TATA STEEL
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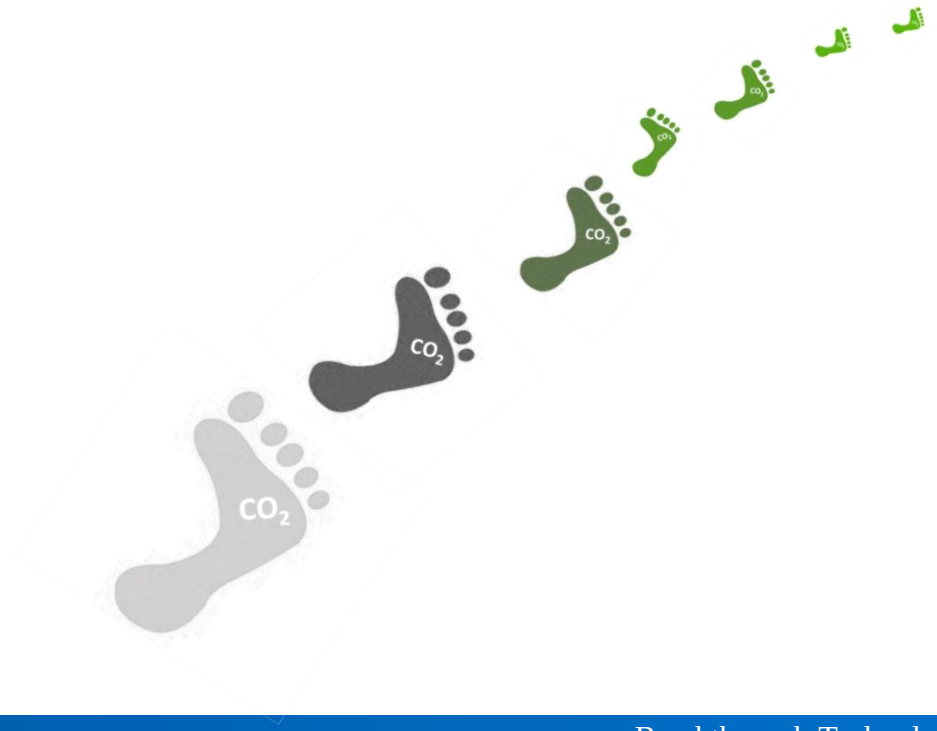
Hydrogen Injection at Tata Steel

Dr. Samik Nag



Breakthrough Technology Conference
Abu Dhabi, 5-7th Dec'2023

Tata Steel footprint

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CAPACITIES

34 MnTPA
GLOBAL CRUDE STEEL

The Netherlands
Manufacturing works
• Tata Steel Ijmuiden

Canada
Mining operations
• Iron ore

India
Mining operations
• Iron ore
• Coal
• Chromite
• Manganese
• Dolomite
Manufacturing works
• Tata Steel Jamshedpur
• Tata Steel Kalinganagar
• Tata Steel BSL, Dhenkanal

Thailand
Manufacturing works
• Tata Steel Thailand

The UK
Manufacturing works
• Port Talbot Steel Works

Asia's first integrated private steel company, established in 1907

Energy Efficient & Environment Friendly Technologies, Equipment & Services
for Indian Iron & Steel Industry: Meeting Global Standards
Ranchi, 8th Sept'22

Tata Steel : Business overview

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11th largest steel producer in the world (crude steel capacity)
**worldsteel 2019 ranking*

34 MnTPA
annual crude steel capacity

>77,000
employees

$ 30.3 billion
Turnover

PRODUCT RANGE

- Hot Rolled Coil
- Cold Rolled Coil
- Galvanised coil
- Wire Rod
- Coated Coil
- Rebar
- Wires
- Tubes

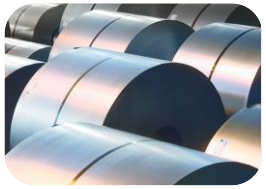
KEY MARKET SEGMENTS

- Construction
- Automotive
- General Engineering
- Industrial Products
- Agriculture

KEY BRANDS

Galvano Value Redefined
TATA SHAKTEE LIVE WITH PRIDE
TATA AGGREKO
durashine TATA BLUESCOPE STEEL
TATA TISCON
TATA ASTRUM HR SHEETS AND COILS
TATA Steelium CR Sheets and Coils Helps shape your dreams
TATA AGRICO A bond of trust
TATA STRUCTURA STEEL – ALLOY SECTIONS THE SHAPE OF THINGS TO COME
TATA nirman
TATA Wiron boandhe rishton ke taar






