Decarbonization Options for Secondary Steel Industry

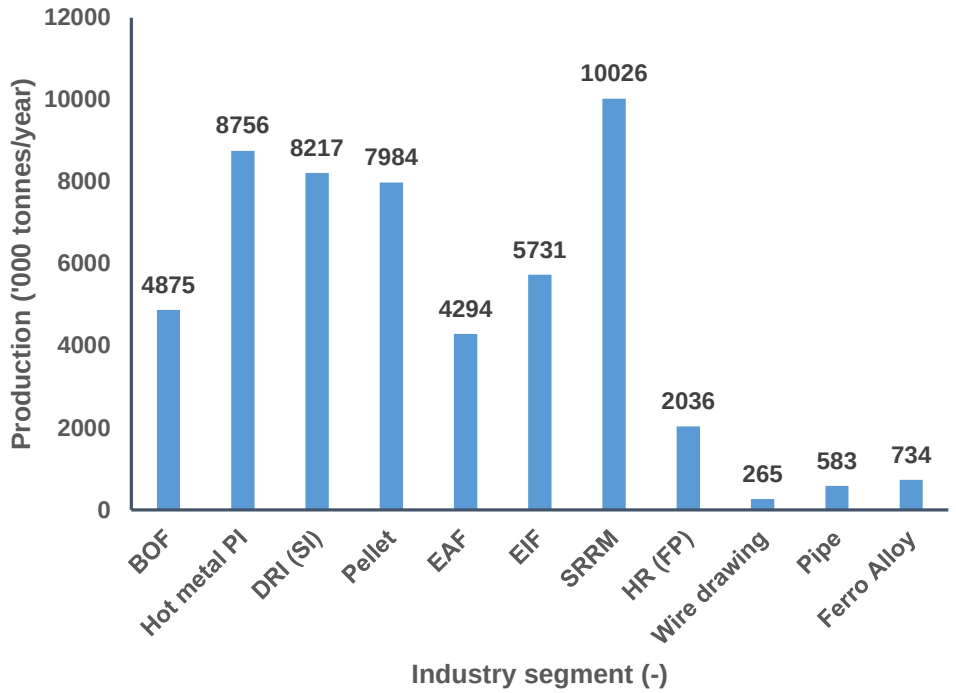
SAMEEEKSHA Platform – 21st Meeting
Raipur, Chhattisgarh

