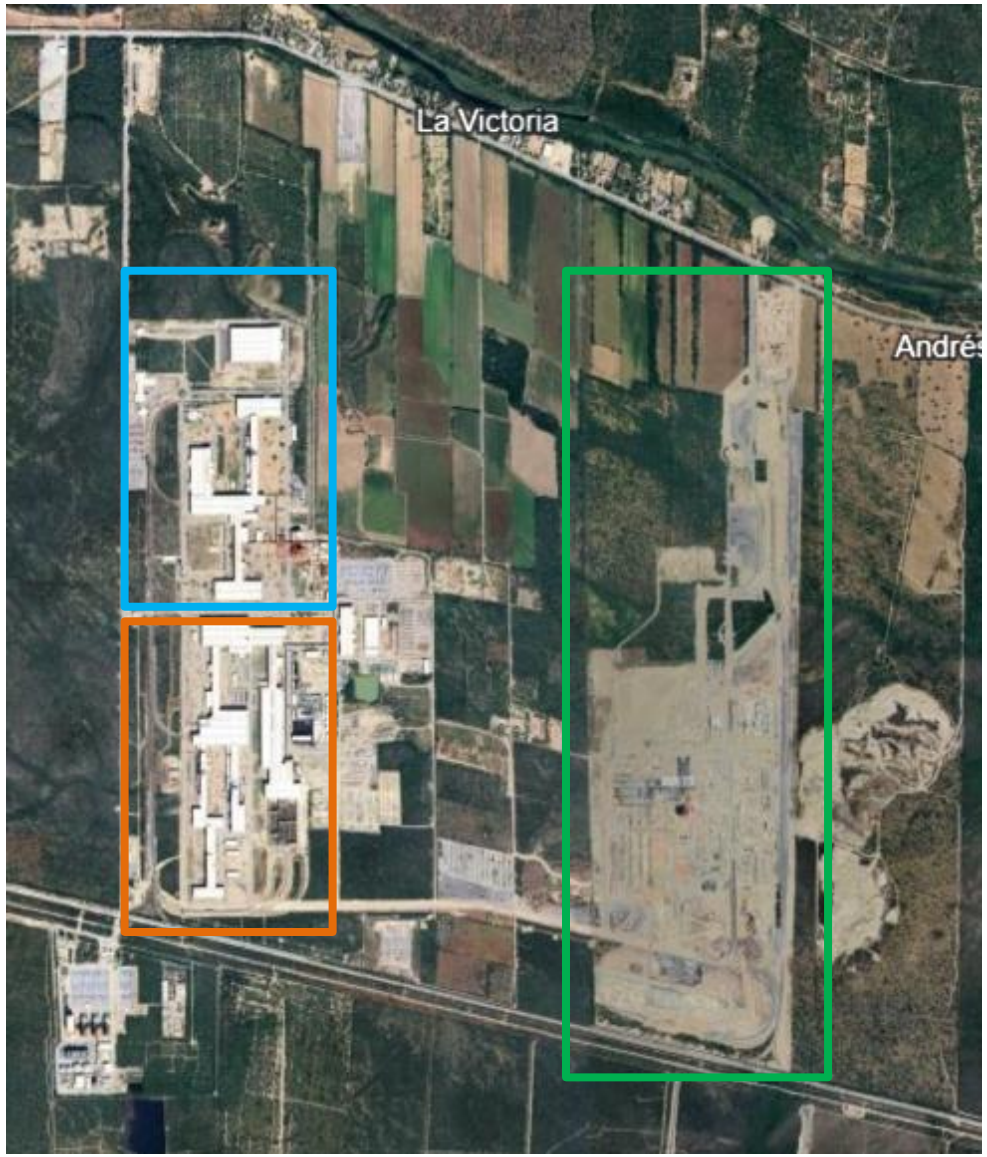
Tomorrow's Steel Mill, Today: Ternium Pesquería Leads Sustainable Innovation

Fadi Abularage – Tenova HYL

Kyle Shoop – Tenova Inc.

Ternium Pesquería Development



- Pesquería, Nuevo León, México.
- Site Size 437 hectares
- Phase 1 – Completed in 2013
  - Cold Rolling Mill, Galvanizing Line, and Site Infrastructure
- Phase 2 – Completed in 2021
  - 4.4 M ton/yr Hot Rolling Mill
- Phase 3 – In Progress; DRI & Meltshop

Ternium

Ternium Steelmill Partners

The Techint Group is building the most modern, sustainable and state-of-the-art DRI facility in North America.