Commitment

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India

Target Net-Zero
Emission by 2070

Tata Steel

Target Net-Zero
Emission by 2045

Target for Tata Steel

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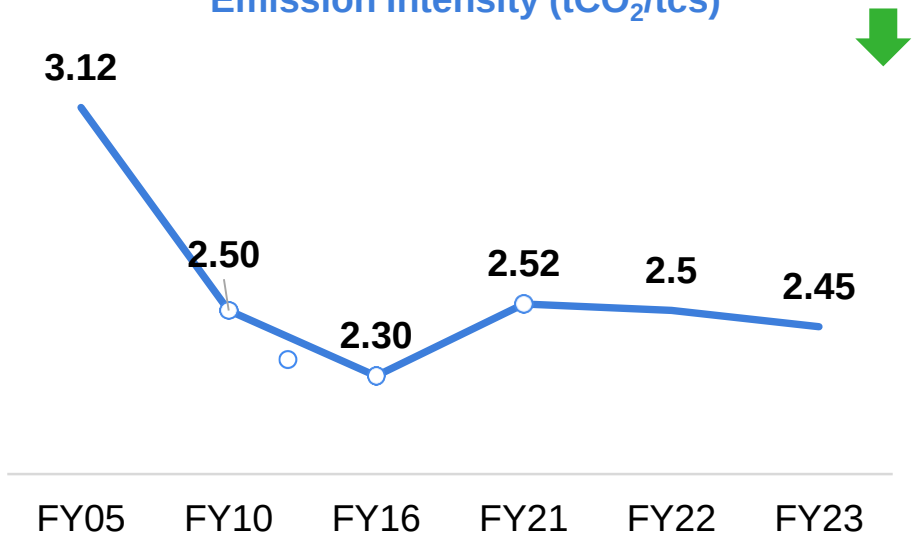
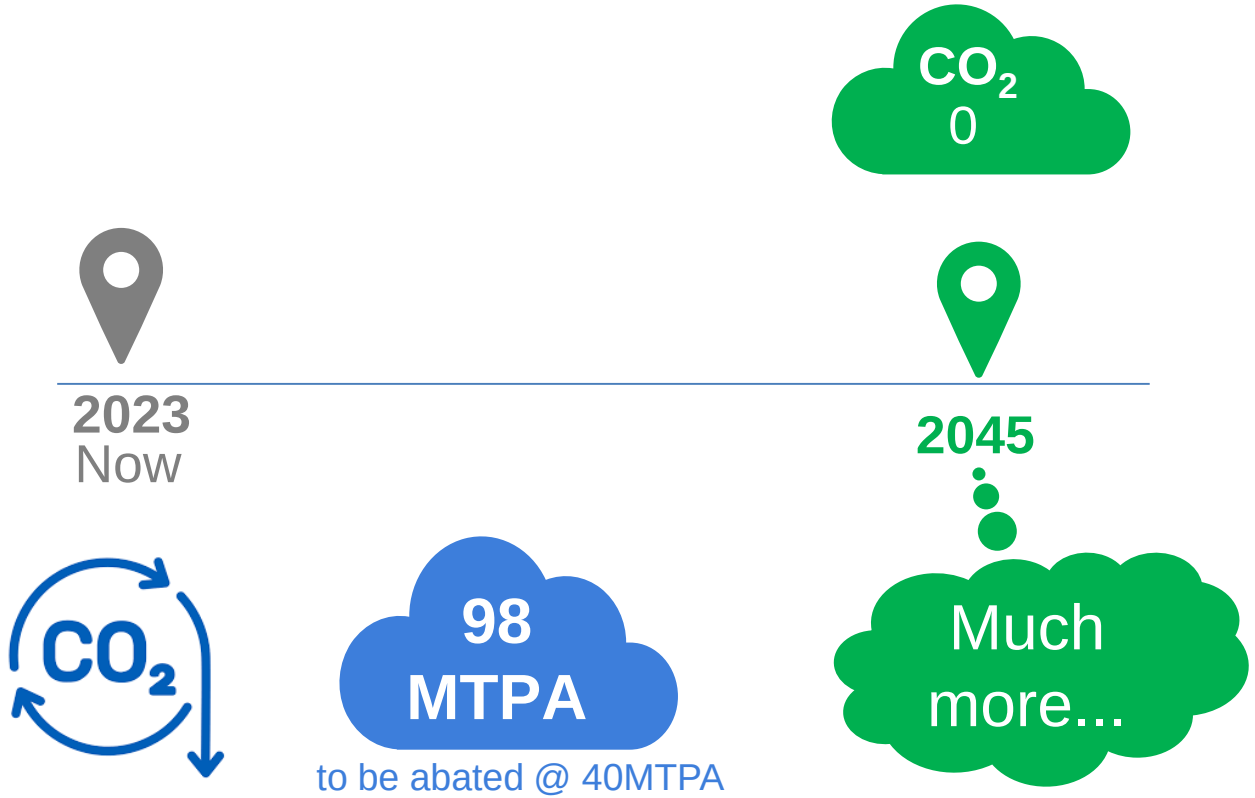
Performance Over the Years

Emission Intensity (tCO_2/tcs)



Tata Steel India

Target



Tata Steel India (TSL Standalone & TSLPL including NINL); GHG Emissions as per WorldSteel Association Methodology

Calculation Standard: World Steel Association

Multitrack decarbonization strategy

Lever #1 → Process Improvement (PI)

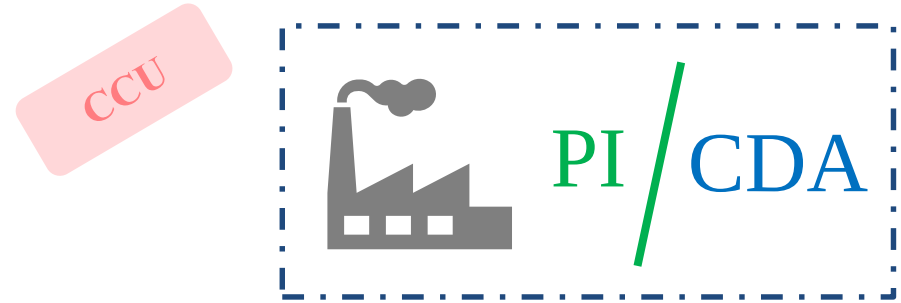
Using best available technologies

Lever #2 → Carbon Direct Avoidance (CDA)

Usage of alternative fuels to replace fossil fuels

Lever #3 → Carbon Capture and Utilization (CCU)