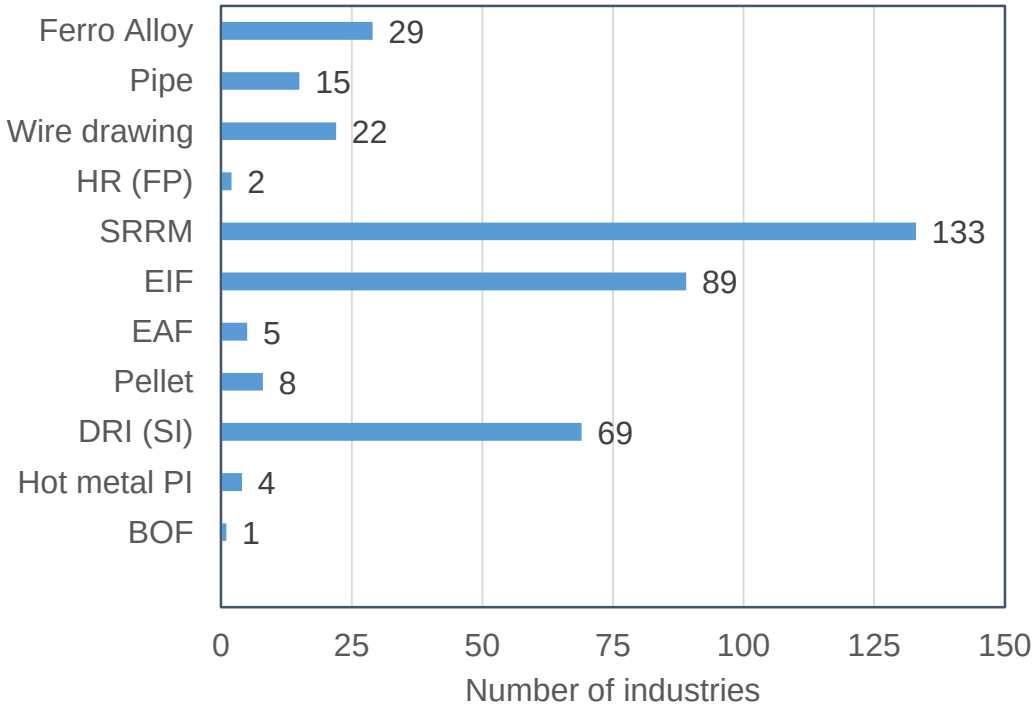
18th November 2022

Overview of Secondary steel industry

Chhattisgarh State

Steel industries in Chhattisgarh



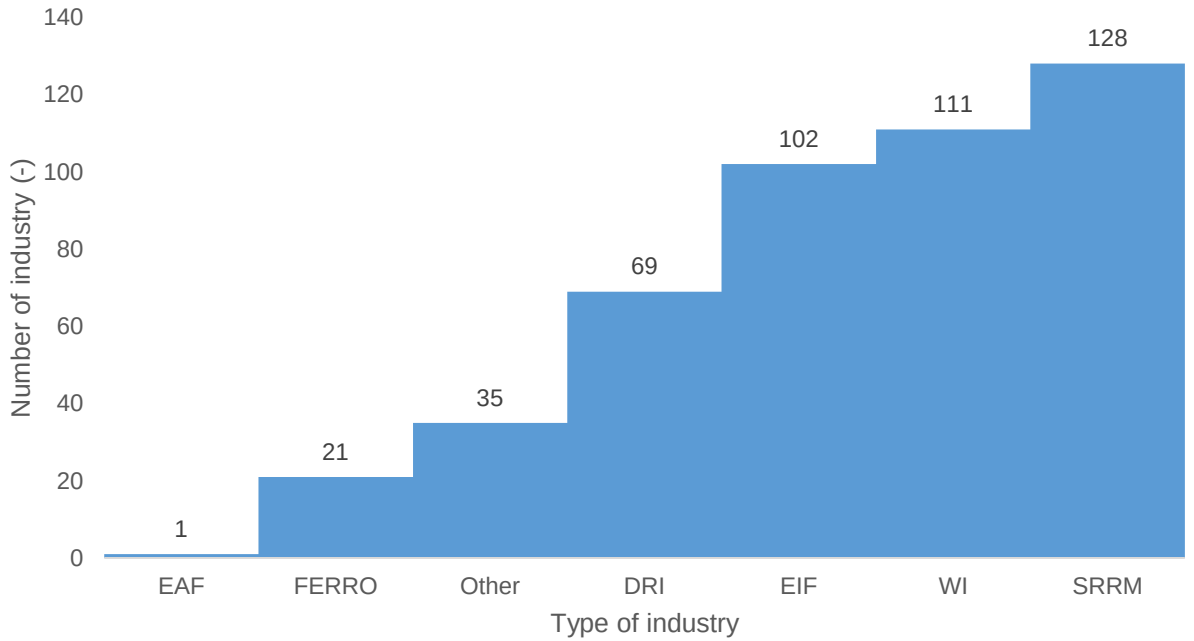


- Primary location – 6 districts (Bilaspur, Bhilai, Durg, Raigarh, Raipur, Rajnandgaon)

Source : JPC data year 2021-22

Secondary steel industries in Raipur cluster

Type	Mixed[@] total	DC[$]	No details	Non DC	Composite[#]	Stand alone	Actual number
DRI	69	25	24	20	27	18	69
EAF	1	1	0	0	1	0	1
EIF	102	19	27	56	55	20	75
SRRM	128	13	0	115	55	73	73
FERRO	21	3	0	18	0	21	21
WI	111	0	0	111	6	105	105
Other	35	0	0	35	0	35	35
Total	467	61	51	355	144	272	379



DC *Designated consumer*

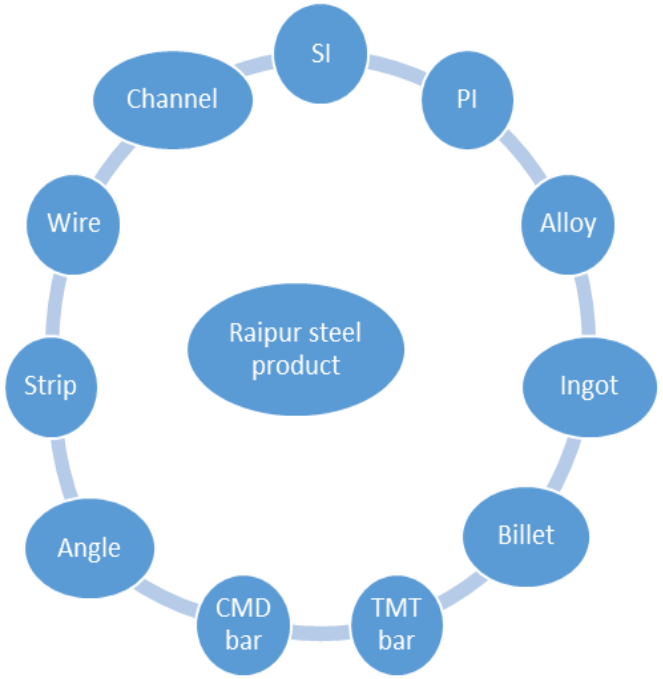
@ *represents the sum of absolute industries that falls under the row of specific type of industry*

