3/day)</td>
<td>3</td>
<td>2.945</td>
<td>2.77</td>
<td>0.9</td>
<td>2.98</td>
<td>3.64</td>
<td></td>
</tr>
<tr>
<td>Coke Rate</td>
<td>kg/thm</td>
<td>396</td>
<td>431</td>
<td>315</td>
<td>542.6</td>
<td>351.5</td>
<td>407</td>
<td>465</td>
</tr>
<tr>
<td>Nut coke</td>
<td>kg/thm</td>
<td>40</td>
<td>13</td>
<td>35</td>
<td>0.9</td>
<td></td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>CDI</td>
<td>kg/thm</td>
<td>117</td>
<td>134</td>
<td>160</td>
<td>188.4</td>
<td>129</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Fuel rate</td>
<td>kg/thm</td>
<td>552</td>
<td>578</td>
<td>520</td>
<td>543.4</td>
<td>541</td>
<td>558</td>
<td>598</td>
</tr>
<tr>
<td>Slag Rate</td>
<td>kg/thm</td>
<td>411</td>
<td>366</td>
<td>350</td>
<td>254.7</td>
<td>288</td>
<td>402</td>
<td>359</td>
</tr>
<tr>
<td>Sinter</td>
<td>%</td>
<td>71</td>
<td>64.5</td>
<td>75</td>
<td>94.8</td>
<td>47.3</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Fe in Sinter</td>
<td>%</td>
<td></td>
<td>54.68</td>
<td>57.5</td>
<td></td>
<td>55.6</td>
<td>52.1</td>
<td></td>
</tr>
<tr>
<td>Fe in Ore</td>
<td>%</td>
<td></td>
<td>62.62</td>
<td>----</td>
<td></td>
<td></td>
<td>58.89</td>
<td></td>
</tr>
<tr>
<td>- 5mm in sinter</td>
<td>%</td>
<td>2.01</td>
<td>1</td>
<td>5%</td>
<td></td>
<td></td>
<td>2.44</td>
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</tr>
<tr>
<td>Coke Ash</td>
<td>%</td>
<td>12.235</td>
<td>10.5-12</td>
<td>17%</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Coke M10</td>
<td>%</td>
<td>5.51</td>
<td>6</td>
<td>5%</td>
<td></td>
<td></td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>Coke M40</td>
<td>%</td>
<td>88.66</td>
<td>84</td>
<td>92%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Hot Blast Temperature</td>
<td>Degree C</td>
<td>1069</td>
<td>1200</td>
<td>940.0</td>
<td>1162</td>
<td>1123</td>
<td>1093</td>
<td></td>
</tr>
<tr>
<td>O2 enrichment</td>
<td>%</td>
<td>2.98</td>
<td>7</td>
<td>4.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAFT</td>
<td>Degree C</td>
<td>2118</td>
<td>2200</td>
<td>2200</td>
<td></td>
<td></td>
<td>2268.5</td>
<td></td>
</tr>
<tr>
<td>HM Silicon</td>
<td>%</td>
<td>0.61</td>
<td>0.68</td>
<td>0.7</td>
<td>0.74</td>
<td>0.59</td>
<td>0.59</td>
<td>1.29</td>
</tr>
<tr>
<td>Comp. coke rate</td>
<td>kg/thm</td>
<td>578</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>566</td>
<td></td>
</tr>
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</table>
Journey towards zero water intake

Napoli mining pumping
- 4.5 lakhs m³ FY2017
- 5 lakhs m³ FY2018

High impact business improvement projects
- Develop Amona mining pit as storm water reservoir – Completed
- Develop PID settling pond – Completed.
- Develop at Gocatari Rain water pumping with pond By FY2018 – Planned.
- Develop more storages / Collection & connection storage at PID-2

Rain water utilization @ PID-II
- 0.5 lakhs m³ FY2015
- 1 lakhs m³ FY2016
- 2 lakhs m³ FY2017

Rain water utilization @ VAB
- 3 lakhs m³/year FY2017
- 5 lakhs m³/year FY2018

Project – Sonshi mining Water usage.
- Annual Water 25 lakhs m³ / yr FY2018-19.

Water Positive

RWH
- Mining Pit
- Surface & Roof
PIG IRON – Specific Water Consumption

Specific Water Consumption M3/THM

FY13-14 | FY14-15 | FY15-16 | FY16-17
---|---|---|---

Blast Furnace Relining Water Included FY15-16

Cum 20%

• Specific Water Reduction 20% FY13-14 to FY16-17

• Vision towards Zero water intake & discharge through RWH and Mining Water Collection