tenova

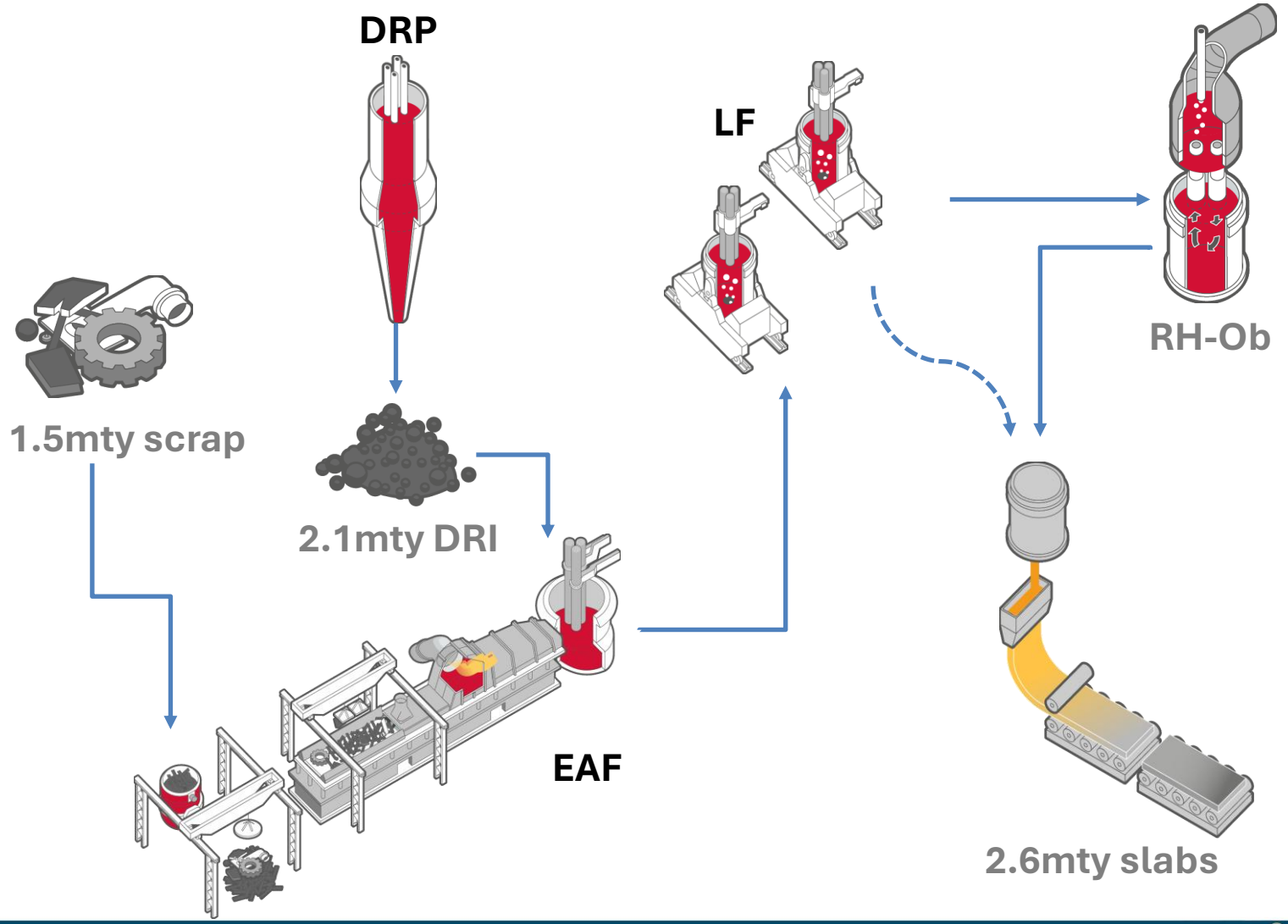
Ternium

TECHINT
Engineering & Construction

ENERGIRON HYL
DRI TECHNOLOGY BY TENOVA AND DANIELI

Steel Production – DRI & Meltshop

PRODUCTION LINE



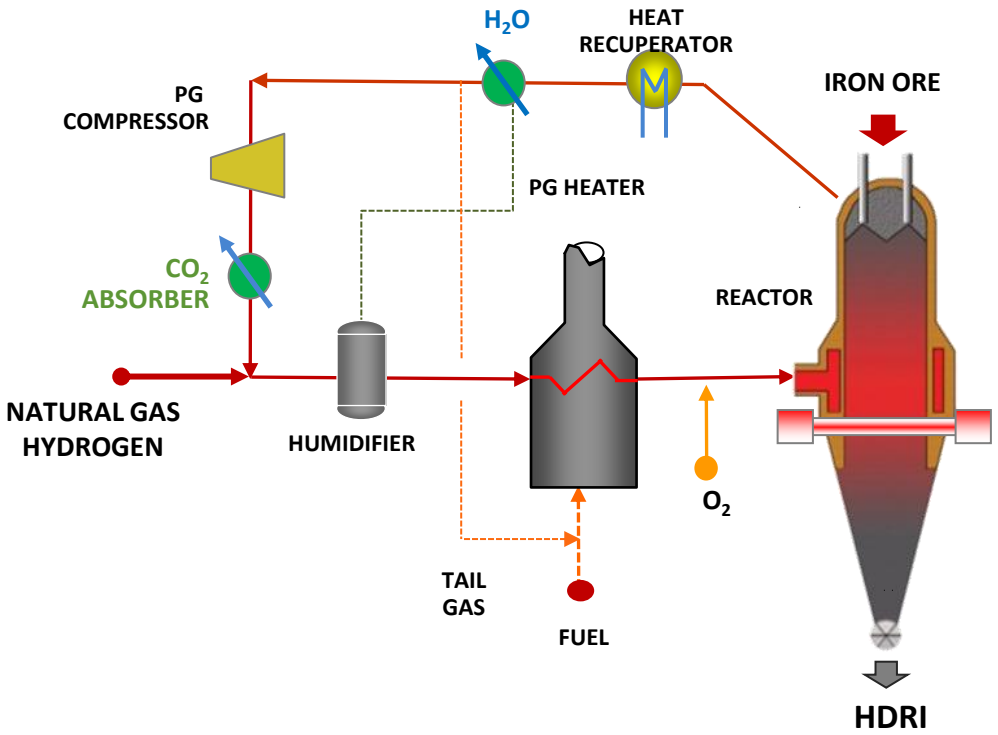
Ternium DRI Plant

- Pesquería, Nuevo León, México.
- 2,100,000 TPY of HDRI/CDRI

Ternium

DRI Plant - Characteristics

PLANT DESCRIPTION & MAIN FEATURES



ENERGIRON ZR FLOW SHEET

MAIN PLANT CHARACTERSITICS

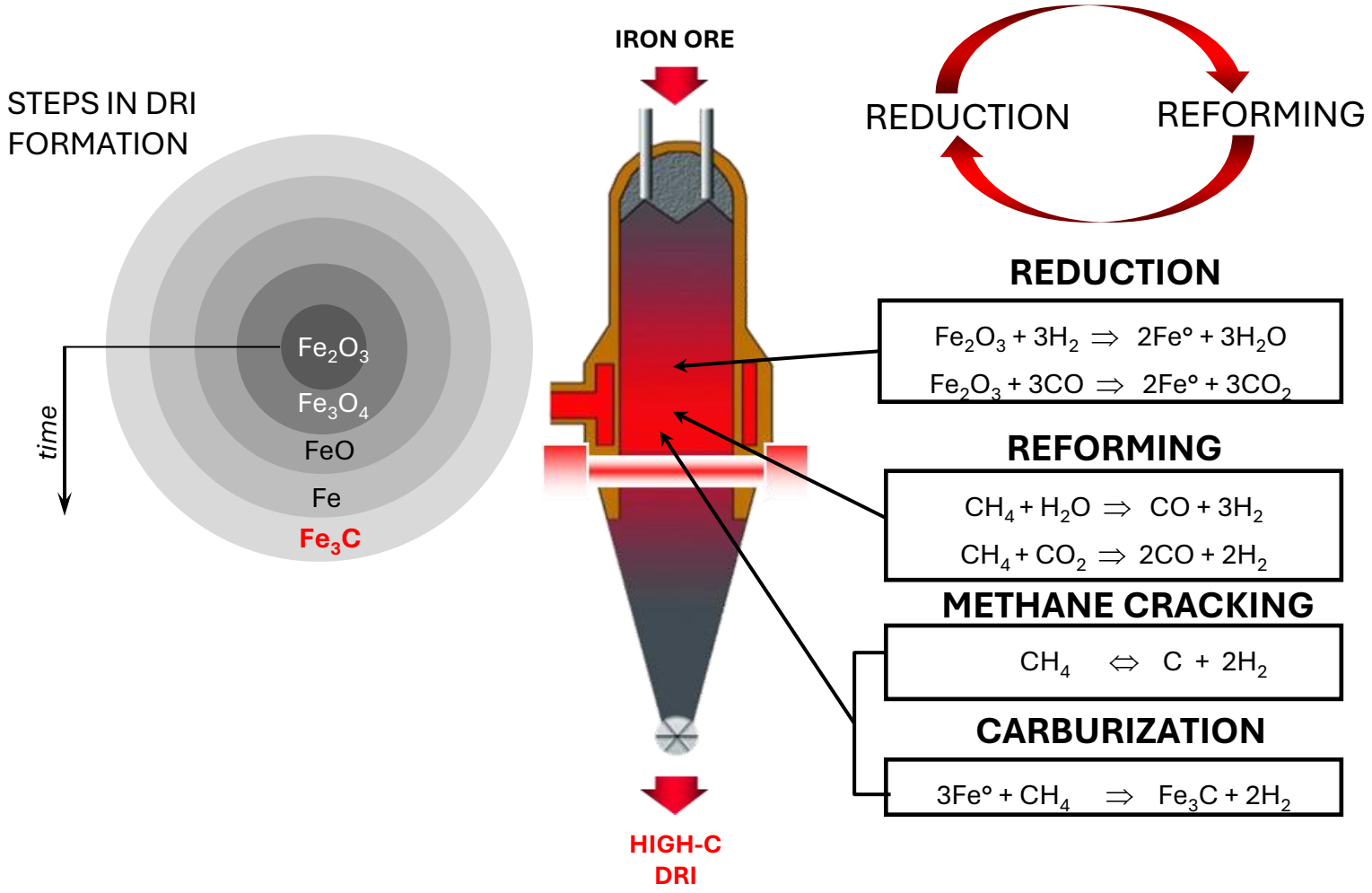
- **Plant Capacity**: 2,100,000 ton/year
- **Process Scheme:** Zero Reformer (ZR)
- **Type of Product:** Hot DRI (HDRI) / Cold DRI (CDRI)
- **DRI Quality:** >94%Mtz; variable carbon 2.0%-4.5%C
- **Reducing gases:** Natural Gas / Hydrogen ready
- **DRI Shafts:** one, 6.7m ID – prepared for future expansion
- **Process Gas Heater:** one, radiant / convective fired-type
- **PG Compressors:** two, centrifugal type
- **CO_2 Removal Unit:** one system, amine-based absorption
- **Hot DRI Transport System:** one, pneumatic transport system (HYTEMP system) for conveying the HDRI to the Tenova EAF.
- **Digitalization:** Digital Twin model for plant efficiency and predictive maintenance.

ENERGIRON ZR (zero reformer)

PROCESS CHARACTERISTICS WITH NATURAL GAS

MAIN CHARACTERISTICS:

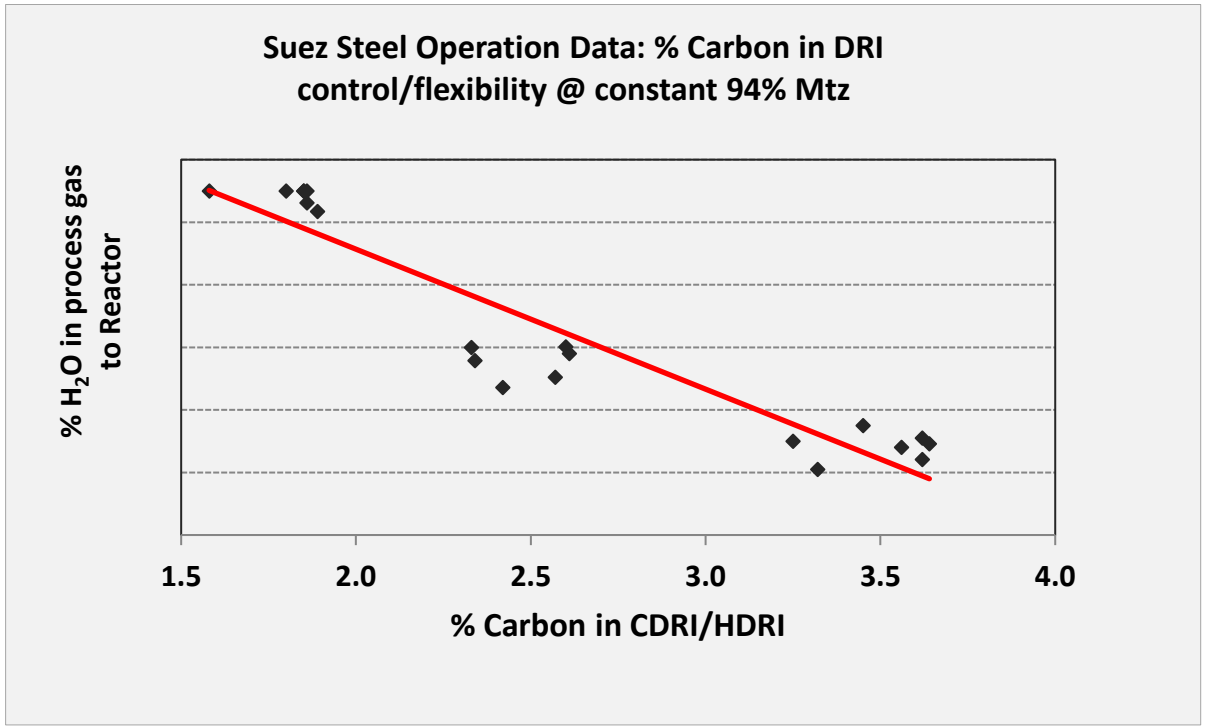
- NG Reforming, iron ore Reduction and DRI Carburization take place in the SAME Reactor.
- Catalyst is the SAME iron (Fe) in DRI being produced and always renewed.
- High temperature to comply with *in-situ* reforming & reduction (>1050°C)
- Production of UNIQUE High-C DRI.
- No need of external reformer.
- Most efficient DR process.

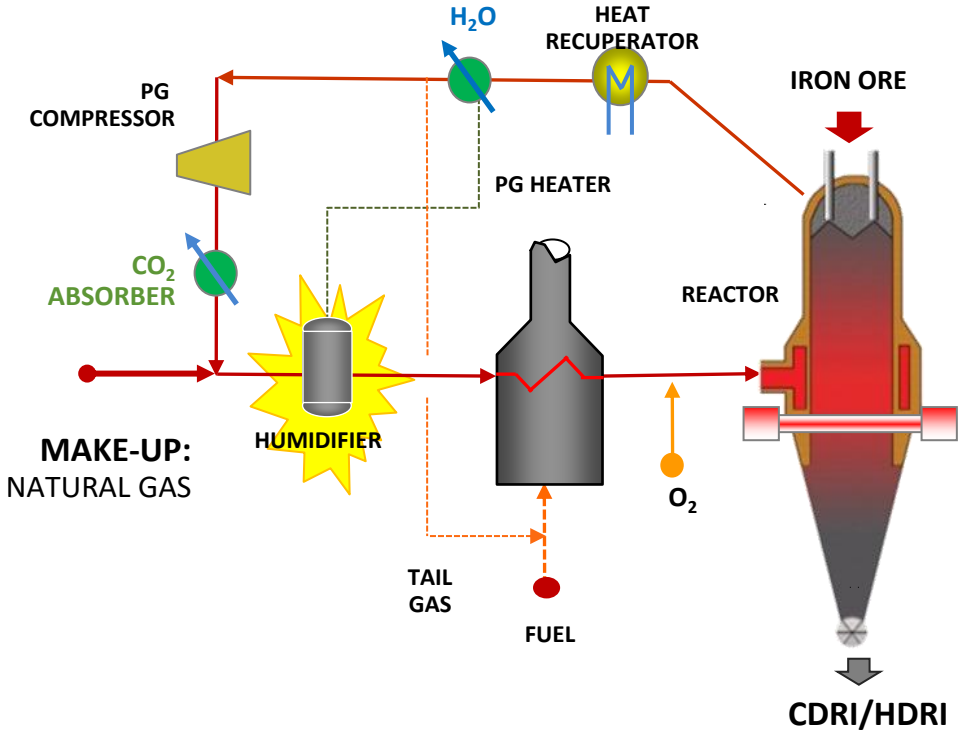


High Carbon DRI

SIMPLEST AND FLEXIBLE WAY TO PRODUCING HIGH-CARBON DRI

- % Carbon control in DRI in ENERGIRON ZR is very simple: with the same NG to process, the Carbon deposition rate is controlled by %humidity (through humidifier) in the reducing gas fed to the Reactor, promoting the re-gasification back to CO and H_2.
- Simple and direct %Carbon control **without additional systems**, gas treatment/injection, more equipment and added-complexity/costs operations.



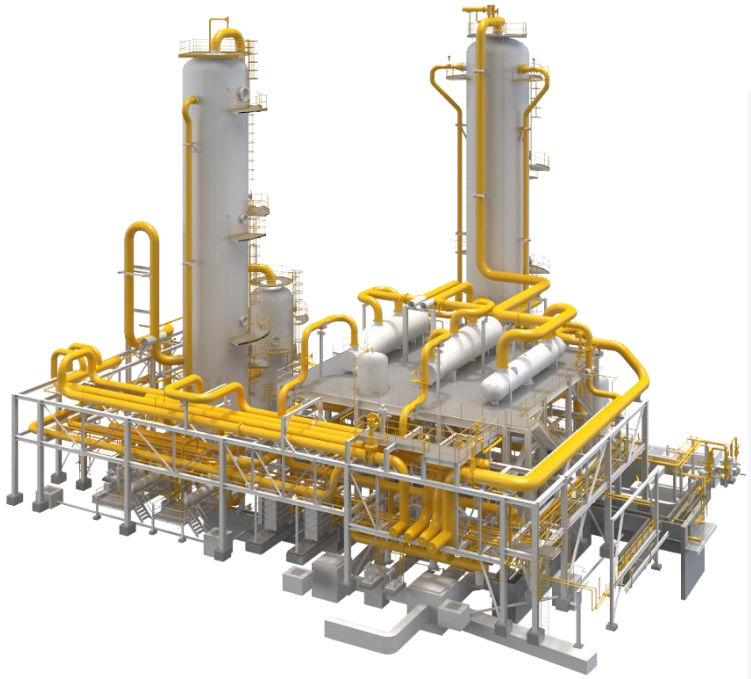


DRI Plant - Carbon Capture

CARBON CAPTURE AND UTILIZATION

TERNIUM New DRI Plant will be one of the **GREENEST** facilities emitting <190 kg CO_2 / ton DRI

SELECTIVE CO_2 REMOVAL → POSSIBILITY FOR CCU / CCS



Selective CO_2 → CRYOINFRA®

Captured Process CO_2:

- Aprox. **250 kg CO_2/ ton DRI**
- Purity: >99% (dry basis)
- Pressure: 0.3 barg
- Temperature: 50°C

Above captured CO_2 is equivalent to **~60% of the total produced CO_2** (i.e. the sum of the process CO_2 and the CO_2 from combustion).