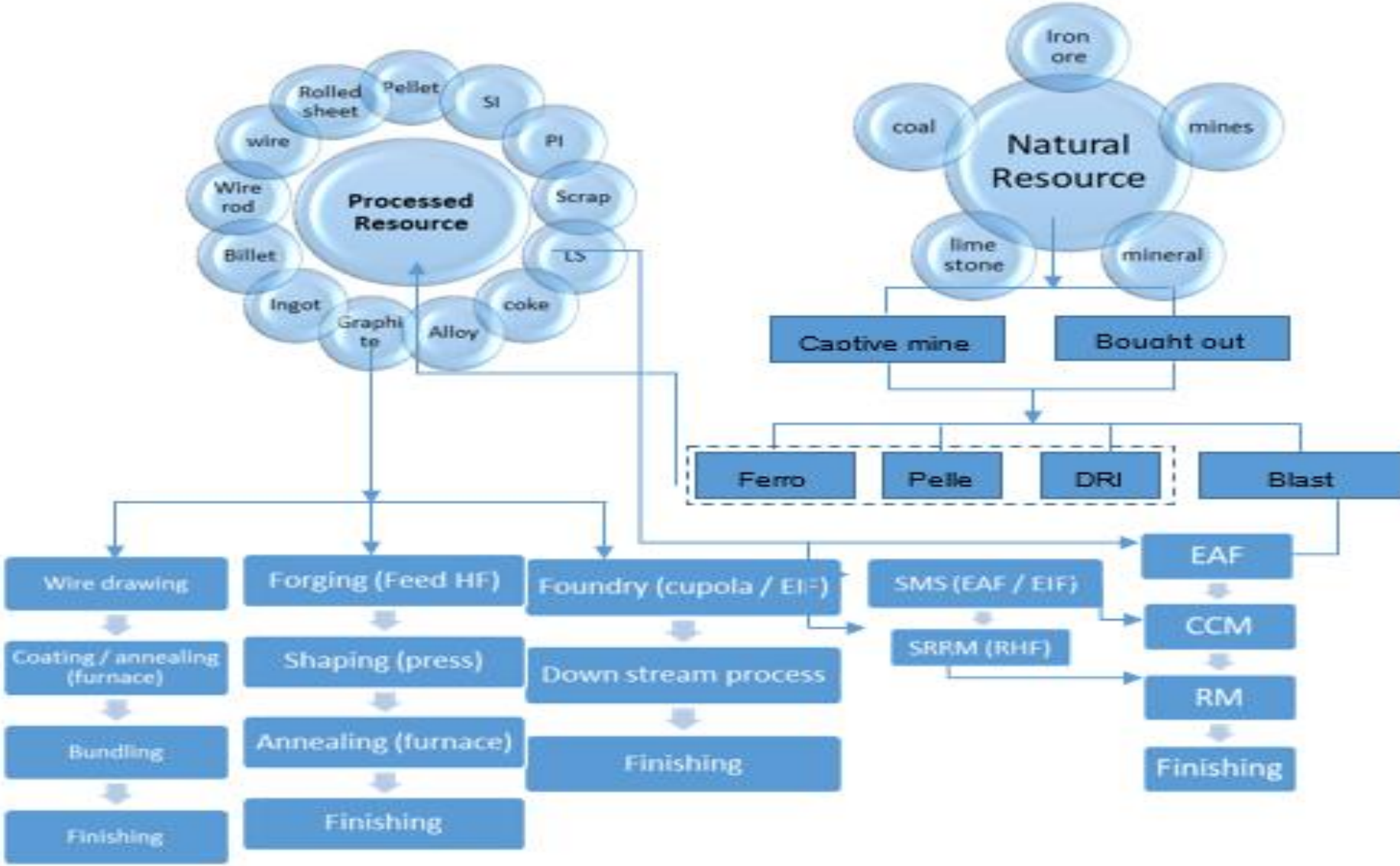
*industry type under the row has also integrated backward and forward process steps within the same premises*

Details of technologies and resources in use

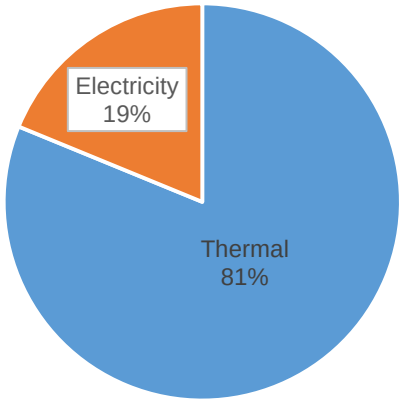
Technology	User industry	Raw material	Process step	Energy used	End product
Rotary kiln	DRI	Iron ore	Heating and reduction	Coal,electricity	Sponge iron
Submerged arch Furnace	Ferro alloy	Mineral ore	Heating and reduction	Coal, electricity	Alloys
Electric induction Furnace	SMS	Sponge iron, scrap	Steel melting	Electricity	Ingots and billets
Re-heating furnace	SRRM	Ingots and billets	Heating	Coal	Heated feed stock for milling
Continuous casting machine	SMS	Liquid metal	Casting	Electricity	Hot billets for milling
Rolling mill	SRRM	Hot ingots and billets	Rolling	Electricity	Rolled products
Wire drawing machine	Wire Industry	Coiled wire	Drawing	Electricity	Drawn wire
Annealing furnace	Wire industry	Drawn wire	Annealing	Furnace oil, electricity	Annealed wire
Coating bath	Galvanizing industry	Drawn wire	Galvanizing	Furnace oil, electricity	Galvanized wire

