

SUSTAINABLE STEEL INDUSTRY

AN INDIAN PERSPECTIVE
VOLUME : FIGURES

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Chapter 2

STEEL AND ECONOMIC DEVELOPMENT

FIGURE 2- 1 STEEL INDUSTRY IMPACT

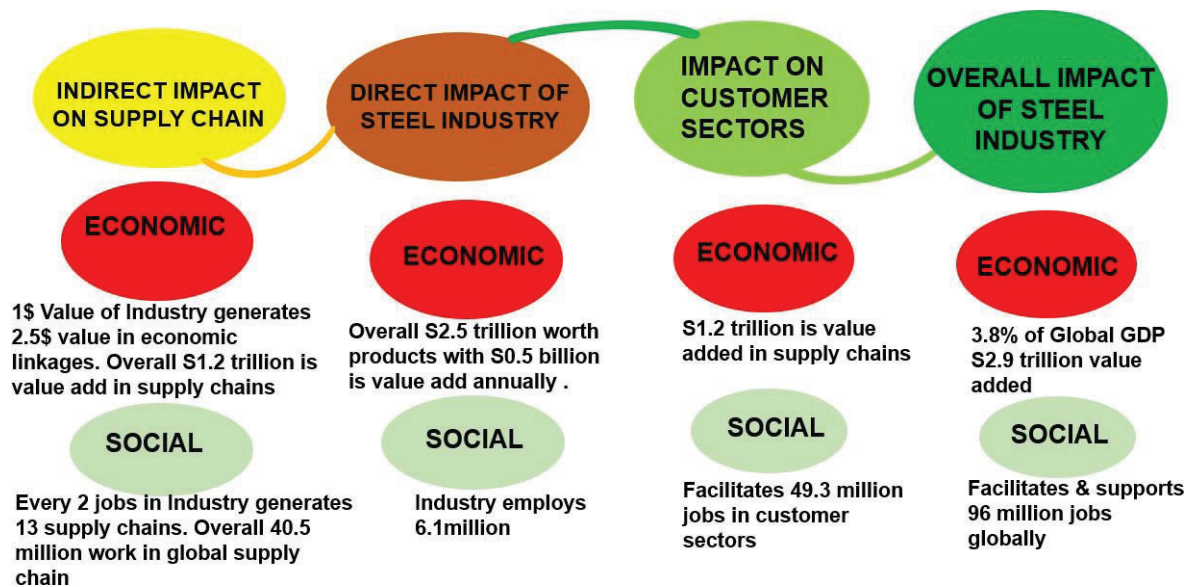


FIGURE 2-2 CLASSIFICATION OF STEEL IMPACTS

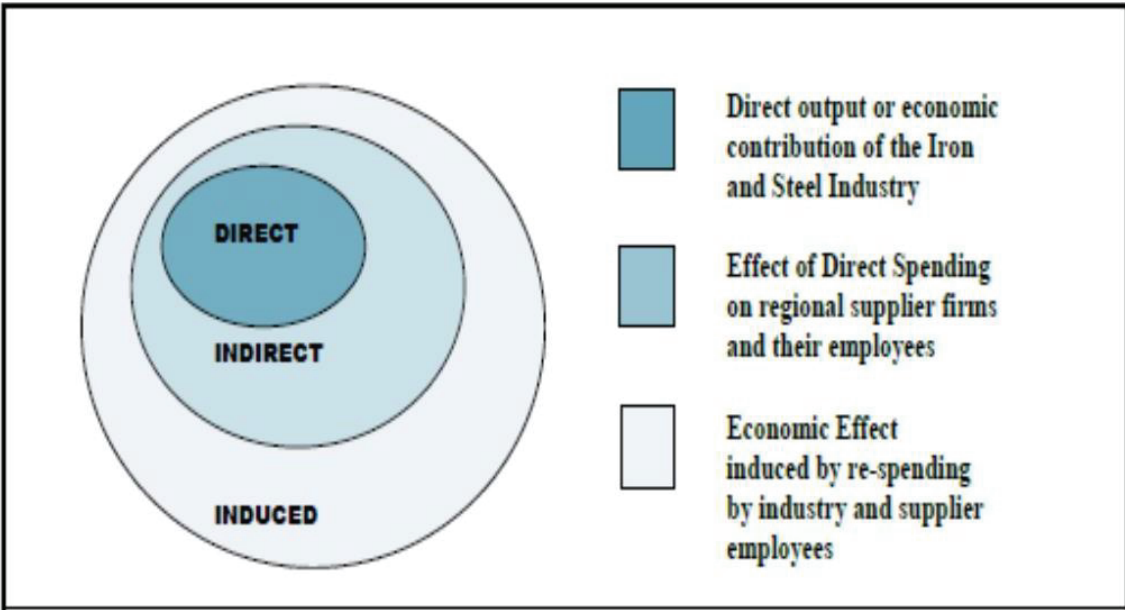


FIG. 2-3 NARROW MEASURE OF STEEL’S GLOBAL “VALUE CHAIN”