Captured CO_2 to be sequestrated and make valuable products



98 **MTPA to be abated** → **71 MTPA Methanol**

Methanol

71 MTPA

✓ Global Projection: 385 MTPA by 2050

Green H_2

13.4 MTPA

✓ India Projection: 55 MTPA by 2050

Land

5000 Acre

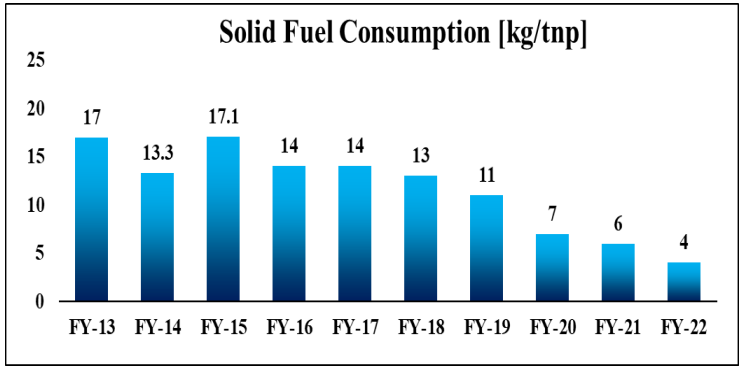
✓ TSJ: 1750 Acre

Ref: Innovation Outlook, Renewable Methanol, IRENA
Energyworld.com

Process Improvement || Some shining cases

A Reduction of solid fuel consumption in Pellet

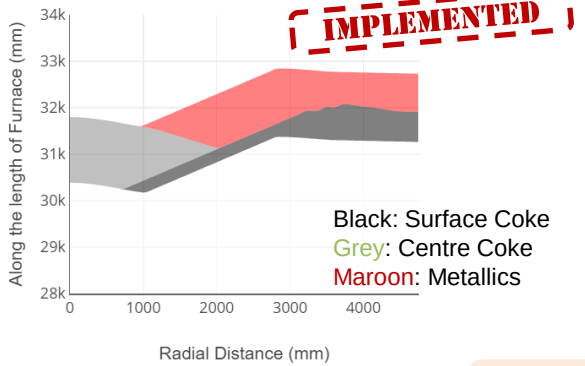
Use of waste carbonaceous material for pellet making



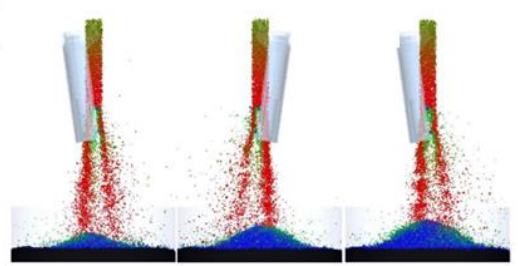
CO_2 savings | 20 kg/tcs

B Burden Distribution Simulators for Blast Furnace

Continuum Model

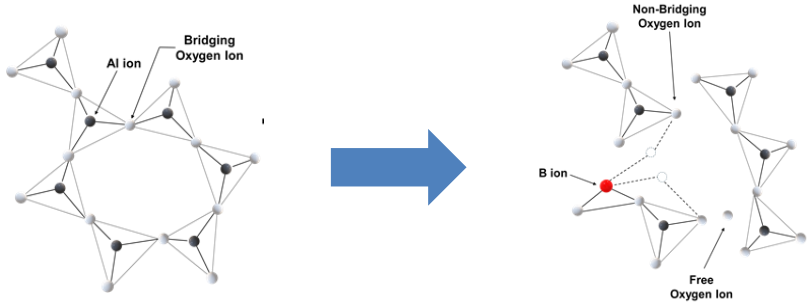


Center Coke Optimization : DEM



CO_2 savings | 26 kg/tcs

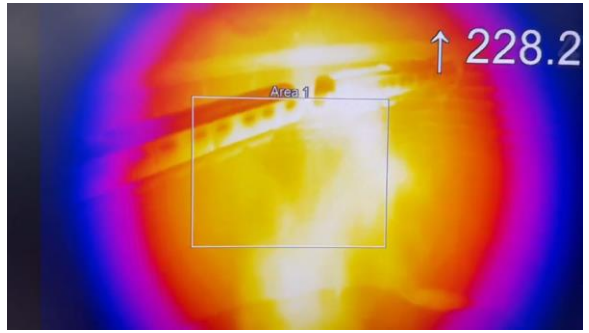
C Managing low grade ore



CO_2 savings | 17 kg/tcs

D

- Visualisation inside furnace
- Best ever coke rate in F BF



CO_2 savings | 50 kg/tcs

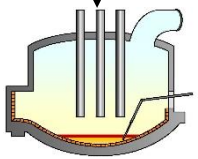
tcs: ton of crude steel

Tata Steel's efforts

Carbon Direct Avoidance

Scrap Utilization

BOF



EAF ConArc

Partial Replacement of Hot Metal

Alternate Iron making route

Coal Gasification

H_2 or Syngas

Gas-based DRI

H_2 bearing gases Injection

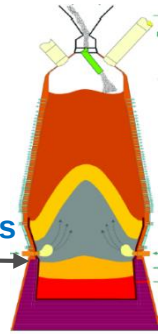
- Mill off gases COG, LD Gas
- Coal Bed Methane (CBM)

H_2 Generation

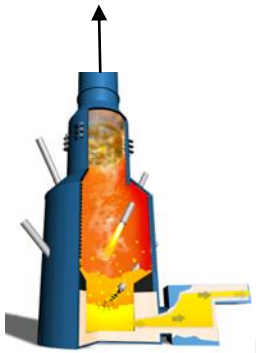
- Electrolysis
- Biomass gasification
- Other Technologies
  - Chemical Loopin

CO_2 → Syngas

Steel Mill off gas



Blast Furnace



HIsarna

H_2 or Syngas Injection

Electrification: Superheated

Carbon Capture & Utilization

PSA-based separation

Gas Separation

CO & N_2 removal

CO_2 Capture, Utilisation and Storage

- Ethanol/Methanol
- Mineral Carbonation
- Polycarbonate
- Carbon Nanotubes
- Sustainable Aviation Fuel
- Storage and sequestration
- Reforming

Decarbonization Strategy

Identified Technology routes

COG: Coke Oven Gas, DRI: Direct Reduced Iron, BOF: Basic Oxygen Furnace, EAF: Electric Arc Furnace, PSA: Pressure Swing Adsorption

Vision

BEGINNER

115 Years of Blast Furnace operation

No Gas Injection

COMPETENT
Learn with Hydrogen bearing gas

PROFICIENT
Design system for pure H_2 injection

EXPERT
Plan for continuous use

Carbon Direct Avoidance journey at a glance

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Jan' 22 — CBM injection — One-month long trial