Material flow chain and primary products

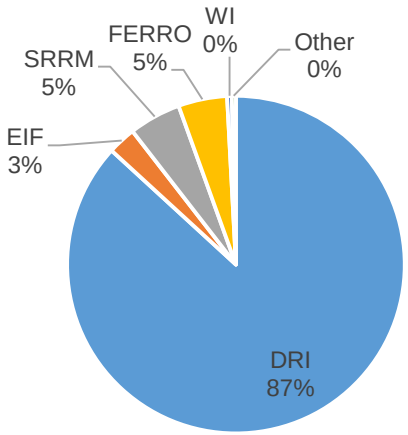




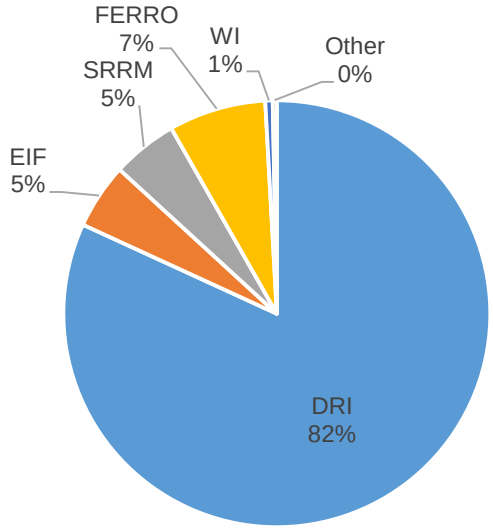
Energy consumption and GHG emission in Raipur cluster



Share of energy type



Share of energy consumption by industry sub-sector



Share of GHG emission by industry sub-sector

- Total energy consumption – 3.91 m toe/year
  - *Thermal – 3.17 m toe/year*
  - *Electricity – 0.74 m toe/year*
- Total GHG emission – 19.56 m t-CO_2/year

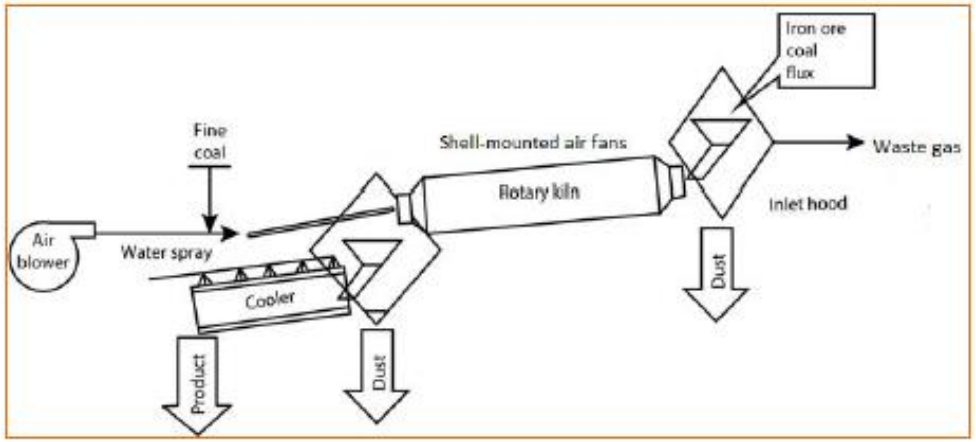
Source: TERI's analysis

SECs per tonne basis for different industries

Industry type	Specific consumption (unit/tonne)			
	kWh	Coal (kg)	Coke (kg)	FO (kg)
DRI	70 - 80	1000 - 1200	-	-
Ferro alloy	7000 - 8500	-	450 550	-
Electric induction furnace	800 - 900	-	-	-
Re-heating furnace	4 - 6	100 - 130	-	-
Continuous casting machine	80 - 100	-	-	-
Rolling mill	50 - 80	-	-	-
Forging	600 - 800	-	-	850 - 950
Foundry	25 - 30	-	100 - 110	-
Galvanizing	6 - 10	-	-	25 - 30
Wire drawing	200 - 300	-	-	5 - 8