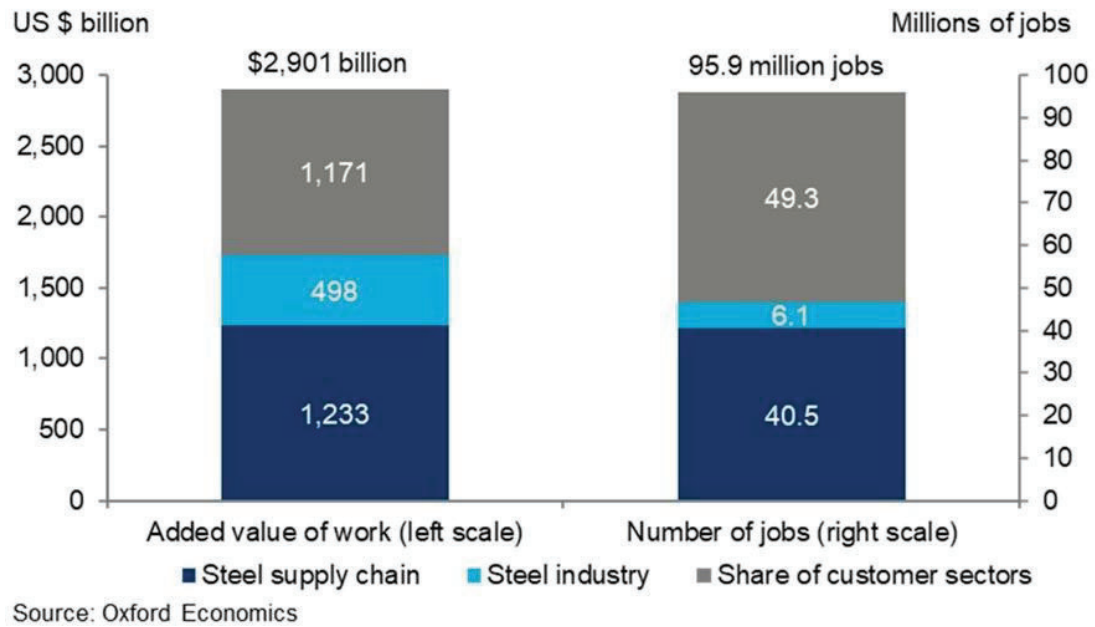


FIG. 2 –4 BROAD MEASURE OF STEEL’S GLOBAL “VALUE CHAIN”