Click Here for Details

Dec' 22 — Bio-char injection — Replacing 10 % PC

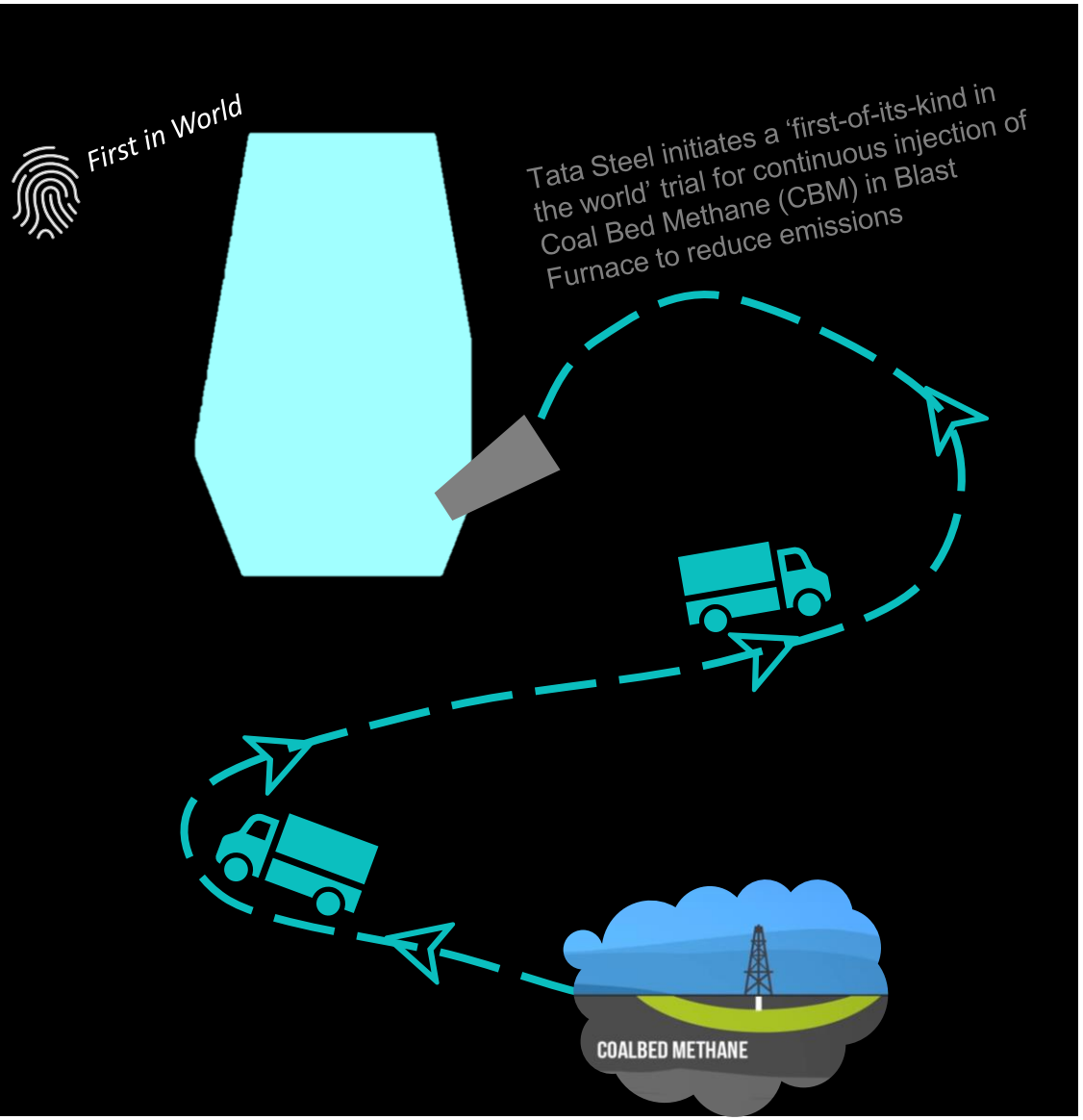
Apr' 23 — H_2 injection — Record injection volume

Click Here for Details

July' 25 — COG injection — Continuous injection with PC

CBM: Coal Bed Methane
PC: Pulverized Coal

CBM Injection



Onsite pressure reducing station & heating arrangement

1 Month-Long Trial

Successfully co-injected with tar

Replacement ratio: ~ 1.2-1.4 kg coke / kg of injectant

Potential carbon footprint reduction: ~ 10 %

H_2 injection challenges

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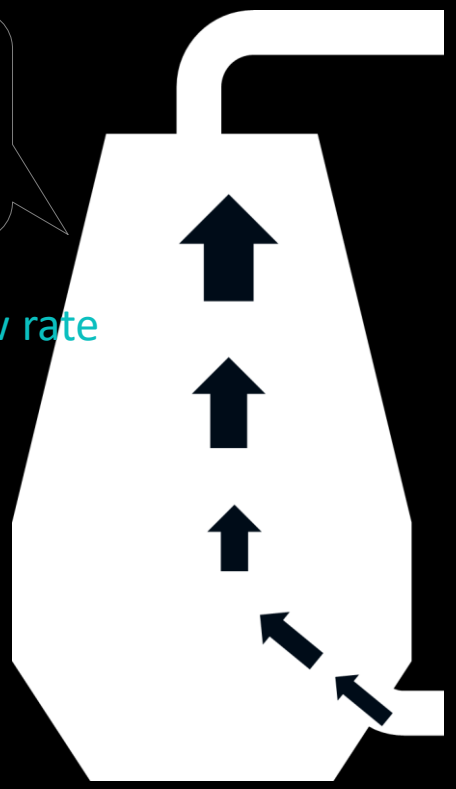
Process Stability