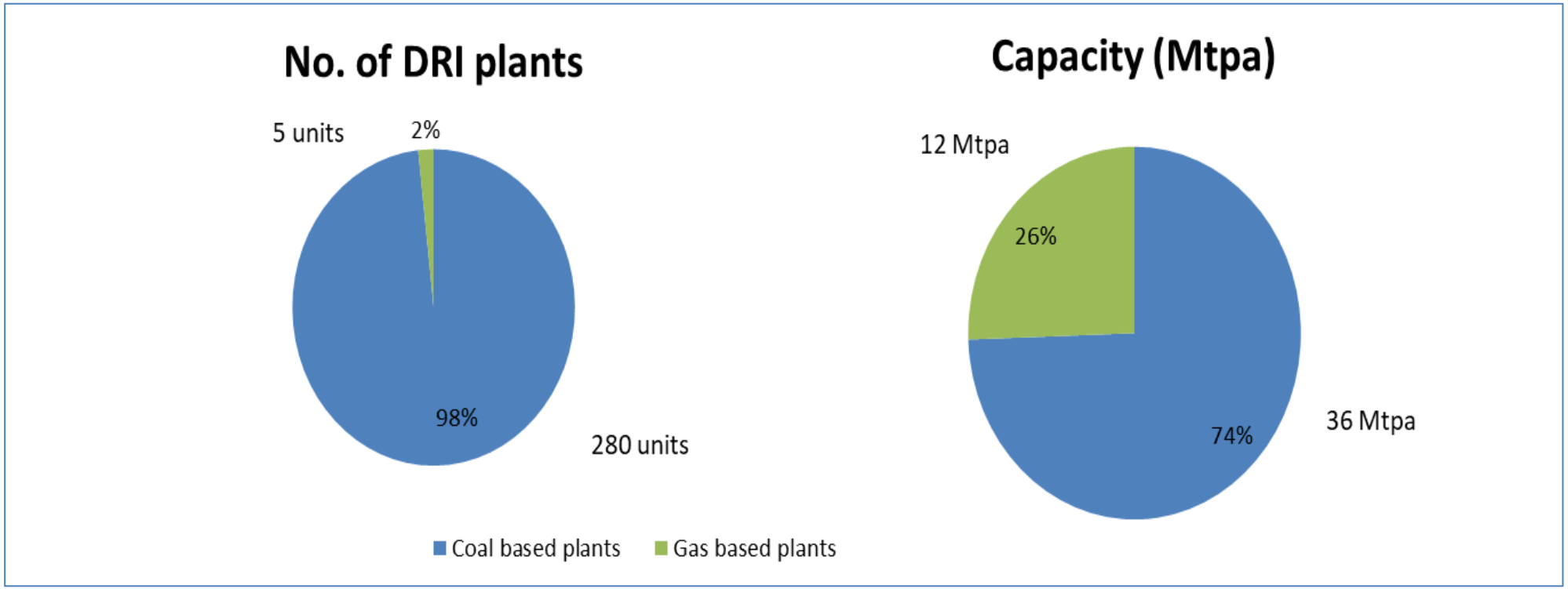
Overview of DRI sector in India

- India is the largest producer of Direct Reduction of Iron (DRI), popularly known as sponge iron
- There are 333 DRI plants spread over 12 states, of which 285 are operational
- Total installed DRI capacity is 52 million tonnes (Mt); and production is 39 Mt (2021-22)- *approximately one-third of total steel production*
- 85% of DRI plants located in 5 states - Chhattisgarh, Jharkhand, Odisha, Karnataka, and West Bengal, *accounting for 75% of total installed capacity*
- Rotary kiln based DRI plants use coal as the fuel
- Single / multiple rotary kilns with capacity 50-500 tpd used
- DRI production is envisaged at 80 Mt by 2030-31 (National Steel Policy, 2017)



Classification of DRI production units

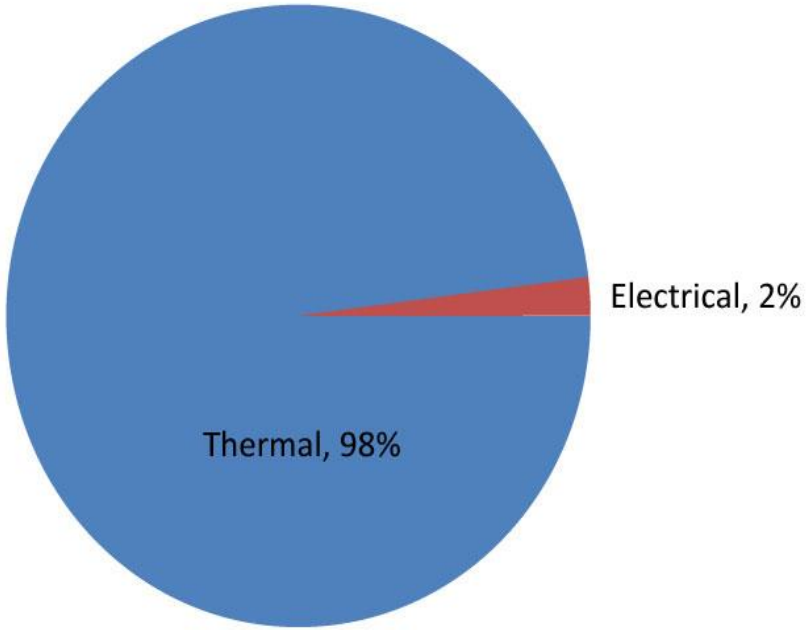
Share of Coal/gas-based DRI plants



Source: TERI analysis based on JPC data

Energy use in coal-based DRI plants

Energy Use	Purpose	Share %
Coal	Principal fuel, for heating and reduction reactions	98
Electricity	To operate motive loads in the plant	2