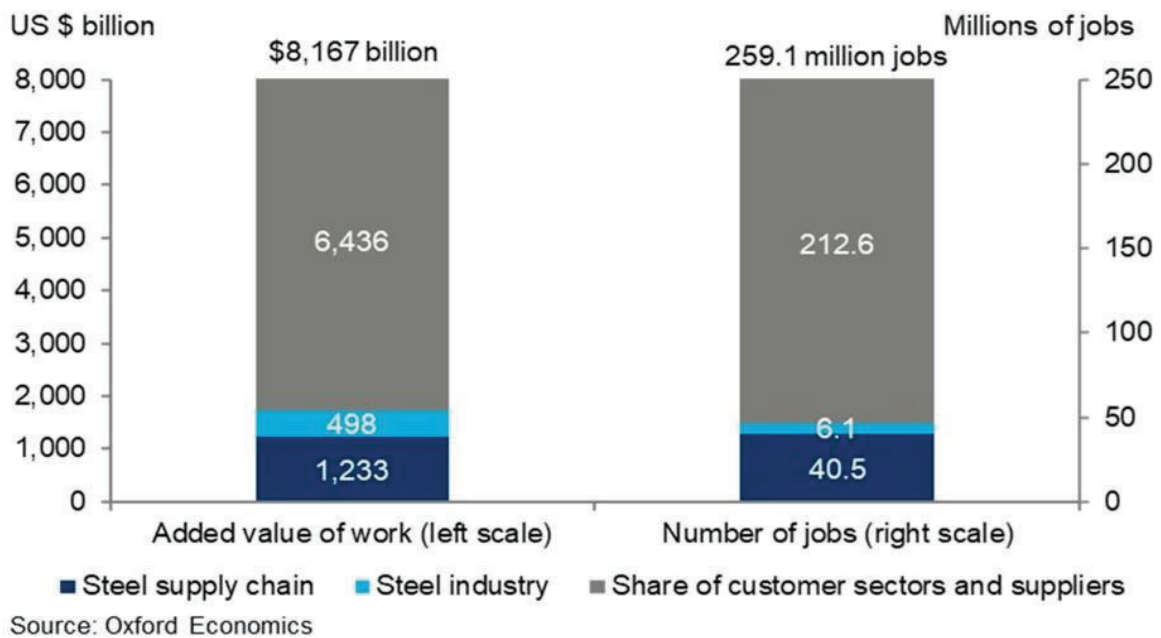


FIG 2-5 INDIAN STEEL SECTORWISE SHARE%

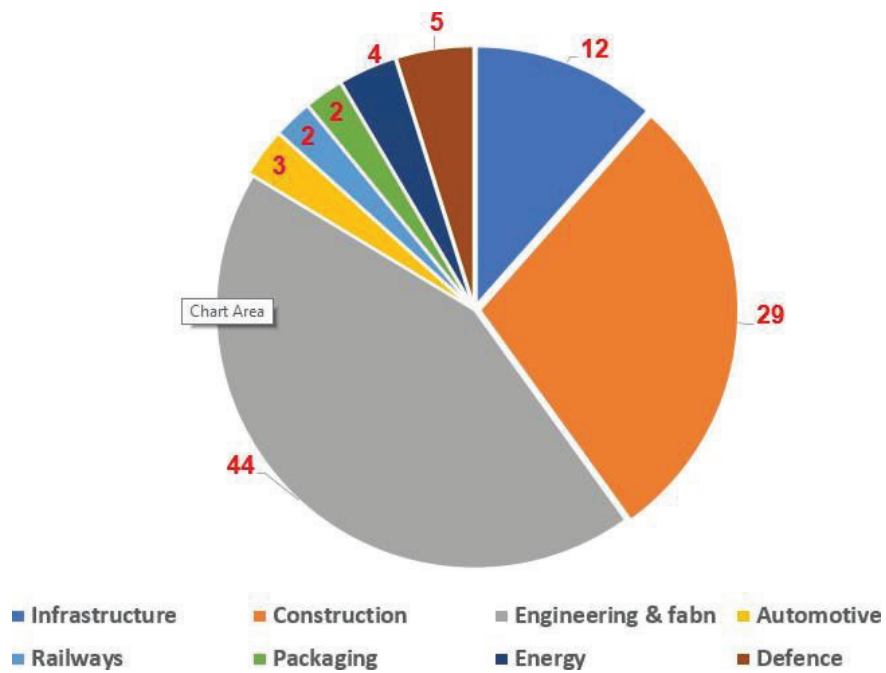
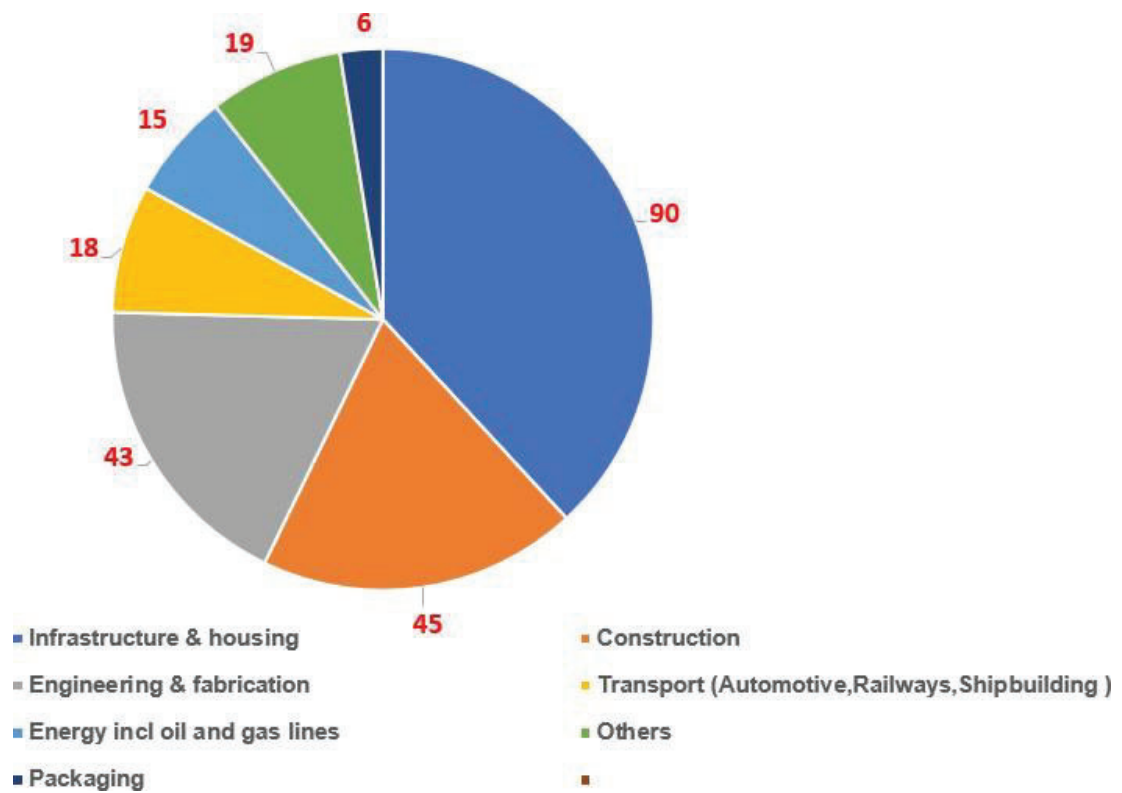


FIGURE 2-6 STEEL INDUSTRY REACH AND IMPACT AREAS



FIG 2-7 INDIAN STEEL DEMAND 2030-31 (MTPY)



Chapter 3

STEEL INDUSTRY PERSPECTIVE

FIG 3-1 GLOBAL STEEL PRODUCTION 2005-2024 (Million Ton)