- Selection of Tuyeres & flow rate
- Control Strategy
- Risk mitigation plan



H_2

Injection System

Material Selection

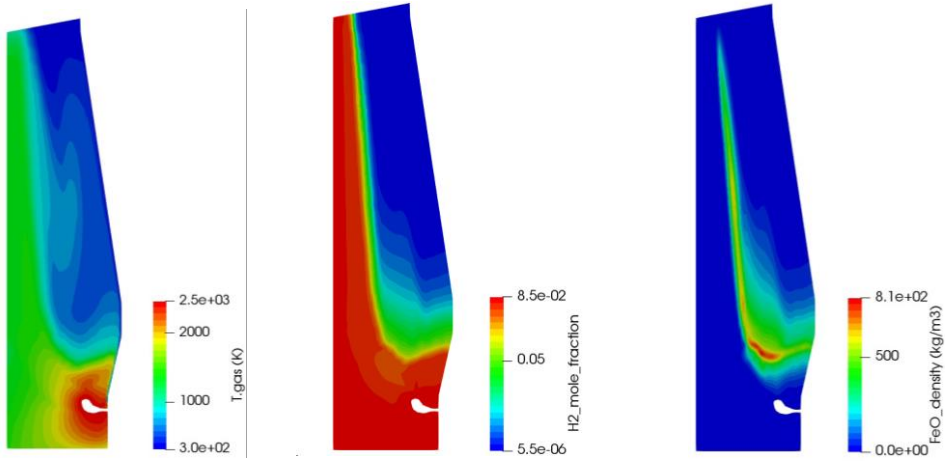
Interlock designs

- Due diligence: PFD, P&ID
- Detailed HAZOP
- CFD analysis of Raceway

Sourcing & Logistics

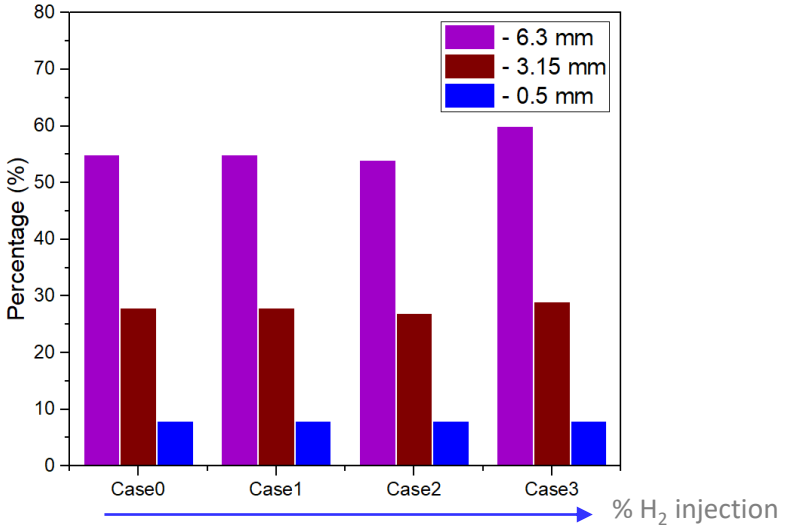
Lab scale analysis

A Gas-Temperature profile from 2-D model

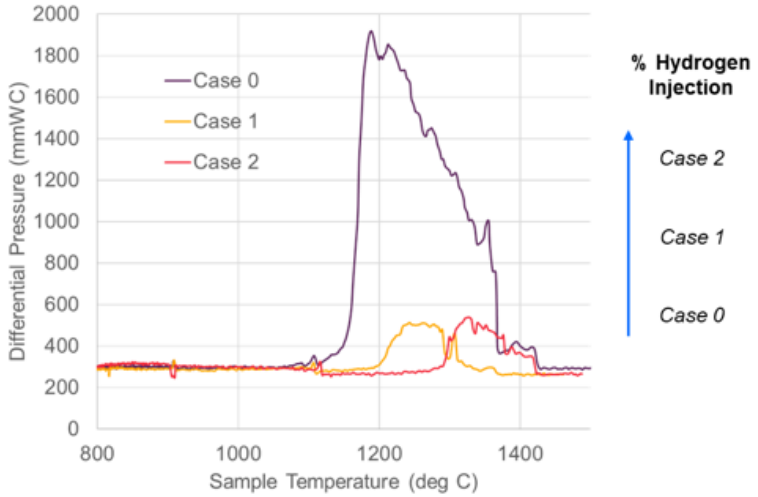


B Degradation studies

Tweaking process to keep degradation under control

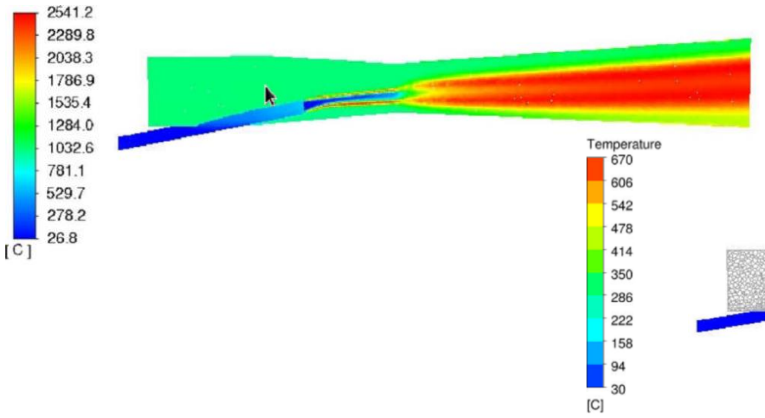


C Simulation of Cohesive zone



D Designing lance

- Optimize flow to maintain lance temperature under control



Lance temperature

Site activities

A Cold simulation of Injection system

105 triggers are cold simulated for robust design

- Design Interlocks
- Process Interlocks

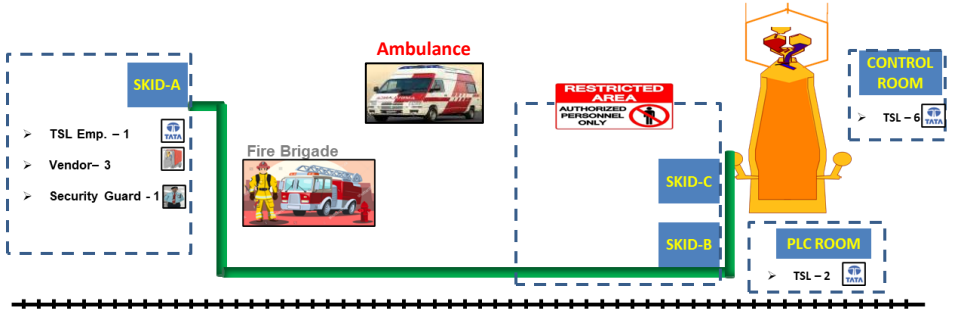
SHORT SHUTDOWN

Lance cooling by N_2, stoppage of H_2 flow

EMERGENCY SHUTDOWN

Vent off H_2 via diluting with N_2

B Access control



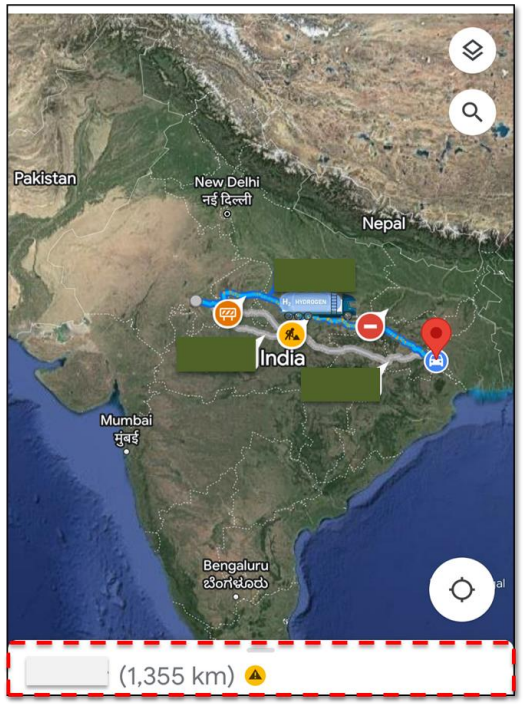
SOP training to all shift employees, Detailed trial plan

Barricading, Do's & Don'ts

Remote monitoring of BF sites