IMPULSAN TERNIUM Y CRYOINFRA LA SOSTENIBILIDAD DE LA INDUSTRIA ACERERA CON PLANTA DE CONVERSIÓN DE DIÓXIDO DE CARBONO

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LA ACERERA ÍTALO-ARGENTINA SUMINISTRARÁ DIARIAMENTE 767 TONELADAS DE CO2 CRUDO A CRYOINFRA, QUE LO PROCESARÁ PARA CONVERTIRLO EN UN INSUMO CLAVE PARA LA INDUSTRIA ALIMENTARIA

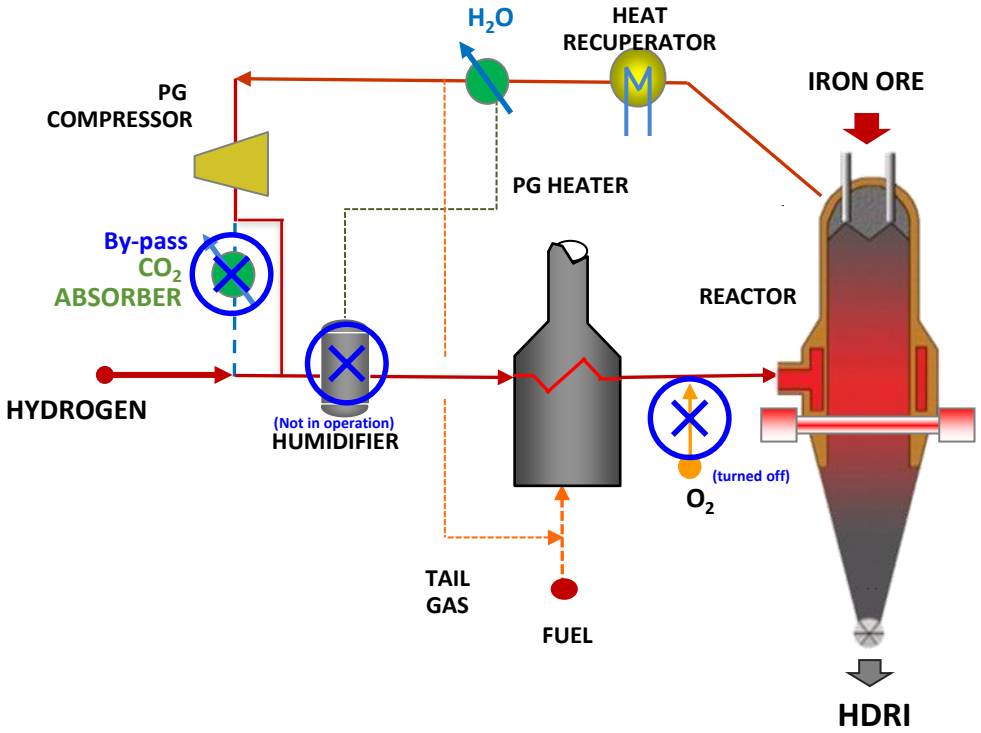
https://nearshorer.com.mx/

3D Render of CO2 Absorption System

DRI Plant - Hydrogen

HYDROGEN USE READINESS

USE OF HYDROGEN → **POSSIBILITY FOR CDA (CARBON DIRECT AVOIDANCE)**



ENERGIRON ZR FLOW SHEET
SAME PROCESS CONFIGURATION WITH HYDROGEN USE

- ✓ **Hydrogen Ready** Flexibility to operate with NG/H_2 at any ratio.
  The DRI Plant will be not only to operate at any proportion of make up gases, but also in in **reversible operating mode** at any moment with no need to modify the process configuration, i.e. back and forth with any feed gas mixture
- ✓ **High Carbon DRI** (>3.0%C) can be achieved even with 35% H_2 feed in energy basis.

DRI Plant – Reactor

DRI SHAFT FURNACE

REACTOR SHAFT:

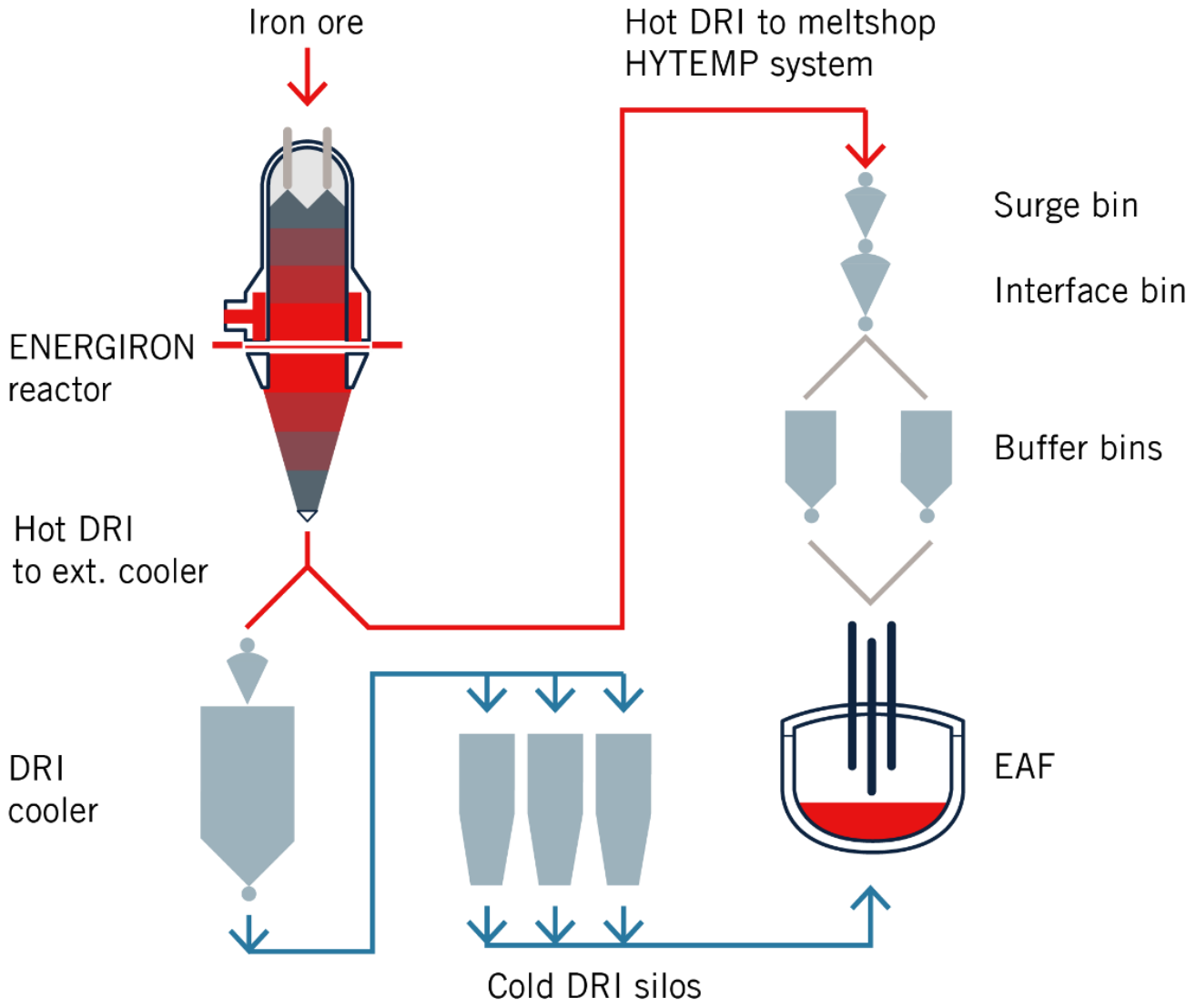
- Reactor design for reduction, in-situ reforming and carburization for high metallized DRI product.
- Main data:
  - Total Height: ~42 meters
  - Internal diameter: ~6.7 meters
  - Weight: ~680 tons
- Shipped in seven pieces due to logistics and transport restrictions.
- Reactor assembled at ground level from seven to three pieces.
- Lifted in three pieces and finally assembled inside the tower.

DRI Plant – Hot DRI Transport

HYTEMP® SYSTEM

Thermal energy of HOT DRI can be recovered by transporting it pneumatically at high temperature directly from the reactor to the EAF

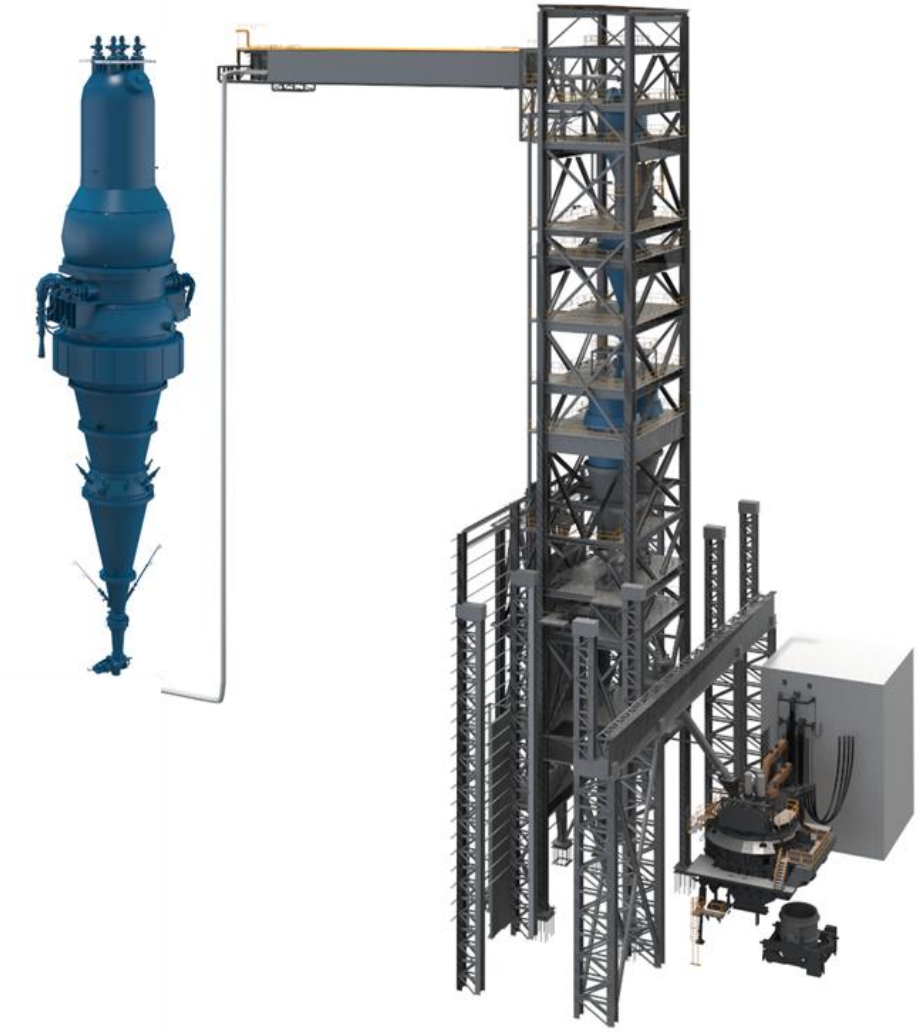
HOT DRI temperature conservation is further improved with the implementation of the innovative ceramic lining at the Reactor Cone.