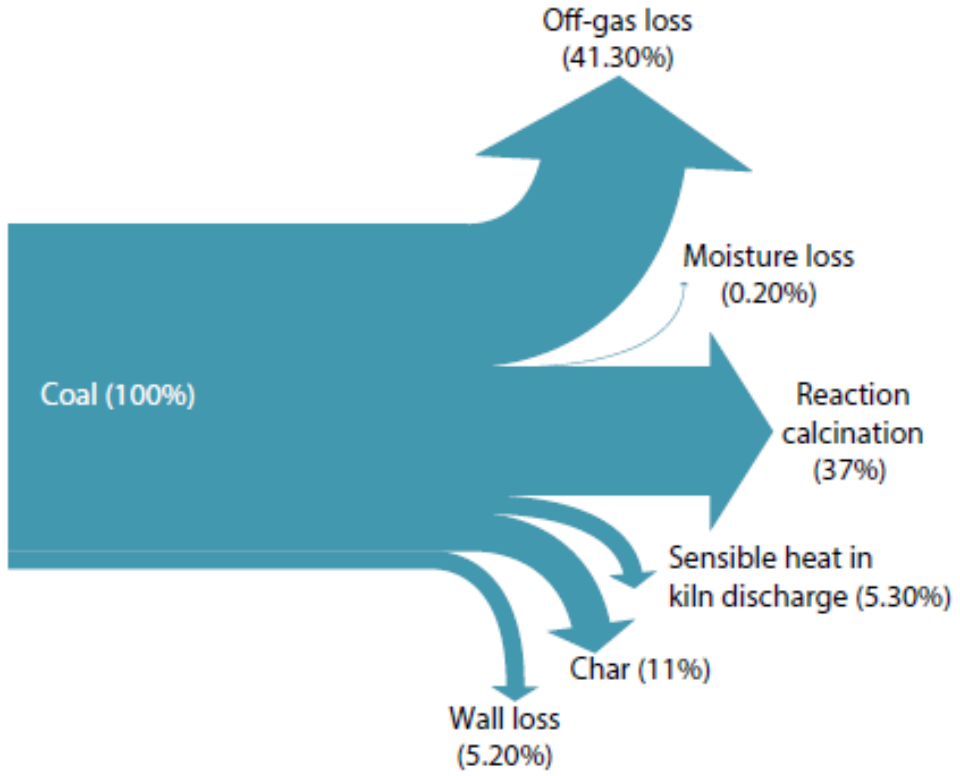


Share of energy consumption in rotary kiln based units

Key performance indicators for DRI

- Energy consumption of rotary kilns:
  - Coal: 0.95-1.4 tonne per tonne SI
  - Electricity: 70-80 kWh per tonne SI
  - SEC: 6.0 – 7.0 Gcal/t SI (World: 2.9-3.0 Gcal/t)

- Emission intensity: 2.6 – 3.0 tCO2/t (World: 1.2-1.4)
- Energy wastage in off-gases is more than 40%; offers significant scope for energy savings through waste heat recovery (WHR)



$$SEC\ (Gcal/tonne) = \frac{Total\ energy\ consumption\ (\frac{Gcal}{year})}{Total\ DRI\ production\ (tonne/year)}$$

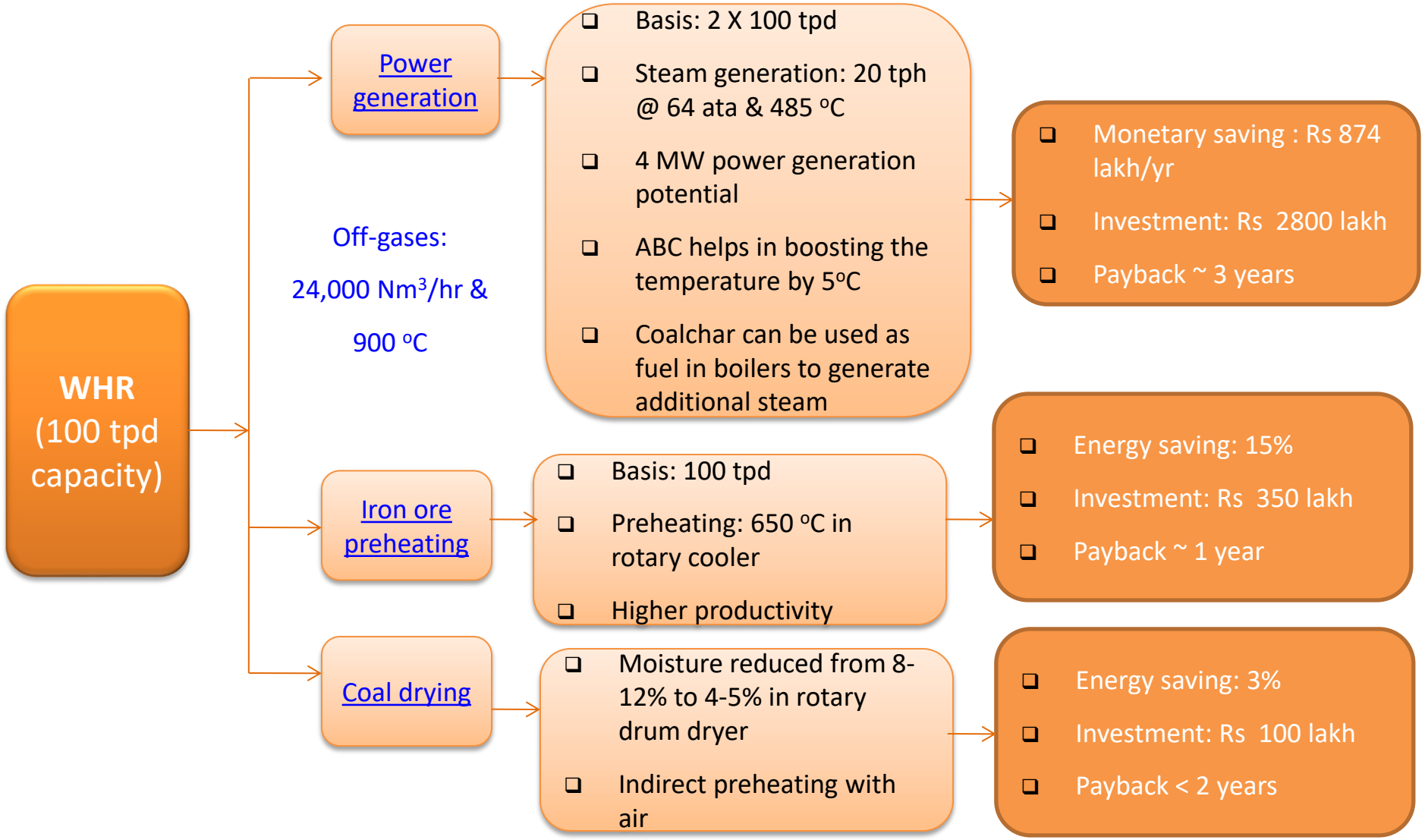
Energy Efficiency (EE) options in coal based DRI plants