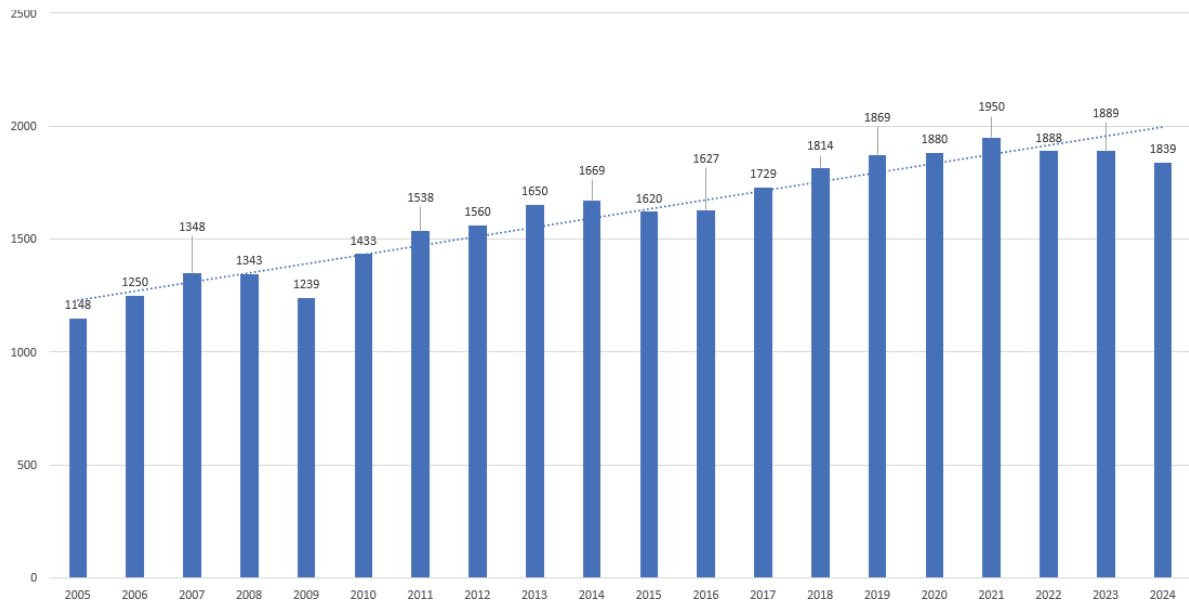


FIGURE 3-2 TOP 10 STEEL PRODUCING COUNTRIES

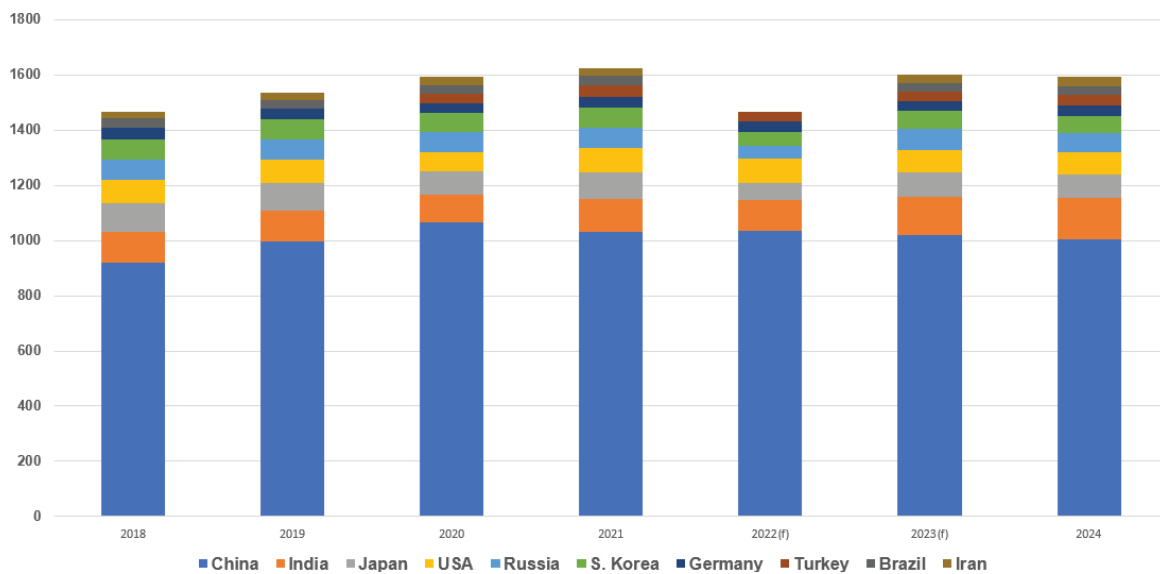
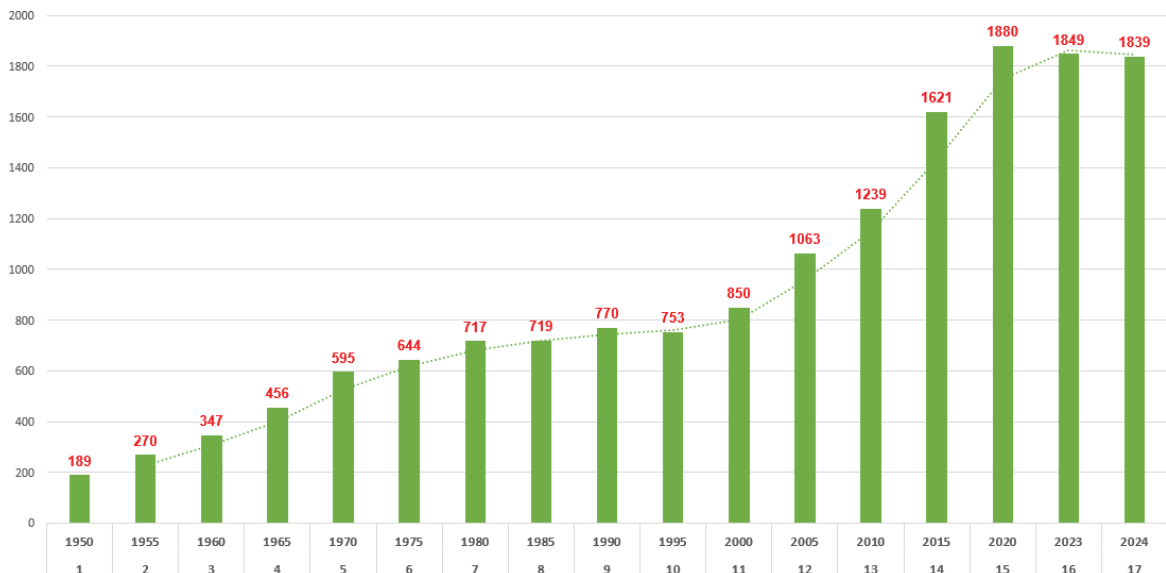


FIGURE 3-3 WORLD STEEL THROUGH AGES



FIGURE 3-4 WORLD STEEL GROWTH 1950-2024 (Million Tons)