DRI Plant – HYTEMP®

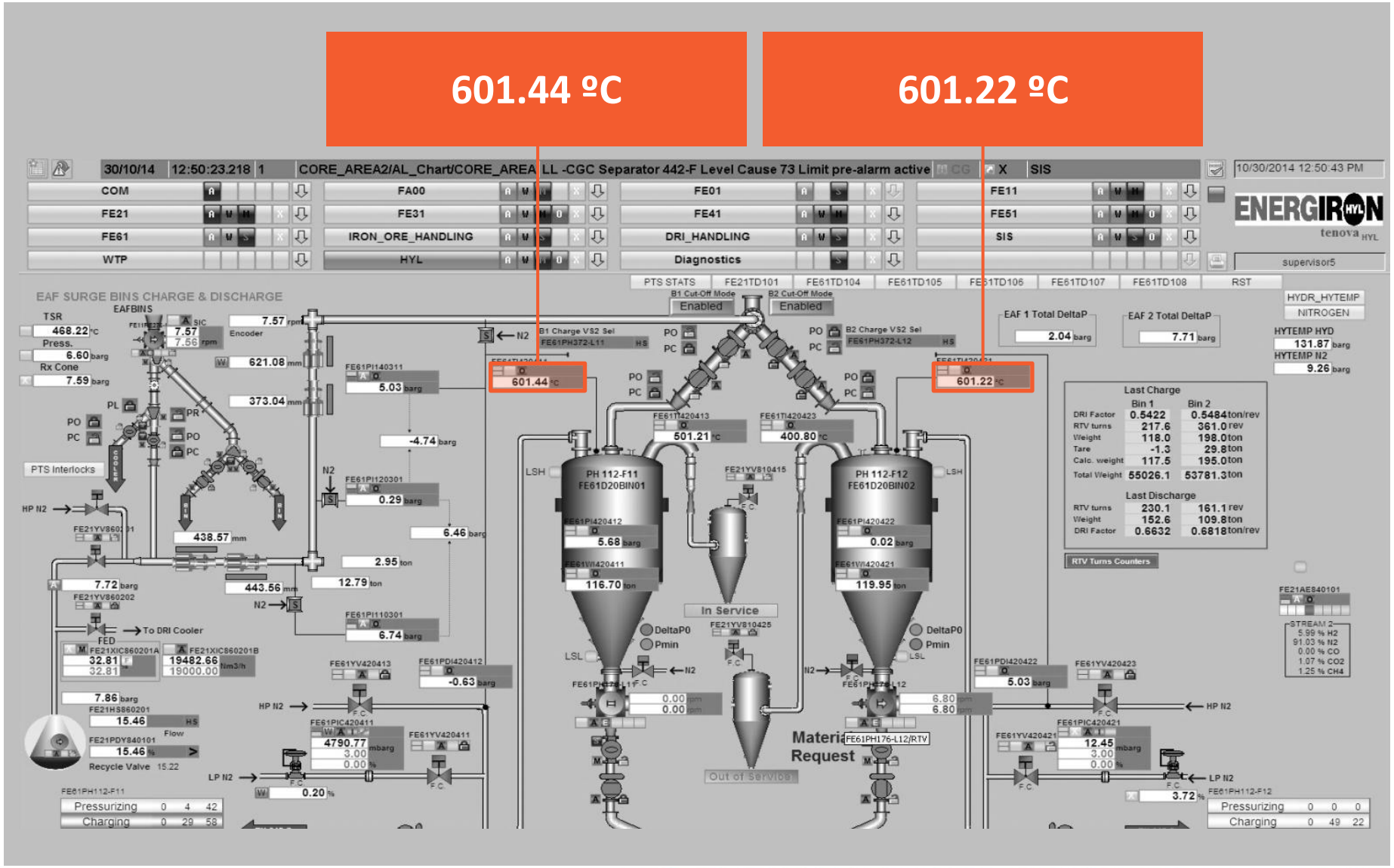
HYTEMP® SYSTEM

- ✓ Pneumatic Transport System
- ✓ In operation since 1998
- ✓ 4 reference installations (Ternium MTY, 2 x ES, SSC)
- ✓ 3 new installations on construction (Ternium Pes, SALCOS, Hyundai Steel)
- ✓ Outstanding reliability and availability, with negligible maintenance requirements
- ✓ Highest safety standards, thanks to the inert carrier gas and the completely sealed design with gas cleaning.
- ✓ Zero material/dust emissions, thanks to the inert carrier gas and the completely sealed design with gas cleaning.
- ✓ Minimum DRI temperature losses
- ✓ Great operational flexibility, Hot DRI or Cold DRI can be produced at any rate (0 ÷ 100%) on continuous basis
- ✓ Fully automated and integrated DRP-EAF system

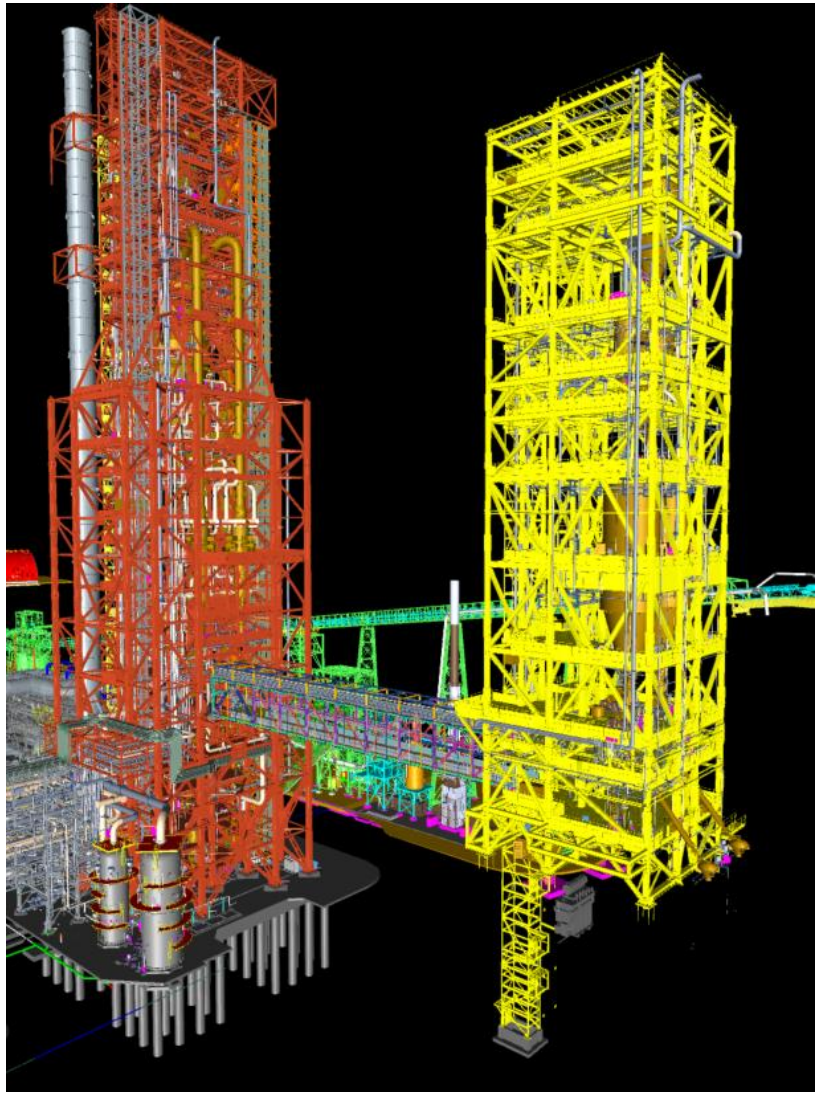


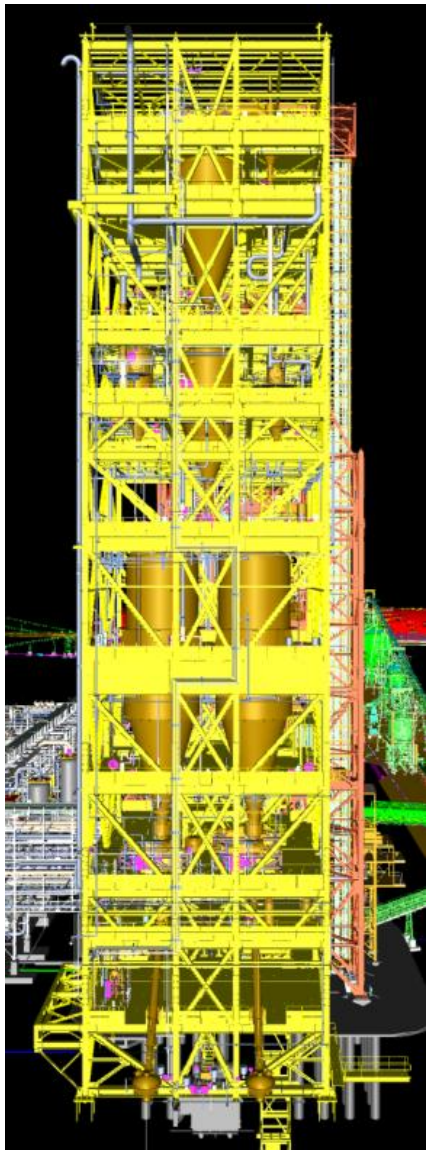
DRI Plant – HYTEMP®

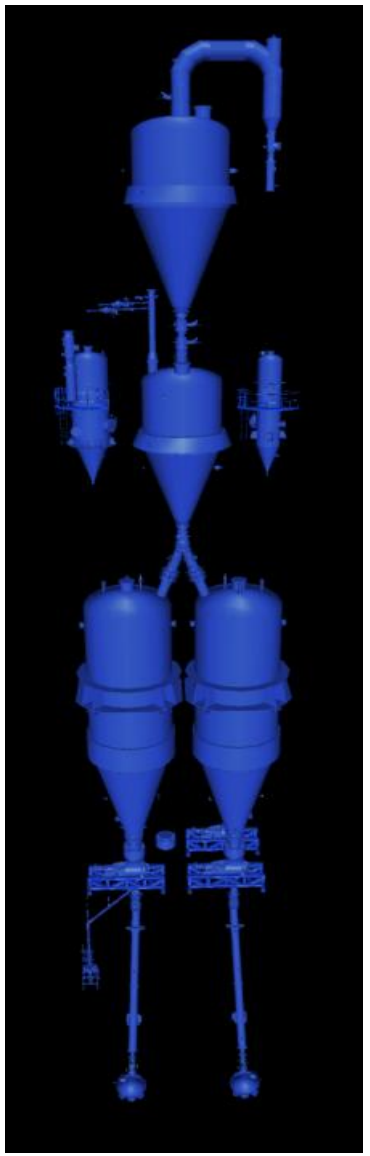
Real operating data at
Suez Steel
HOT DRI T > 600°C