- **WHR System to recover sensible heat in Rotary kiln off-gases**
  - Power generation using WHRB
  - Preheating of input iron ore
  - Moisture reduction of coal

- **Adoption of alternative technologies/ operating practices**
  - Use of producer gas in place of coal at discharge end in rotary kiln
  - Mullite based kiln lining
  - De-centralized VFD control of shell air fans

- **Energy efficiency improvement in utilities**
  - Motors, pumps, air compressors, fans/ blowers, cooling tower, etc.

Waste heat recovery options

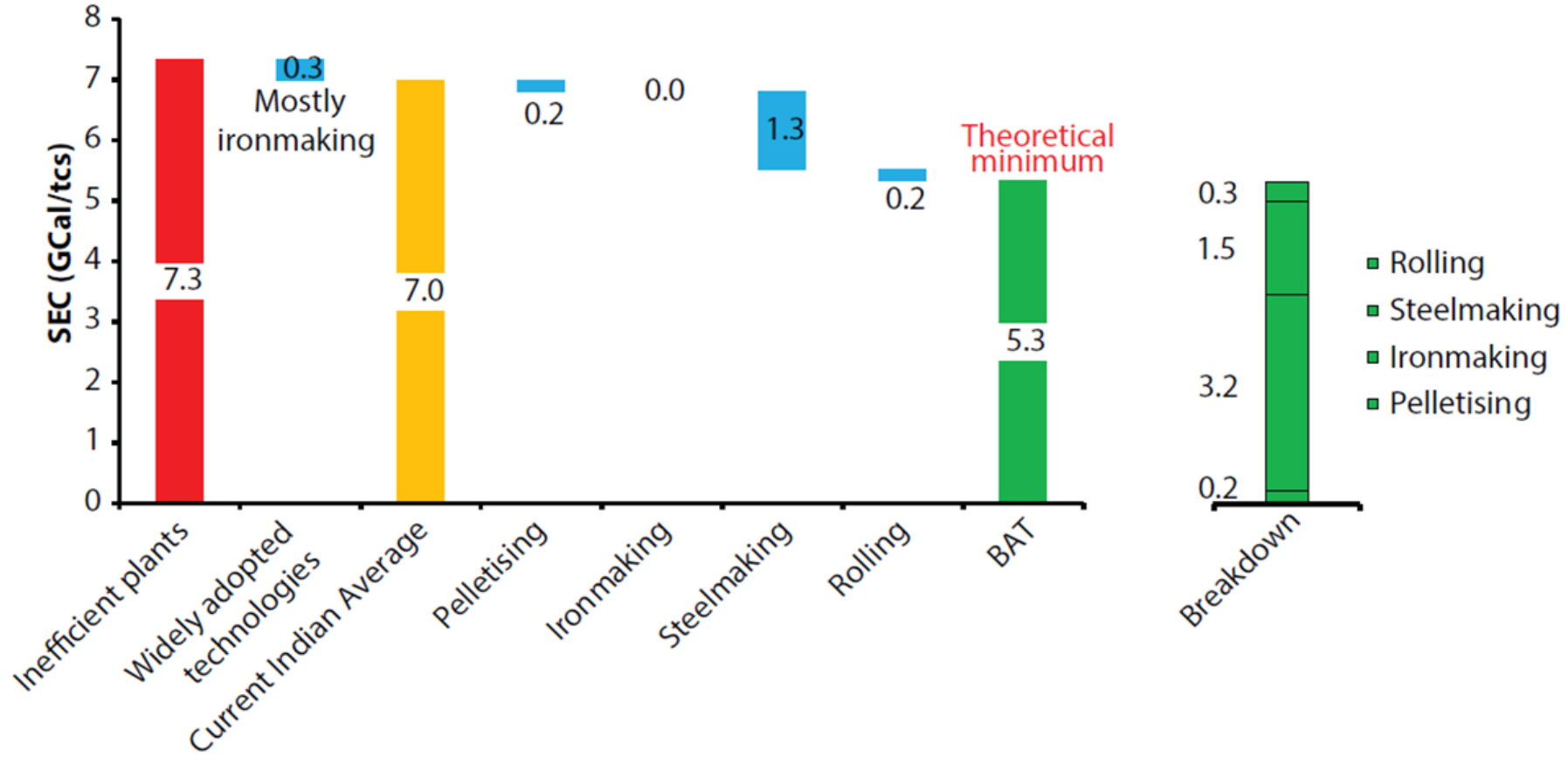


Energy Efficient Technologies for Secondary Steel Industry

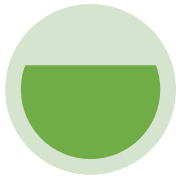
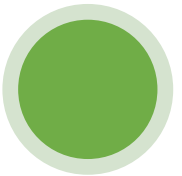
- installation of WHR for SRRM
- installation of CCM (Continuous casting machine)
- Electrification of SRRM
- Installation of energy efficient pumps in rolling mill cooling system
- Installation of shearing scrap machine and operating available bundling machine

Impact of EETs on energy consumption and emission reduction in DRI

- Energy consumption and Emission Intensity can be reduced by 15-25% (from the current average SEC of 7.0 to 5.3 Gcal/tcs) by implementing EETs in coal DRI Plants



Stepwise approach to reduce CO_2 emissions via the direct reduction route

Step 1	Step 2	Step 3
 Commissioning a NG based DR plant	 Blending up to 30% green hydrogen	 Complete switch over to 100% green hydrogen
Build a DRI plant using the most readily available gas. The product of this plant (CDRI, HDRI, or HBI) can be used in existing melting shops, including BF, BOF and EAF.	Replace up to 30% of the gas used in the existing process with hydrogen as it becomes available, without the need for equipment modifications.	Complete transition as low carbon hydrogen becomes available and cost-effective. Some adaptions are required to accommodate plant operation for 100% hydrogen.

Status of natural gas pipelines

Source: GAIL

Sr. No.	State	Cluster	Pipeline - States covered	Status of Pipeline
1	Chhattisgarh	Raigarh	Mumbai, Nagpur, Jharsuguda	To be completed by 2023
2		Raipur		
3	Odisha	Sunderghar	Jagdishpur, Haldia & Bokaro- Dhamra	To be operational in 2022