Installation of detectors, thermography at each shift

C Domestic Sourcing from ~1400km dist.



- Tankers' parking area barricaded; security force deployed with fire hydrant is in position for round the clock
- ***Special Permission*** was sought from local administration
- Dedicated work force involved to track movement and ensuring vehicles reach safely at site

Realization

1

Valve station-1

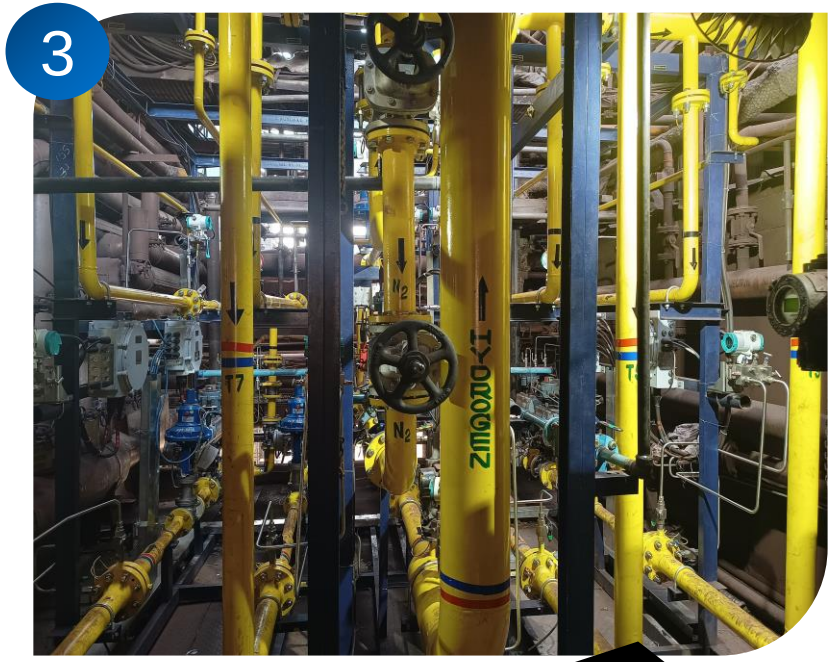
Reduction of pressure: 200-5 bar(g)

2

Valve station-2

To isolate BF from H_2 source

3



Valve station-3

To distribute H_2 across tuyeres

In-house Engineering

> 100 interlocks

Special Material

Trial Findings

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Highlights

- ✓ 4 days of continuous trial
- ✓ Trial performed in 2 phases – 1100 Nm^3/h and 1800 Nm^3/h
- ✓ Injection with 40% tuyeres
- ✓ Highest volume injected | **6kg/thm**
- ✓ Drop in resistance | **5%**
- ✓ Drop in RAFT | **5 %**

Beyond Injection: Disruptive Technologies

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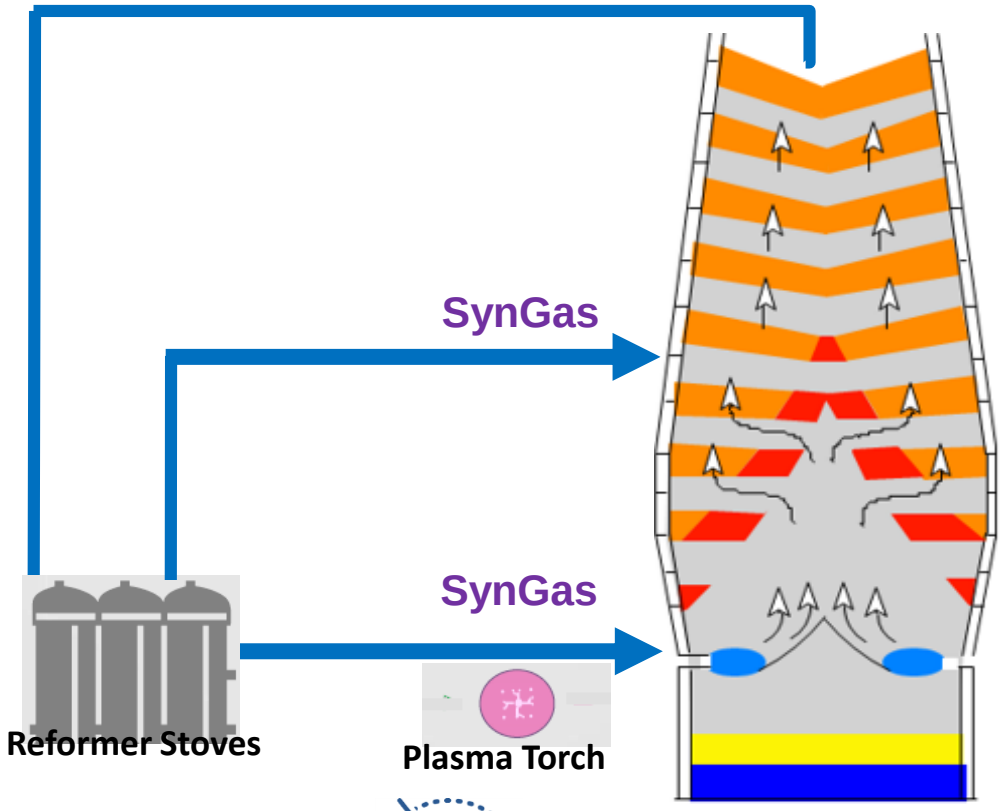
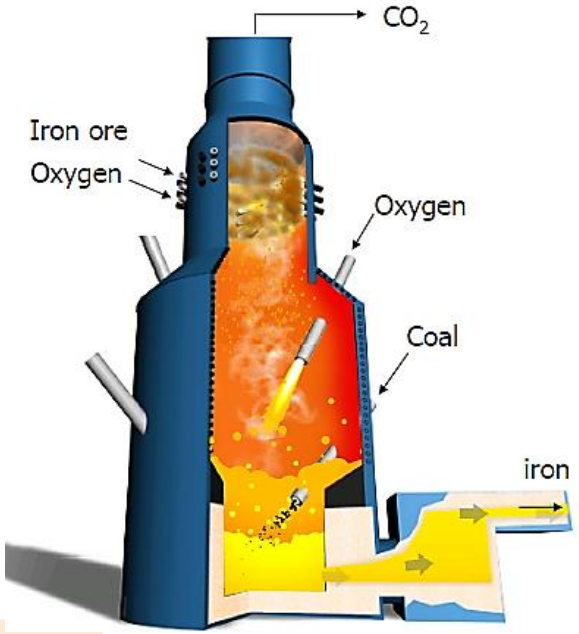
A Top gas Recycling: CO_2 regeneration