**FIGURE 3-5 WORLD STEEL GROWTH RATES
(1950-2020) Average %**

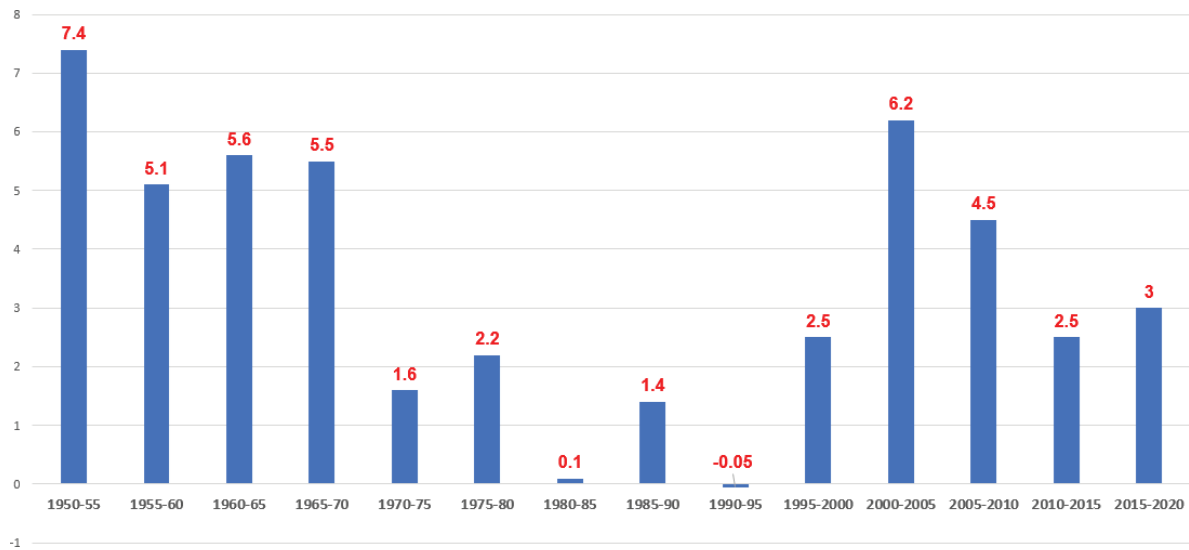


FIGURE 3-6 WORLD STEEL DECADAL GROWTH RATES

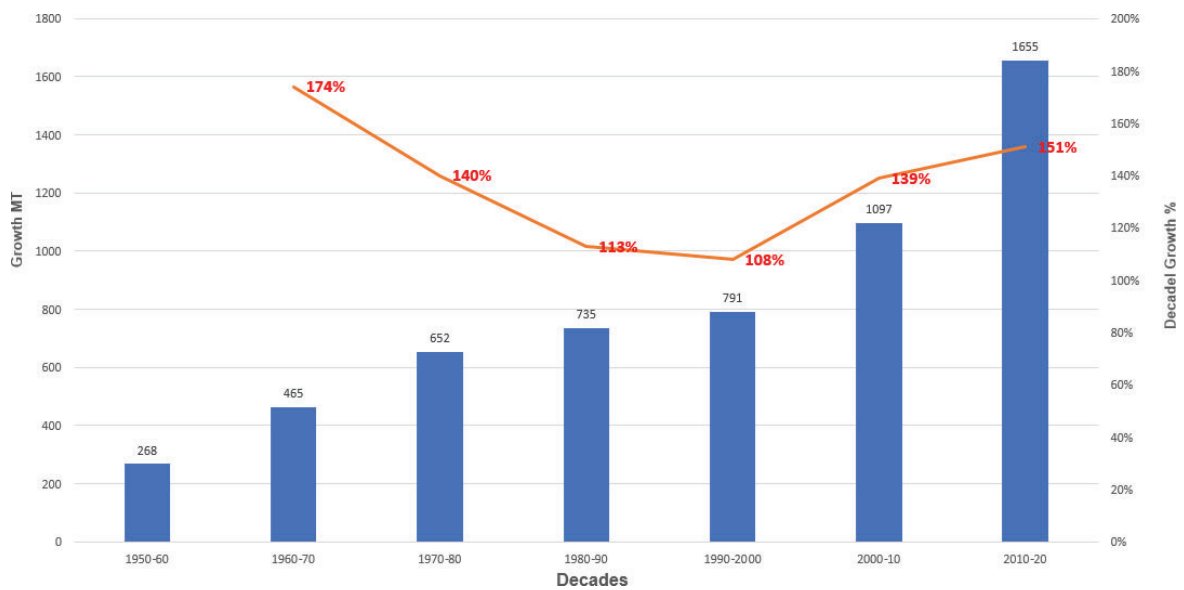