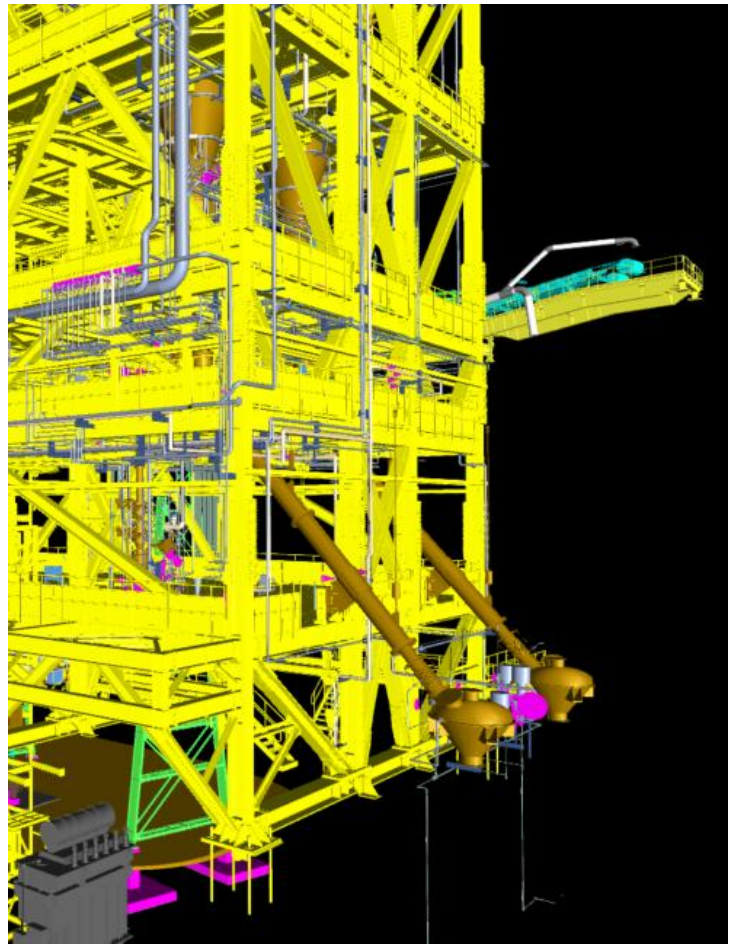


HDRI – HYTEMP Tower and Feeding to EAF





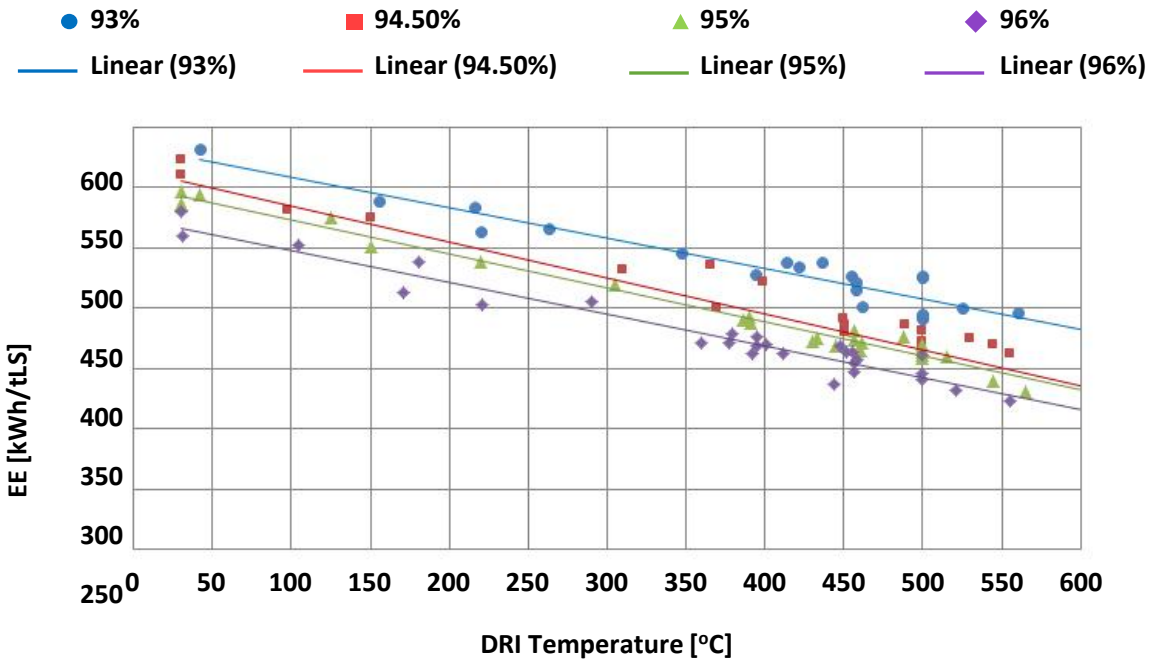




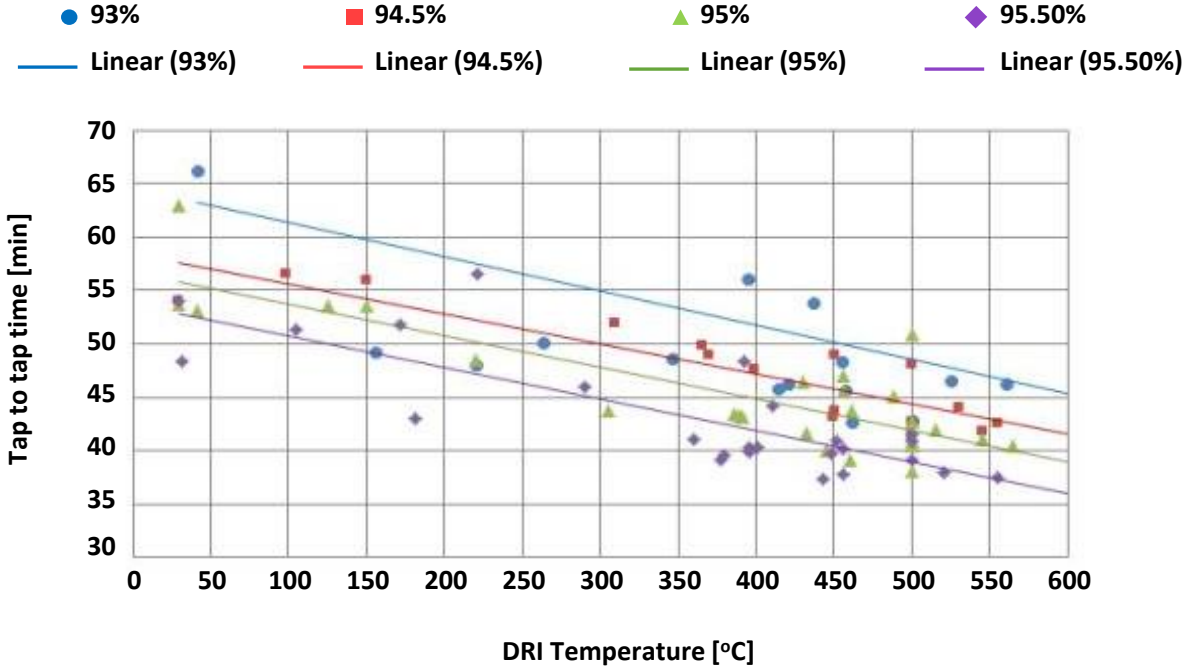
Hot DRI - Properties

Real operating data at Emirates Steel

EL. ENERGY CONSUMPTION WITH CDRI/HDRI BALANCE IN THE EAF CHARGE



TAP-TO-TAP TIME WITH CDRI/HDRI BALANCE IN THE EAF CHARGE



ELECTRIC ENERGY SAVED: 26 kwh/t_{ls}
Saved for every 100°c increase in dri temperature

PRODUCTIVITY INCREASE: 5% more productivity
for every 100°c increase in dri temperature

DRI Plant – DRI Cooler

DRI COOLER

DRI COOLER:

- Main data:
  - Total Height: ~31 meters
  - Internal diameter: ~6.0 meters
  - Weight: ~260 tons
- Shipped in one single piece
- Lifted in one single piece

DRI Plant – Material Handling

MHS for the complete DRP Plant, Iron Oxide Pellets (IOP) and Cold DRI (CDRI) including:

#1 Train Car Dumper;

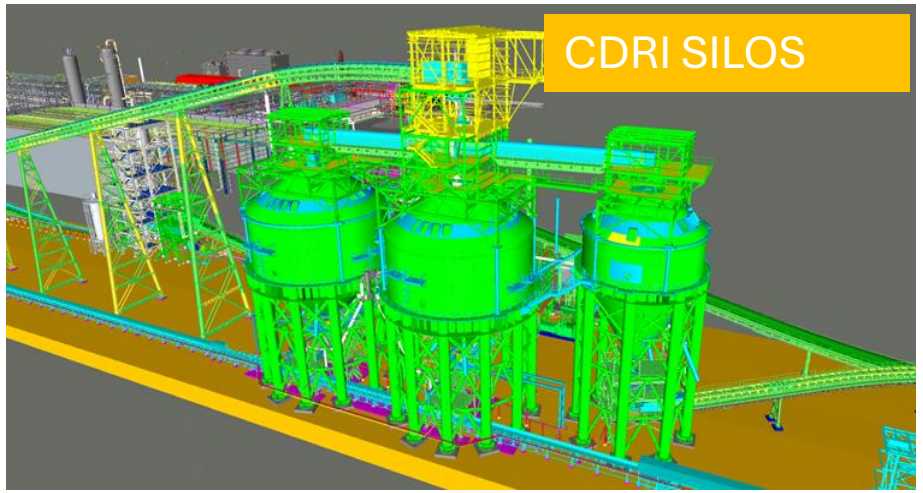
#2 Boom Buckets Stacker-Reclaimer;

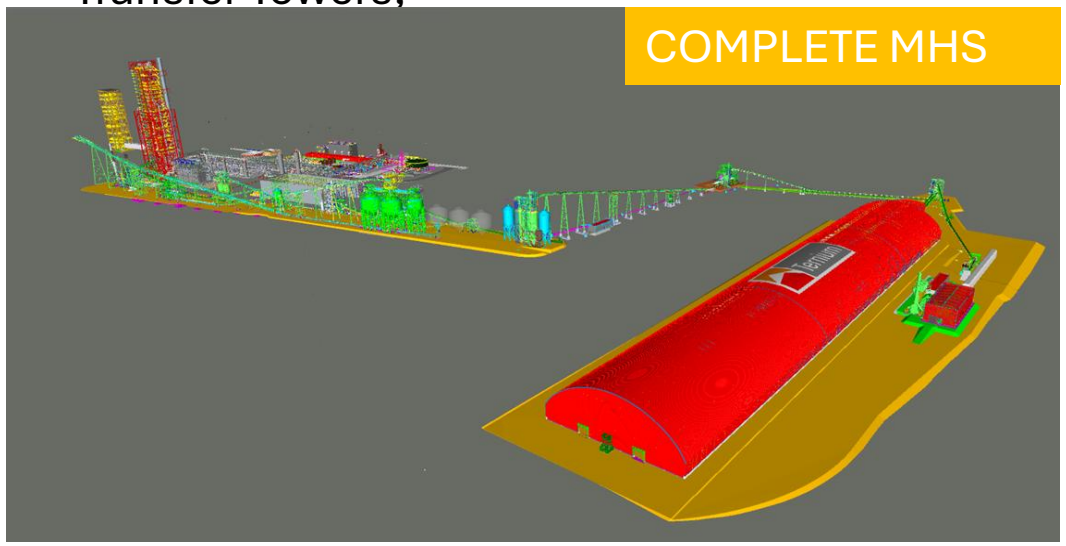
•Daily Bins and CDRI Silos;

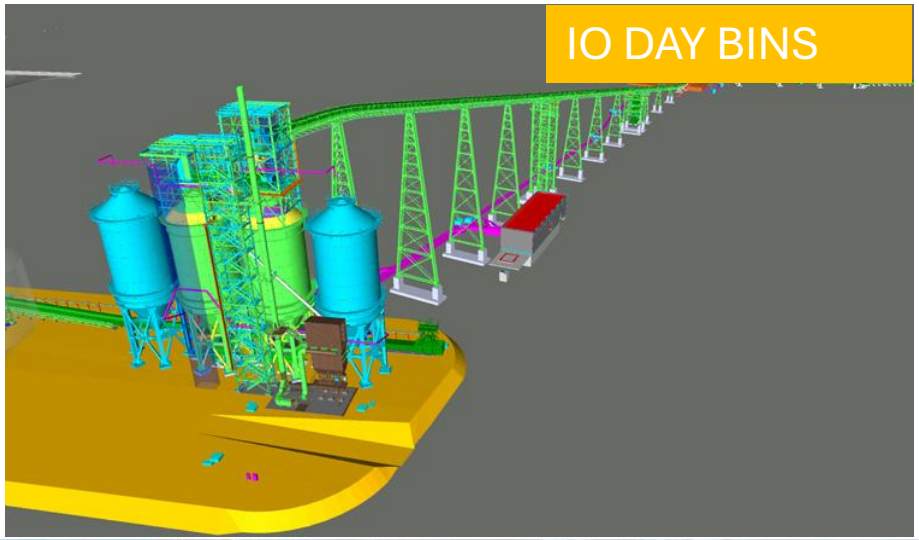
•Screen Towers;

•Conveyors System including Pipe Conveyor;

•Transfer Towers;



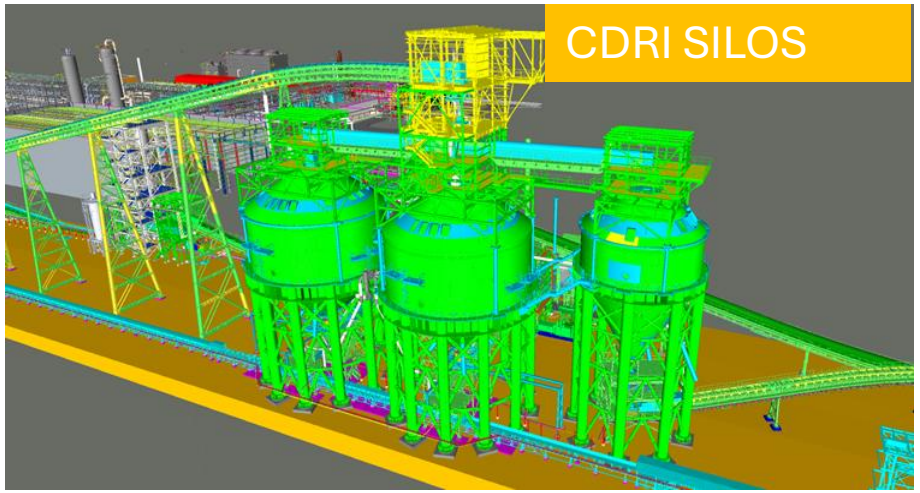




CDRI - Storage

Cold DRI Handling System consisting of:

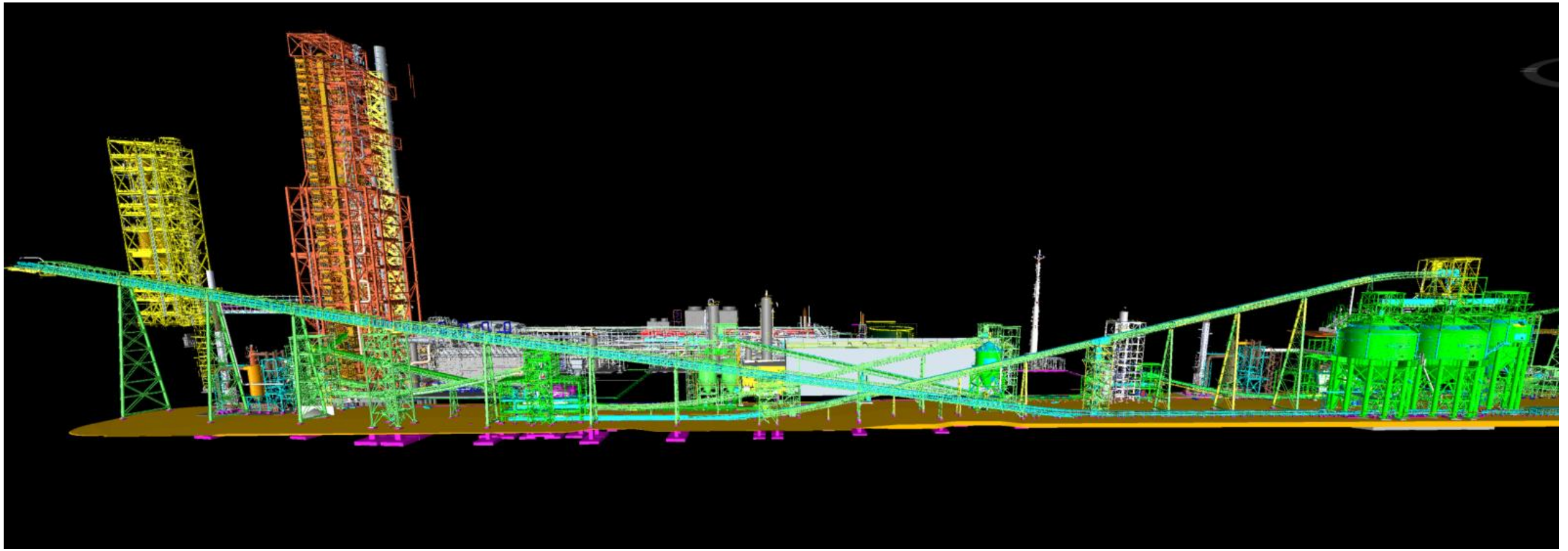
- Conveying System
- Vibrating Screens (two)
- CDRI Silos (two), with inert gas purging
- CDRI Sampling System
- CDRI fines handling System (conveyors, bins)