CO_2 | ~ 50%



PAUL WURTH
SMS group

B HIsarna



CO_2 | ~ 80% (CCU/S)

- **Benefits:**
  - Usage of 100% non coking coal
  - Usage of low-grade iron ore
  - No coke, sinter and pellet plant needed
  - Use of LD slag to replace imported limestone

H_2 production

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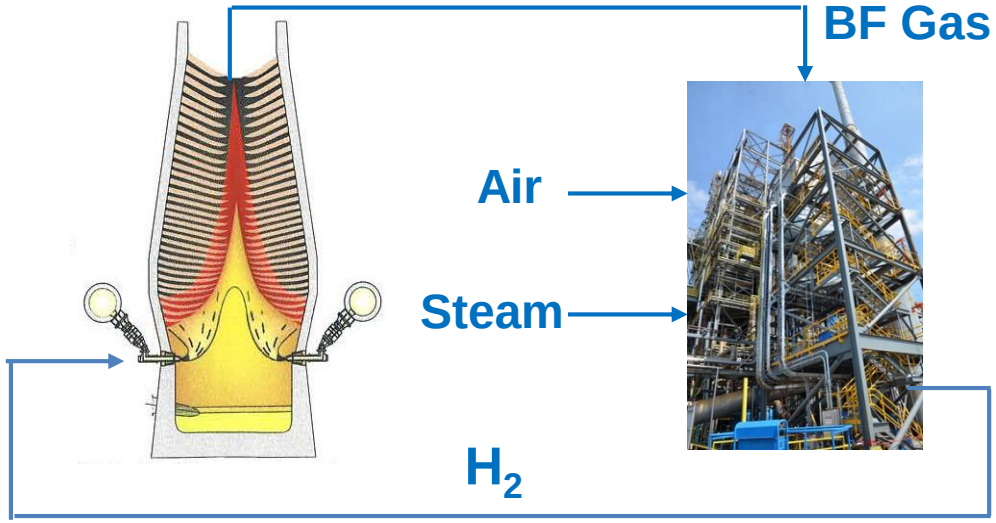
A **Global Research**

Electrolyzer & **Biomass gasification**

B **Unique Proposition of Hydrogen Production**



Integration of Chemical Looping with Steel Plant

Chemical Looping Technology
- Economical

Potential to meet 10% H_2 demand

Completed

Lab Scale(0.1 H_2 kg/h) ▶ **Pilot Plant 5 kg/h** ▶ **Demo Plant 1 TPD** ▶ **Industrial Plant >5 TPD**

Carbon Capture and Utilization

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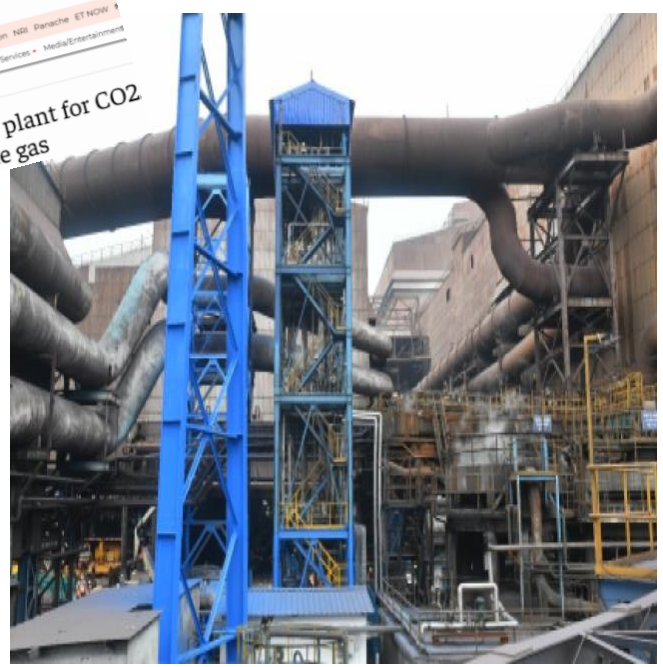
A 5 TPD CO_2 capture plant


THE ECONOMIC TIMES | Industry

Tata Steel commissions India's first plant for CO2 capture from blast furnace gas