FIGURE 3-7 INDIA SHARE IN GLOBAL STEEL

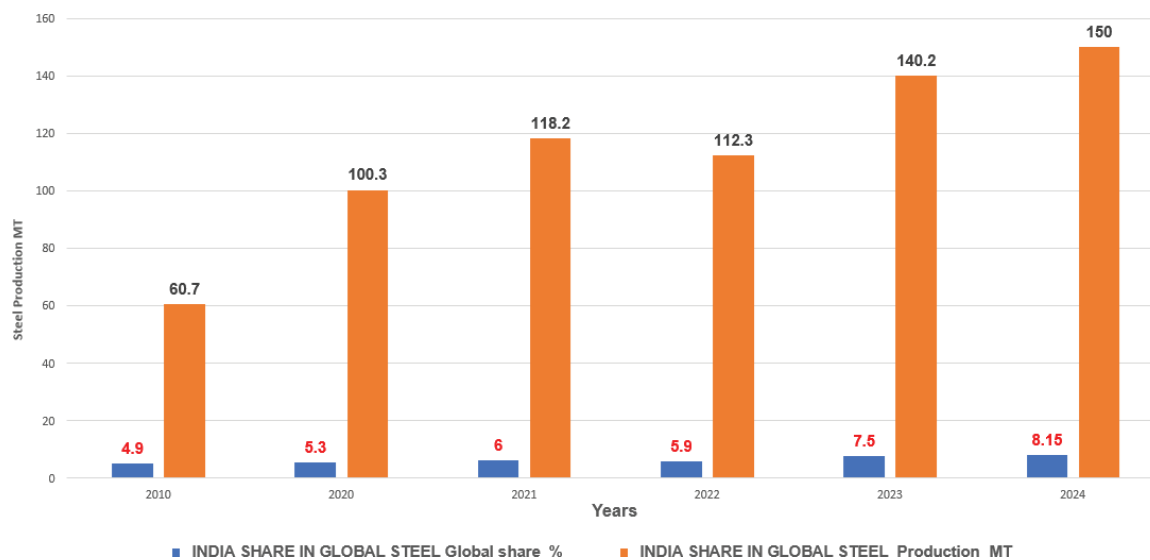


FIGURE 3-8 CHINA SHARE IN GLOBAL STEEL

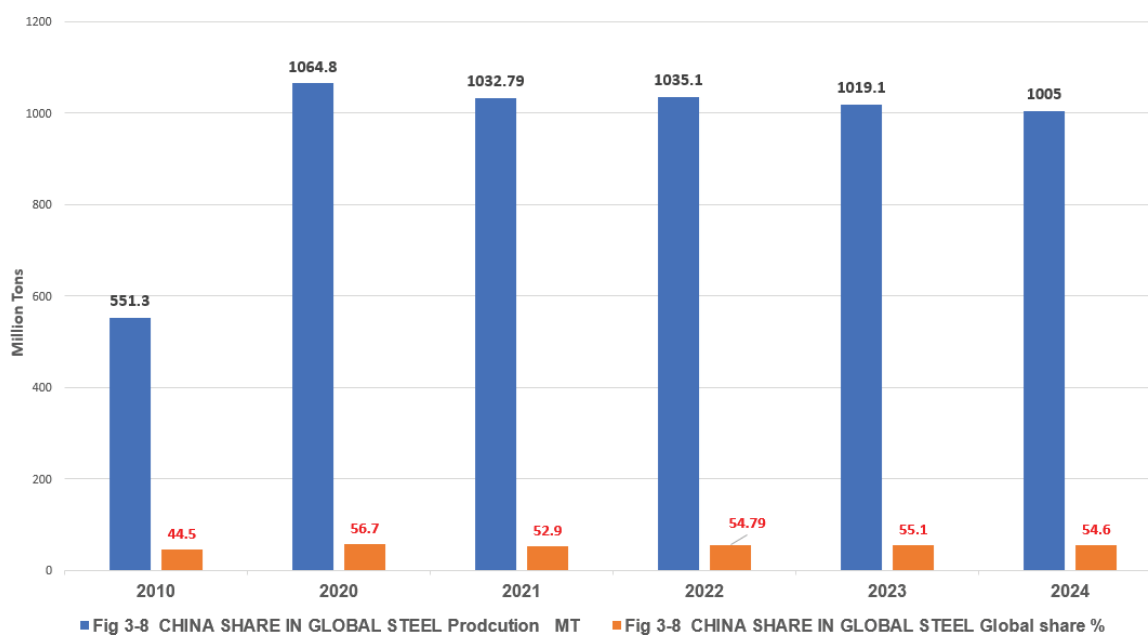


FIGURE 3-9 GLOBAL STEEL PRODUCTION & REGIONWISE 2023