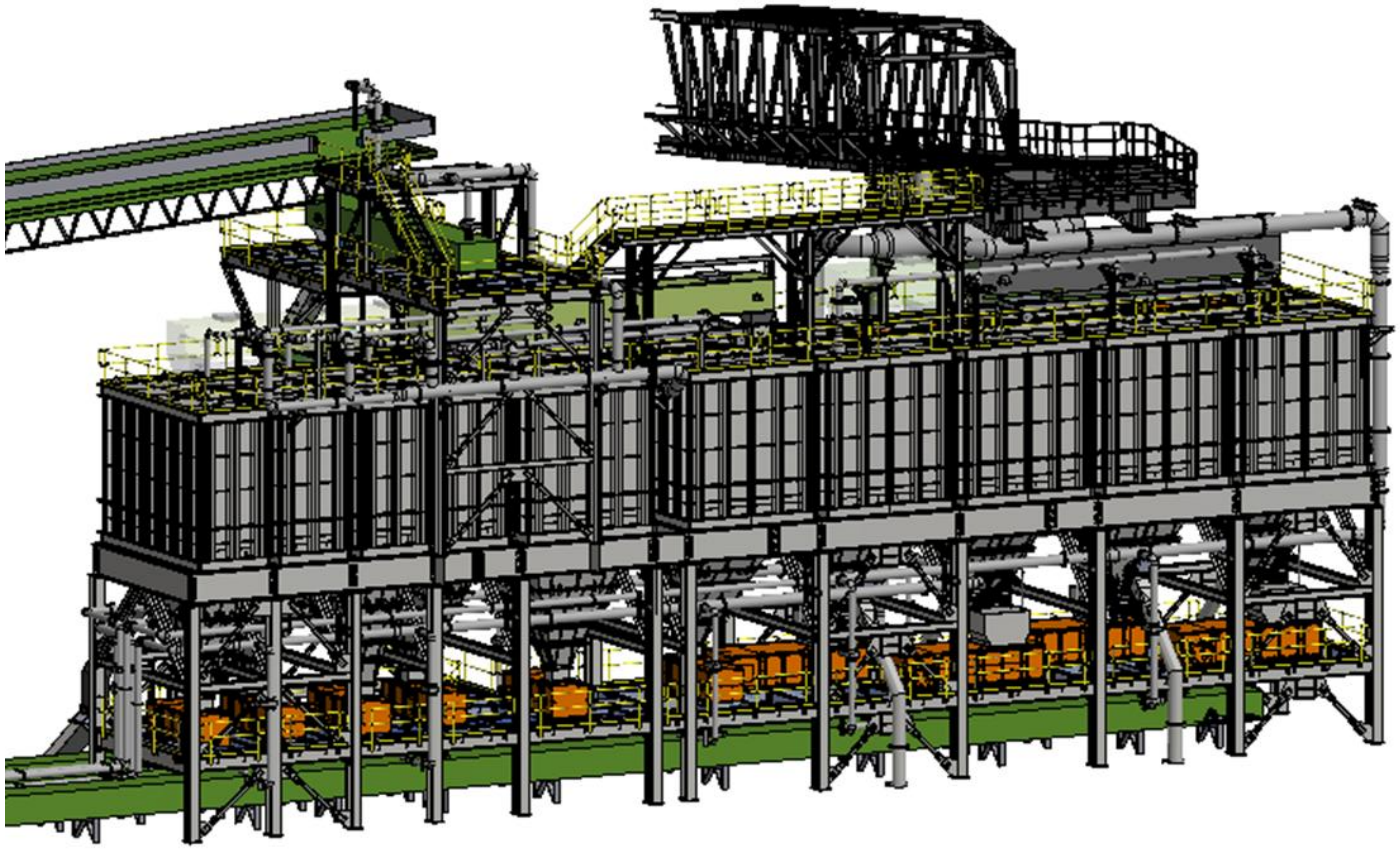
The CDRI Storing and Handling system takes into consideration key design aspects for safety assurance, such as:

- Layout with the minimum possible transfer towers to minimize the degradation of the material (fines generation). Transfer tower design with optimized free fall heights.
- Proper use of inert gas (N_2) in the silos to avoid the risk of re-oxidation (and self-ignition of the metallized product).
- CDRI Temperature monitoring at different locations.

CDRI - Transport to Day Bins



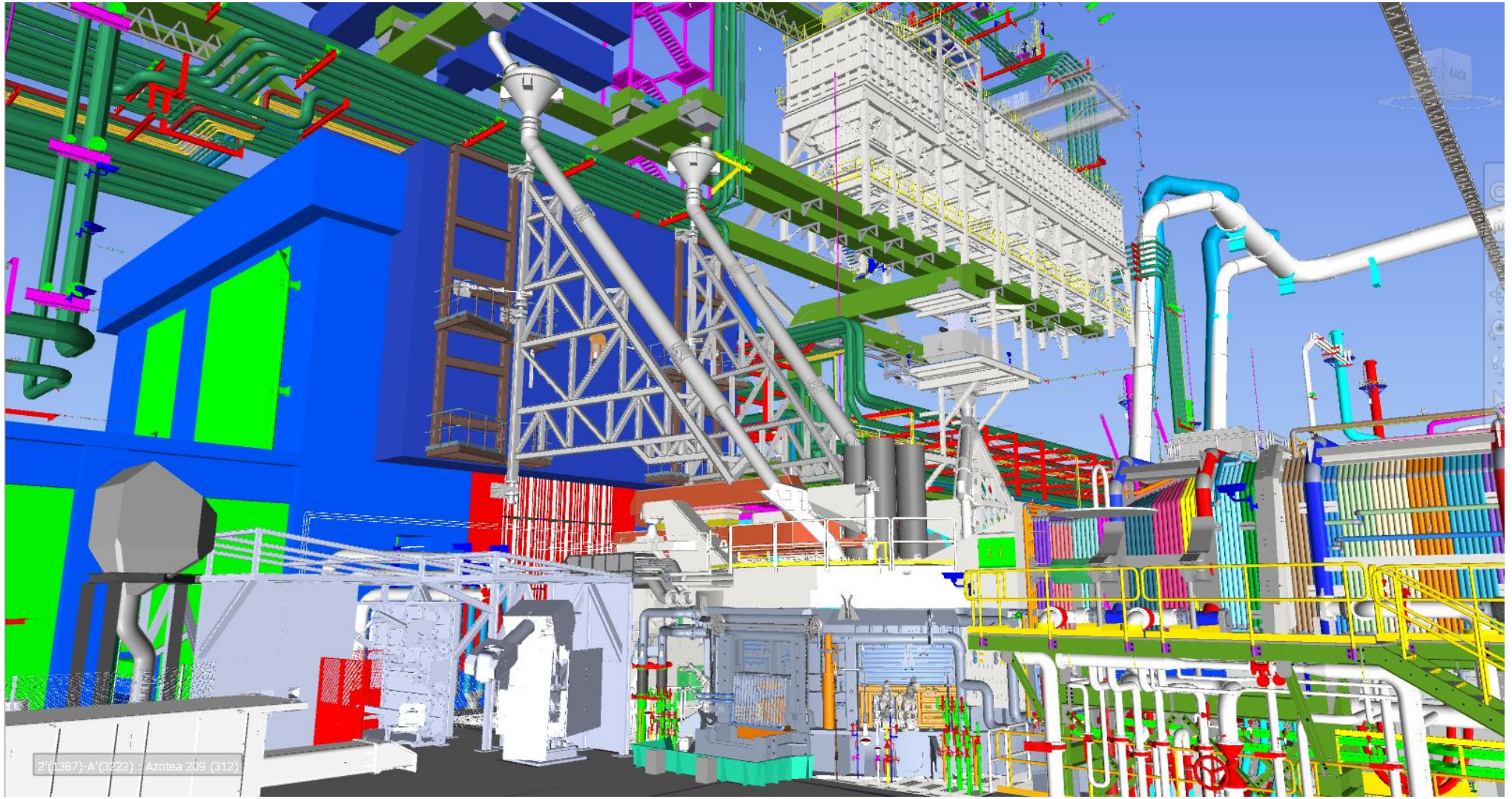
CDRI – Day Bins



MAIN CHARACTERISTICS:

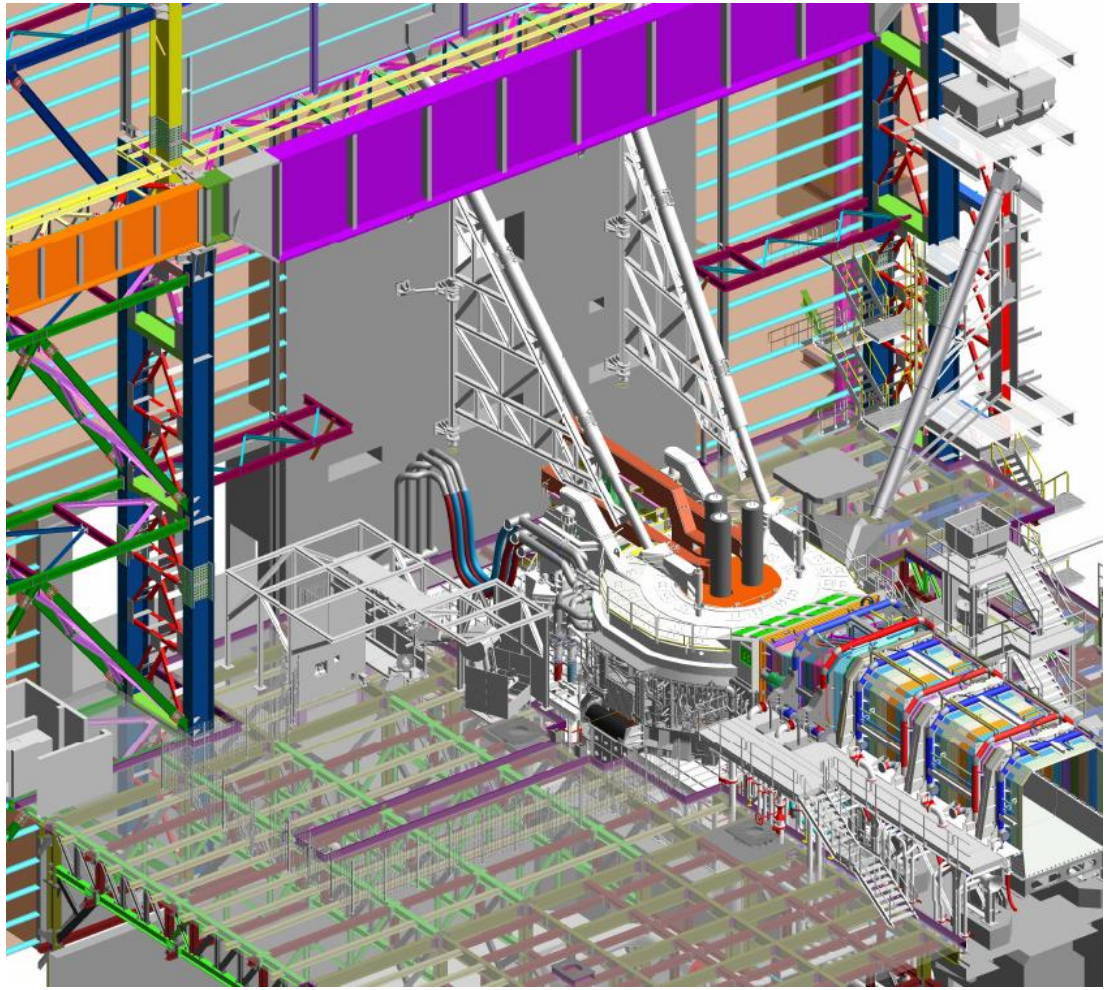
- Four (4) 100 m^3 CDRI Bins
  - Level control
  - Temperature control
  - Nitrogen Purging
  - Emergency discharge chute
- Two (2) 100 m3 Dololime Bins
- Two (2) 50 m3 Carbon Bins
- Two (2) 50 m3 Lime Bins
- Two (2) Hi Temp Conveyors feeding EAF receiving hopper (Flow Rate per Conveyor 260 m3/hr)