○ Novelty

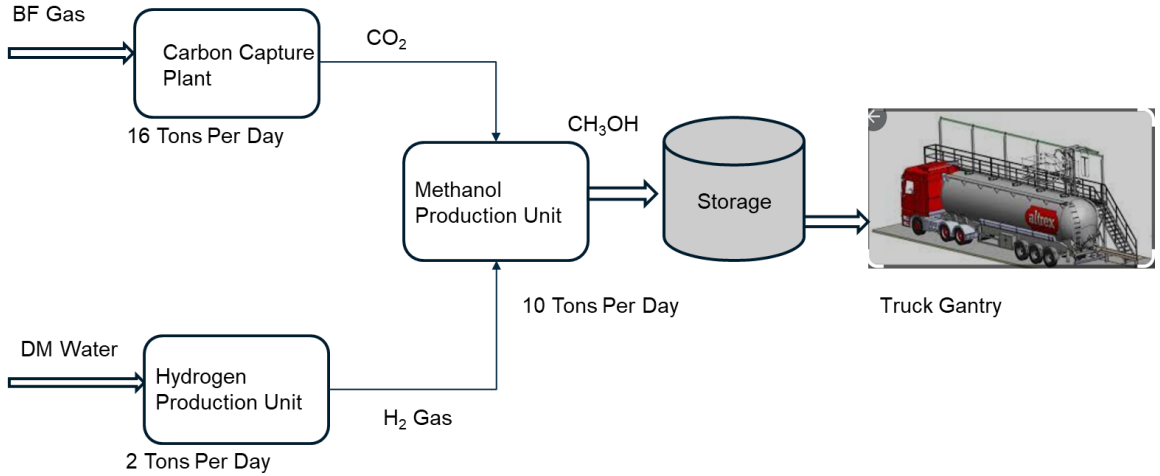
- ✓ 1st time by any steel plant in India
- ✓ Recovery of CO_2 from blast furnace gas
- ✓ Scalable up to 2500 – 3000 TPD
- ✓ Low emission loss and non-flammable solvent

B 10 TPD Methanol generation

Tata Steel to set up a pilot plant for methanol

By **Valve World India and Middle East Publisher** - April 28, 2023

Tata Steel is putting up a 10 tonnes-per-day pilot plant at its Kalinganagar plant in Odisha to produce methanol from blast furnace flue gases. If successful, this has the potential to open an avenue for substantial production of methanol in India.



Summarized Plan to Achieve Net Zero

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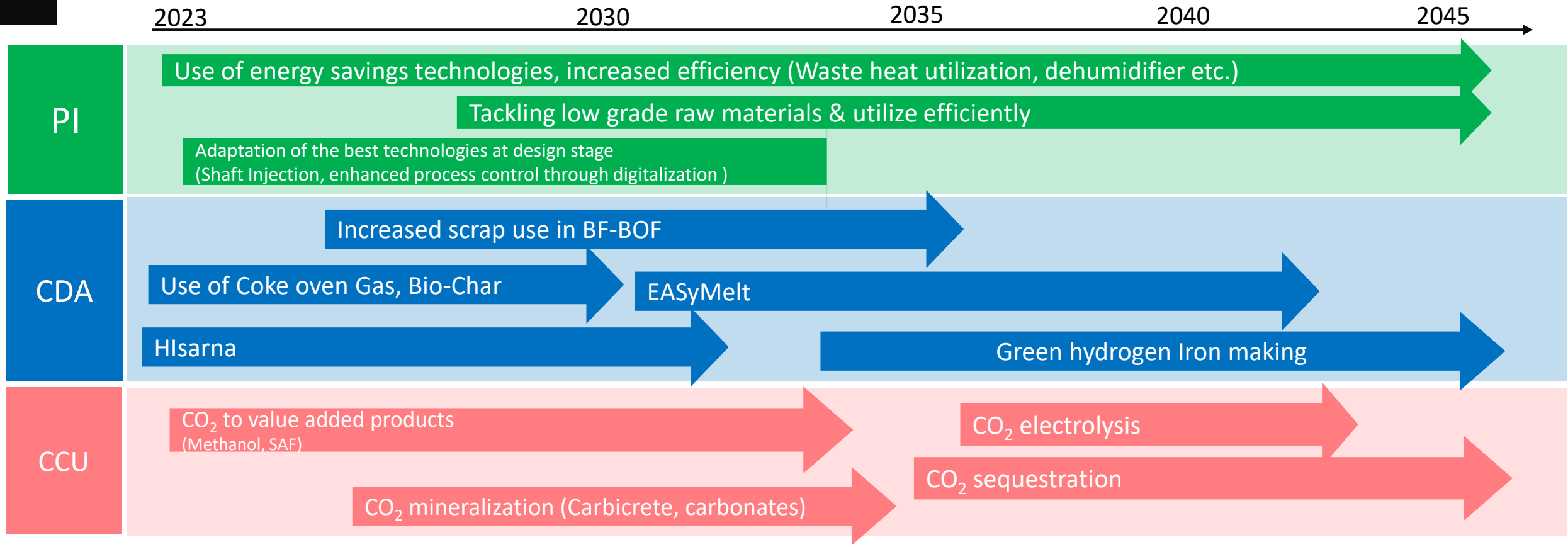

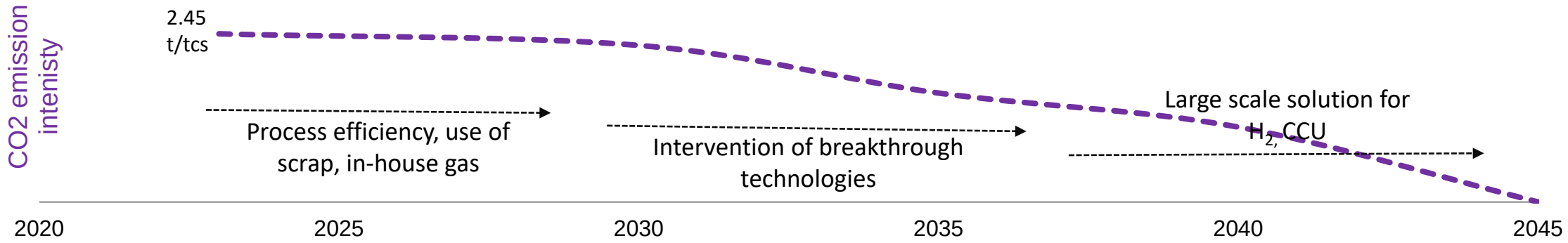

And miles to go