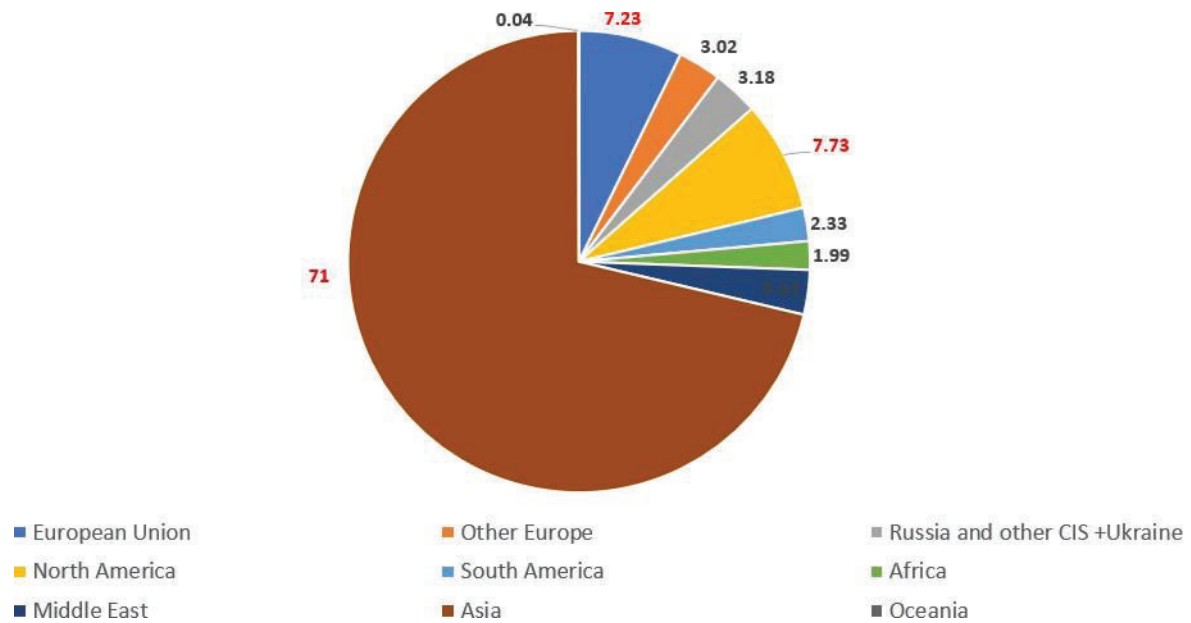


FIGURE 3-10 SECTORWISE GLOBAL STEEL USE

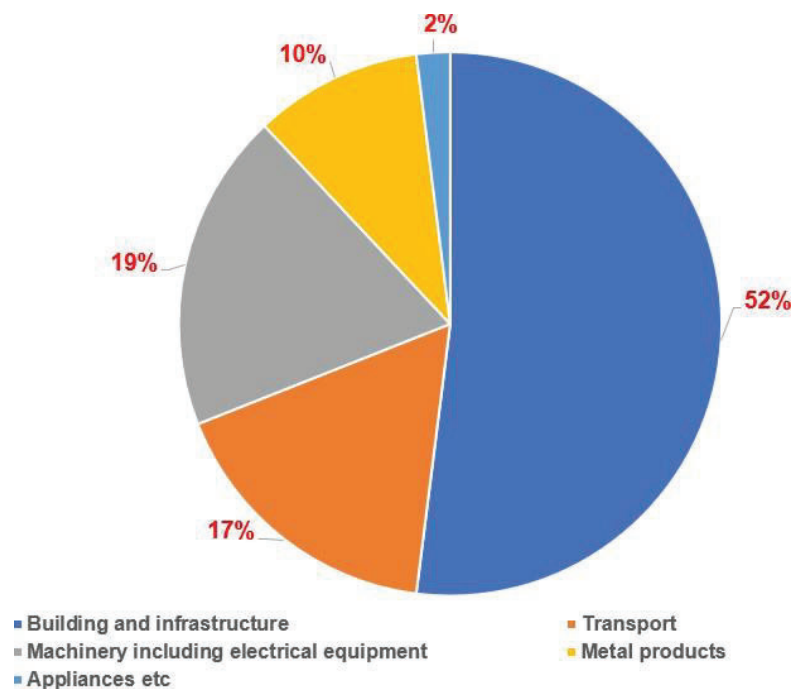


FIGURE 3-11 INDIAN STEEL JOURNEY 1875