CDRI –Feeding to EAF

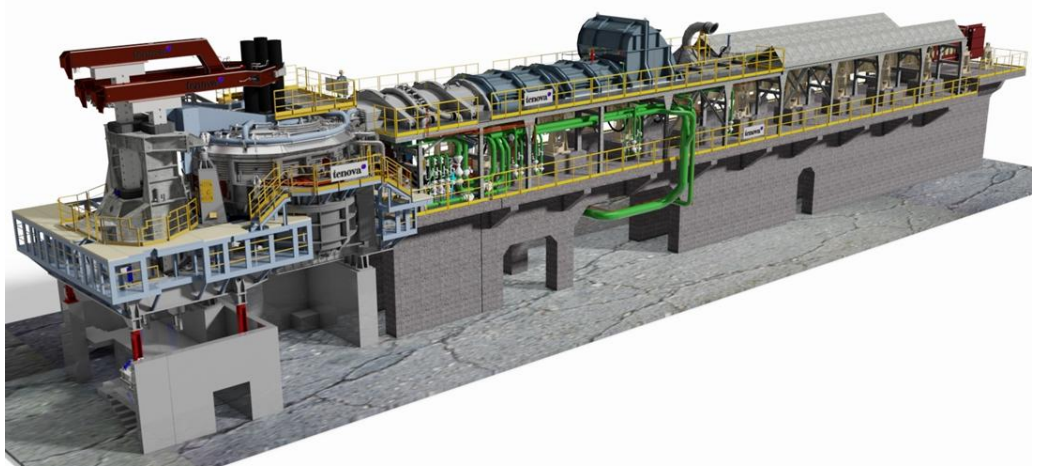


Consteel® EAF Characteristics

MAIN CONSTEEL EAF DATA

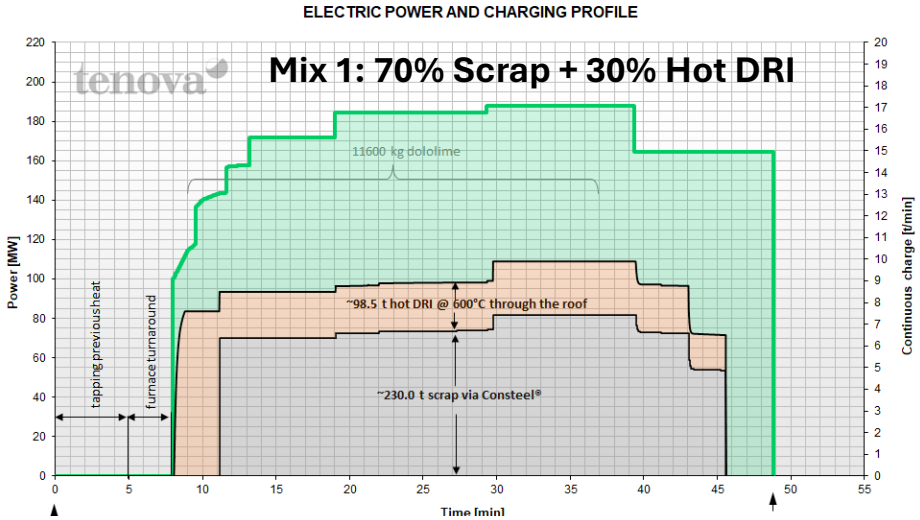


PRODUCTION:	**2,750,000 tls per year**
PRODUCTIVITY:	**up to 385 tls per hour**
CAPACITY:	300 tls +140 tls = **440 tls**
EAF DIAMETER:	9100 mm
EAF TRANSFORMER:	**270 MVA**
CONVEYOR LENGHT:	approx. 110 m

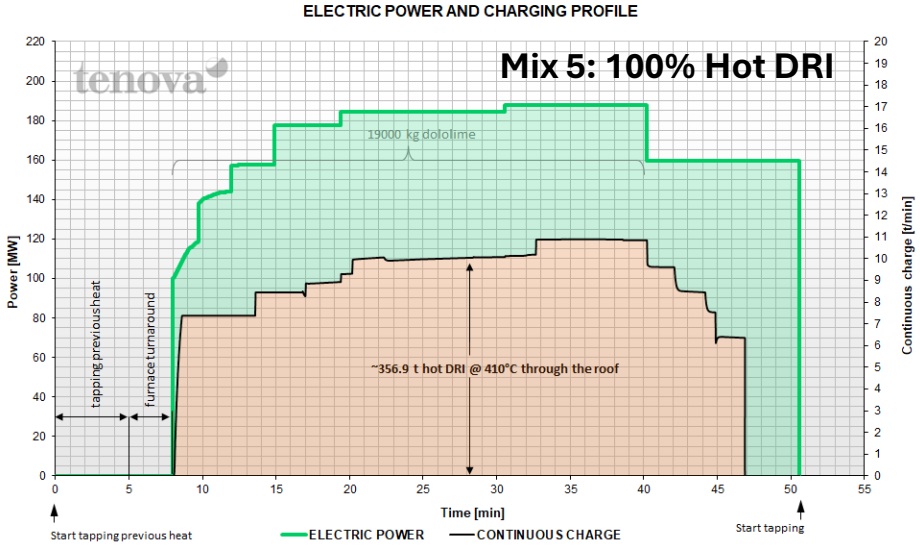


Melting Process

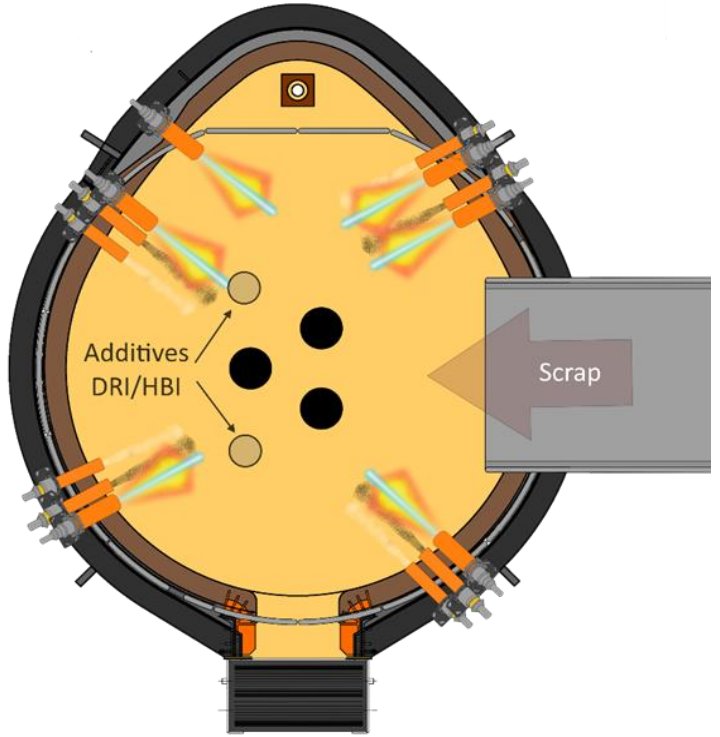
FLEXIBILITY MATTERS



Up to ~ 185 MW
TTT = 49 min



Up to ~ 195 MW
TTT=50.5 min

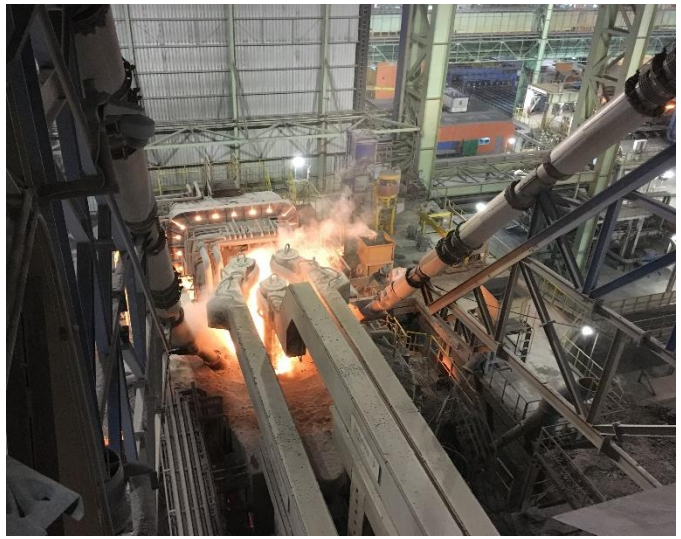


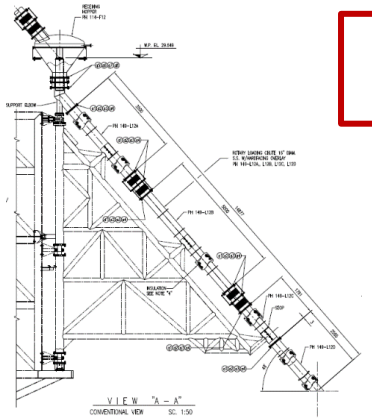
INJECTION SYSTEM:

- 6 x TENOVA KT Oxygen lances (5,000 Nm3/h, 13 bar)
- 4 x TENOVA KT wall Carbon lances
- 4 x TENOVA KT wall Flux lances

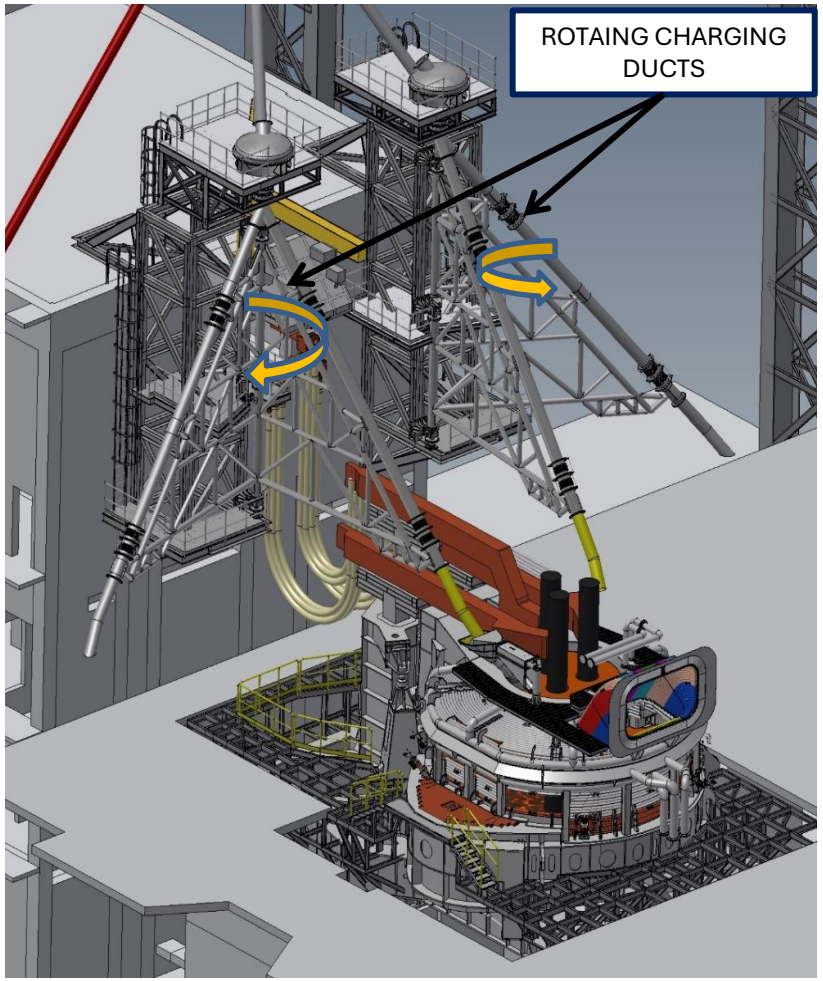
EAF - DRI Charging

HOT AND COLD DRI FEEDING





up to 7 t/min per chute

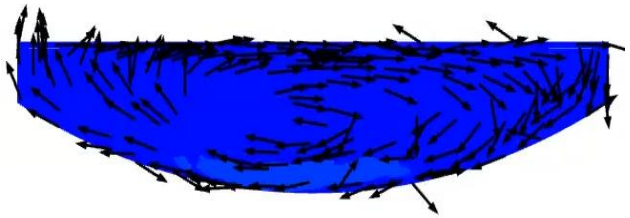


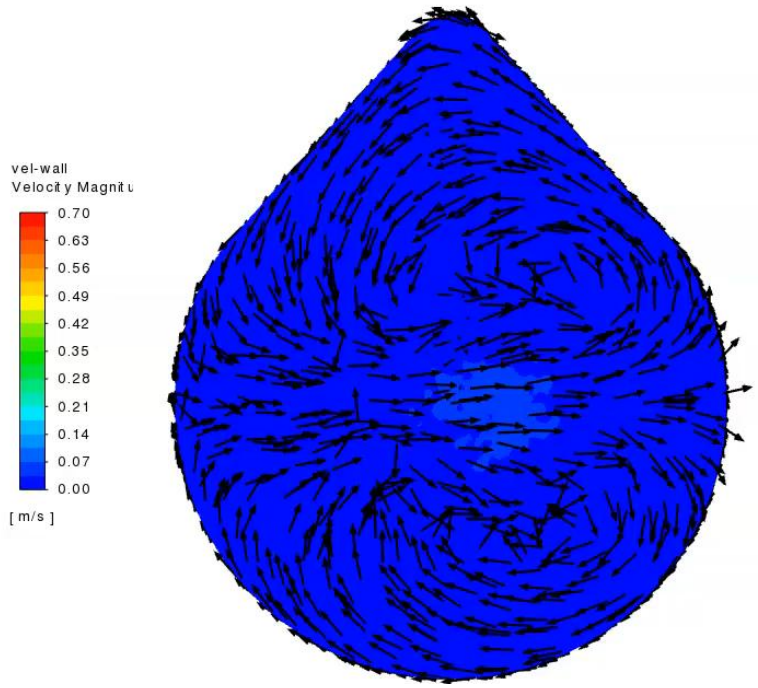
CONCEPTS

- DRI melts on the surface, therefore feeding in the EAF hot spots is optimal
- The AC EAF solution is ideal to maintain short arc and concentrate the power at slag/bath interface, where DRI melts.
- With high DRI feed rates, one singe feed point is not enough to avoid ferrobergs.
- Two charging chutes allows even distribution of the DRI and facilitates high melting rates.