4		Jharsuguda		
		Sambalpur		
5				
6	West Bengal	Bardhaman	Jagdishpur, Haldia & Bokaro - Dhamra	To be operational in 2022
7	Karnataka	Bellary	Maharashtra, Karnataka, Goa	Existing (Supply to steel plants yet to begin)

Source: Petroleum and Natural Gas Regulatory Board (PNGRB); * Status as of 31.08.2022

Key issues to be addressed for increased use of hydrogen in the steel sector

1. Facilitating establishment of pilot and demonstration plants to familiarize the industry with the H2 -DR process, address any technical issues, and build-up the confidence of the industry

2. Access to green finance to enable large-scale investments by steel manufacturers

3. Enabling policy framework for promoting hydrogen production and use in the steel sector

Just Transition

Just Transition (JT) seeks to ensure that workers, communities and businesses are protected, and economic gains are made, by transition from coal to green technologies

Context

“Panchamrita” goals committed by India

- non-fossil fuel energy capacity to 500 gigawatts by 2030
- 50% of energy requirement till 2030 with renewable energy
- reduction of one billion tonnes of projected carbon emissions by 2030
- reduction of carbon intensity of economy by 45% by 2030 and
- net-zero emission levels by 2070

Affect on industry

- Major coal consuming MSMEs are sponge iron/DRI, brick, foundry, steel re-rolling etc
- Preparedness of these industries in adopting green technologies
- Large number of workers are employed by coal based industries
- Direct & indirect workers will be affected by the transition
- What incentives are required for switch-over to green technologies and for creating alternative employment for affected workforce

Industry’s view

- Barriers to the adoption of green technologies
- Policies required for
  - Adoption of green technologies
  - Rehabilitation of workers & communities
  - Promoting other economic activities
- Financial support required for the green transition
  - Training of workforce
  - Economic diversification to create employment
  - Social well being of workforce - roads, housing and electricity

Thank you