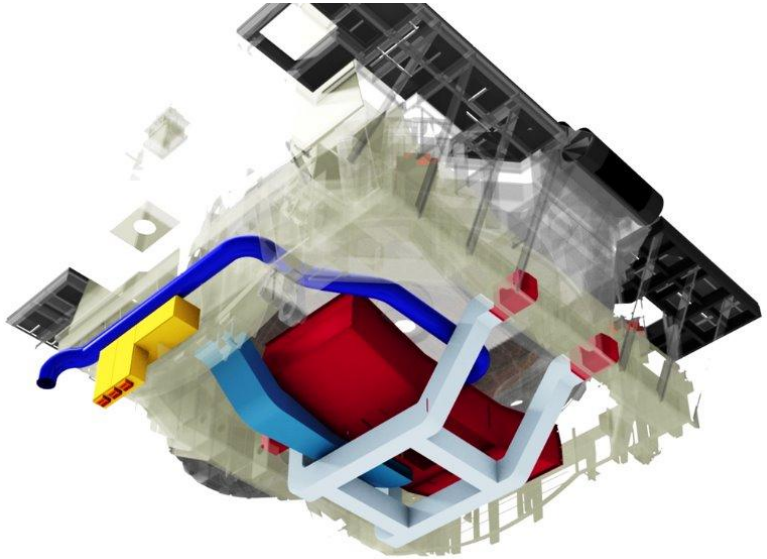
EAF Stirring – EMS (CONSTEERER®)

JOINT PATENT BY TENOVA AND ABB





- **%FeO** reduction in slag by approx. **10%**
- **Increase metallic charge yield by 0.5 - 0.75%**
- **Slag** reduction by approx. **10 - 15%**
- Electrical energy saving of **3 - 4%**
- **AO** in liquid approx. **-10%, l**ess **killing additives** and inclusions
- Increased steel-slag interaction, increased P removal



EAF Stirring – EMS (CONSTEERER®)

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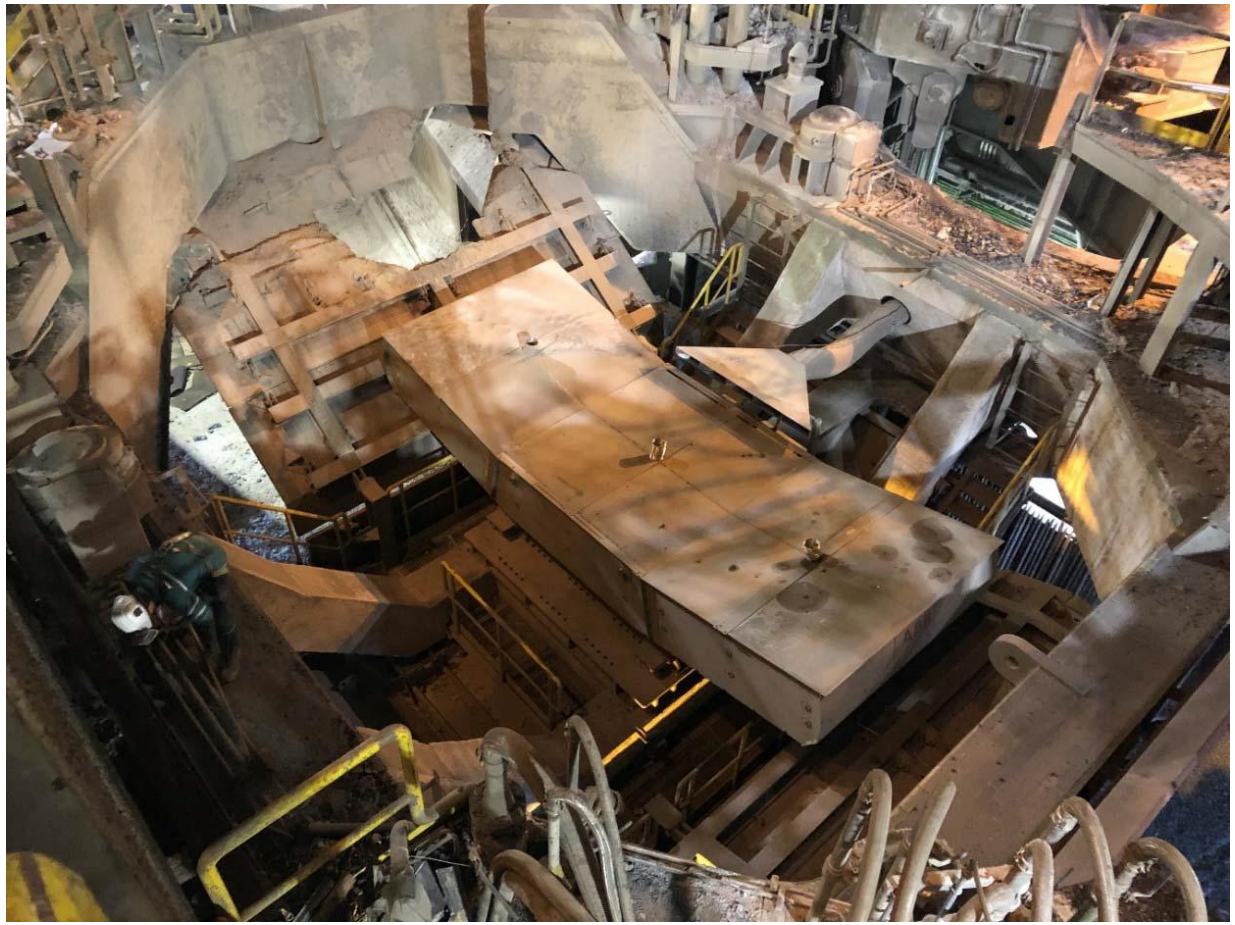
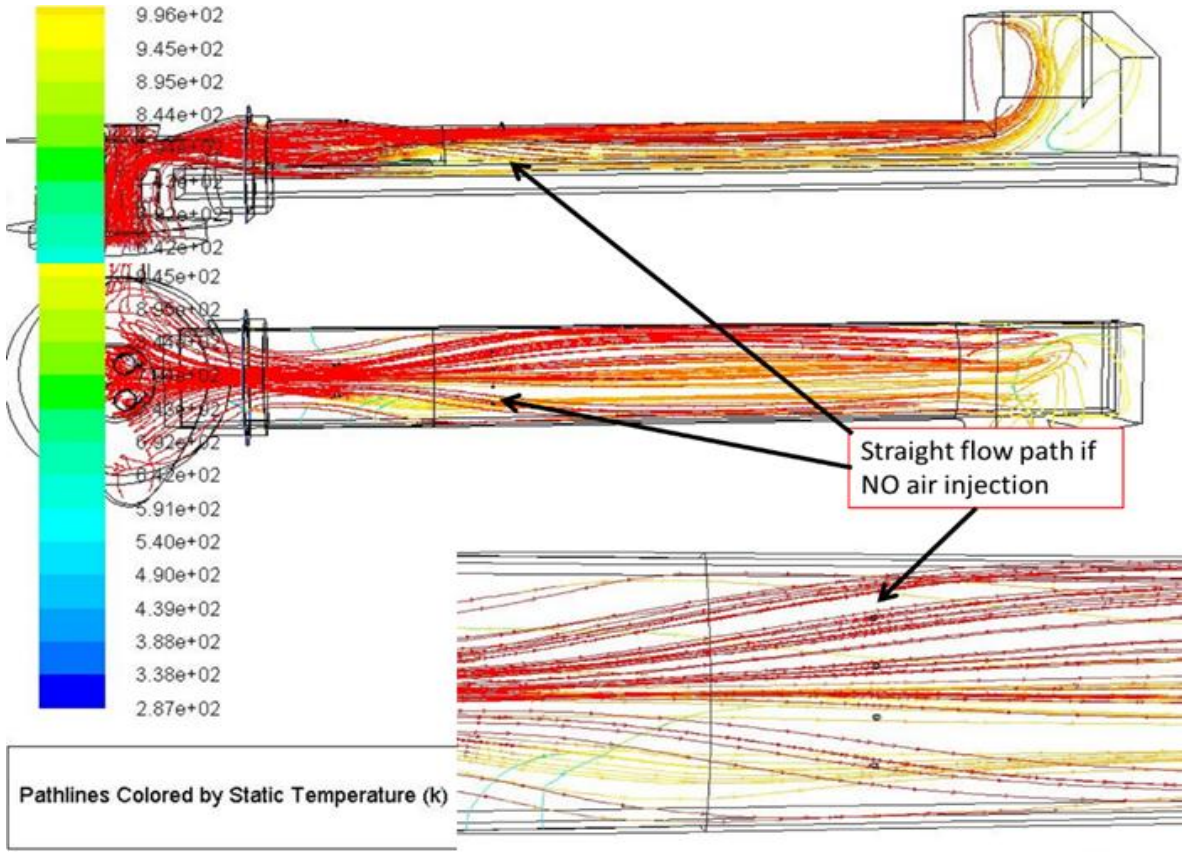


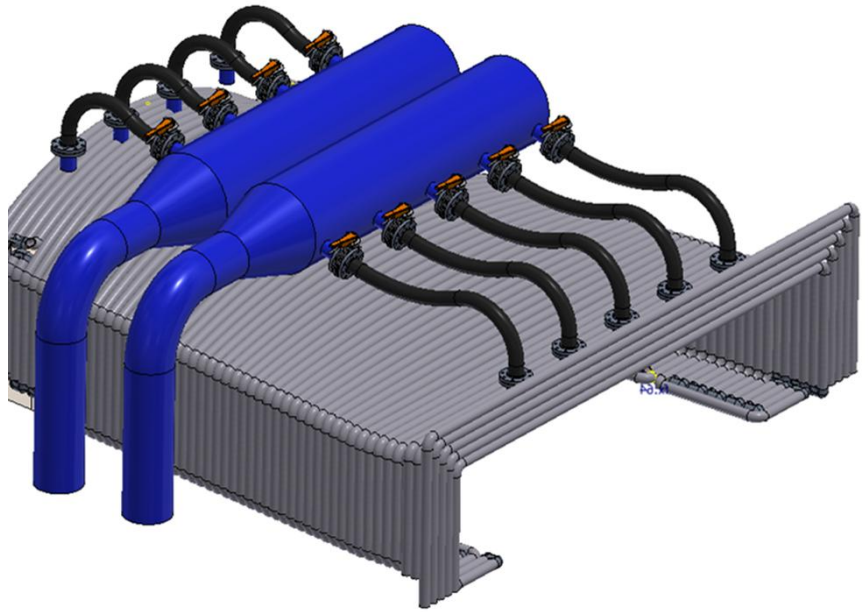
Consteel® - Air Jet Turbulators

POST-COMBUSTION OF EAF OFF GASSES IN THE CONSTEEL PREHEAT TUNNEL



Improve performances, reduce emissions.

- Increase turbulence without reducing reliability
- Improved combustion of CO
- Improved heat exchange



Progress and Status

VIEWS FROM THE SITE

Progress and Status

VIEWS FROM THE SITE

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To be Continued...