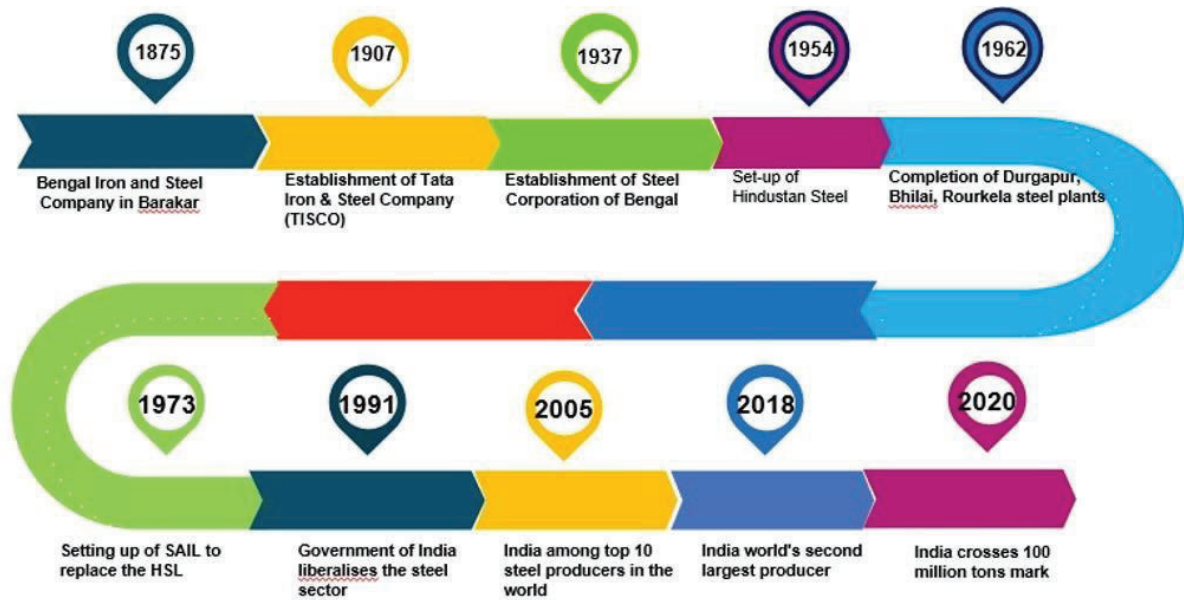


FIGURE 3-12 INDIA STEEL PRODUCTION 1967-2024

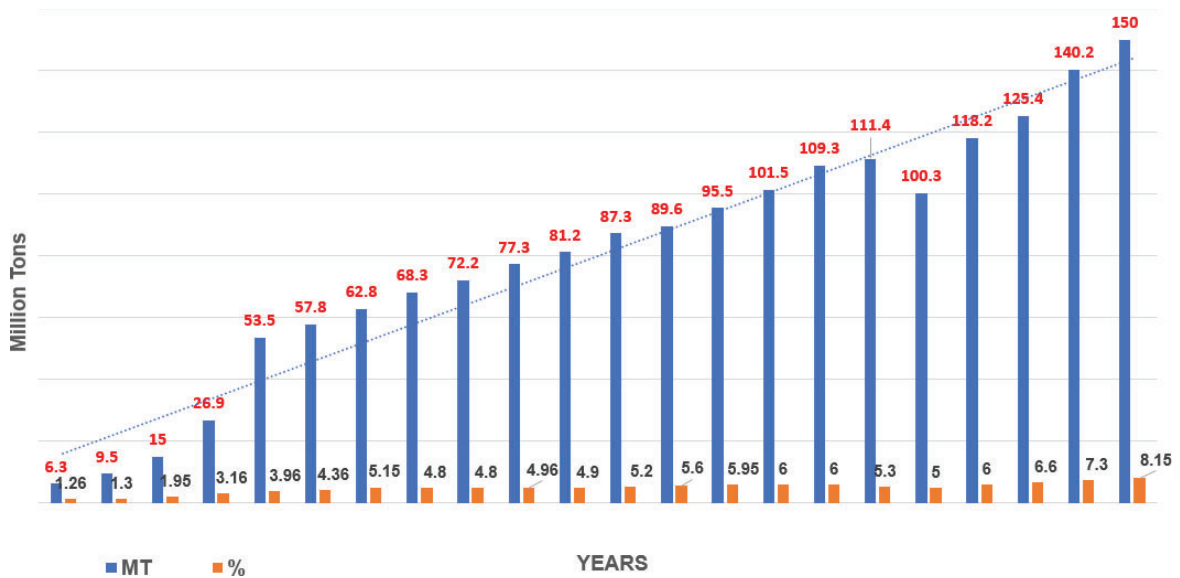
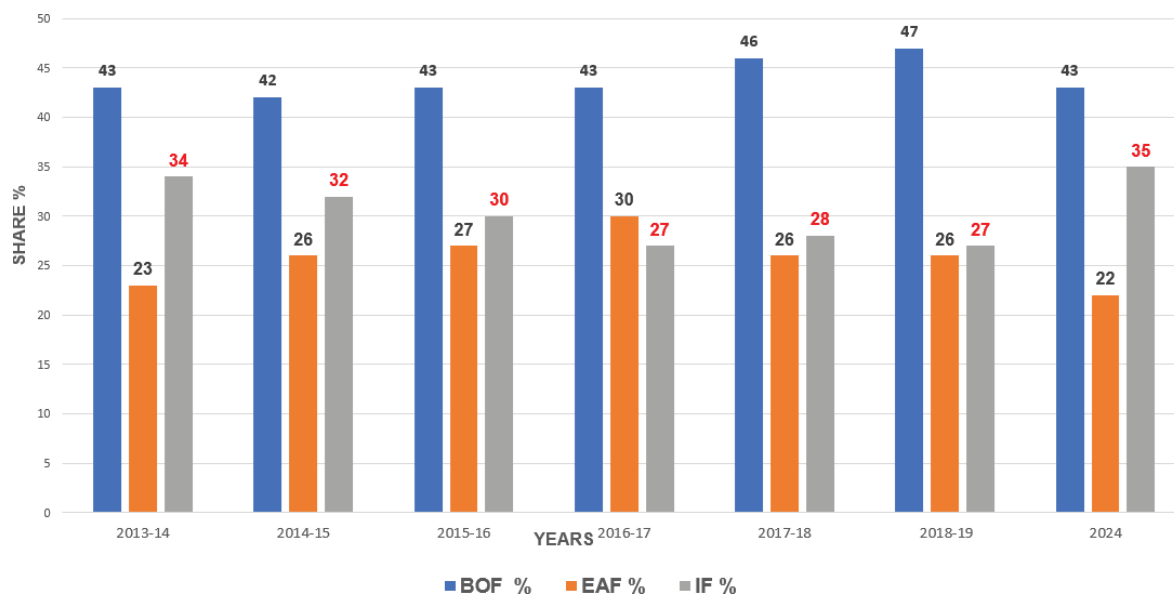
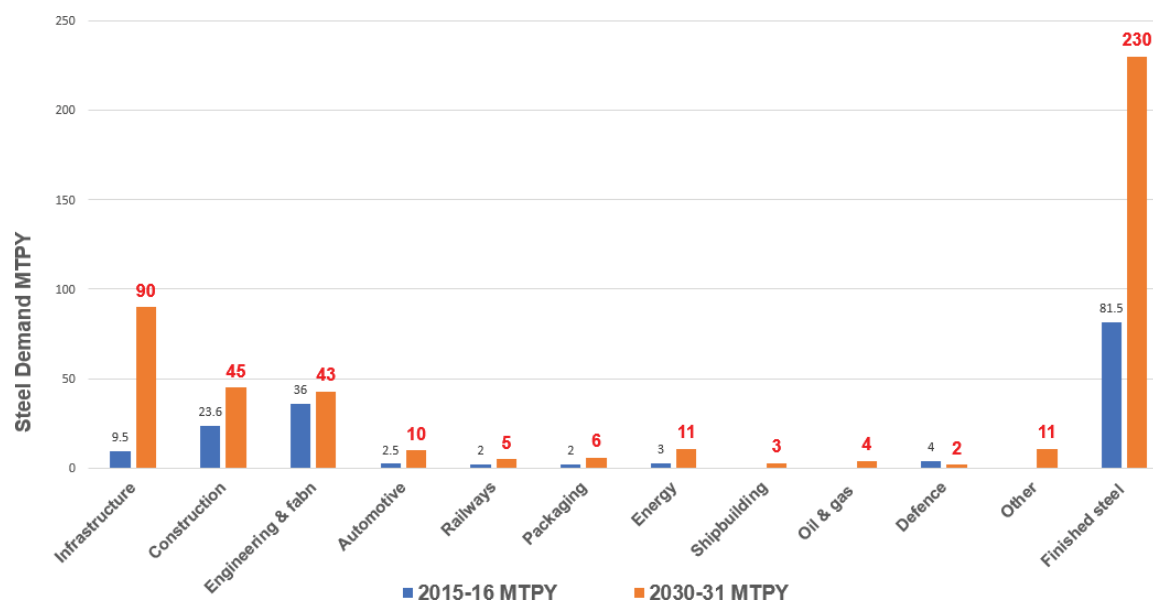


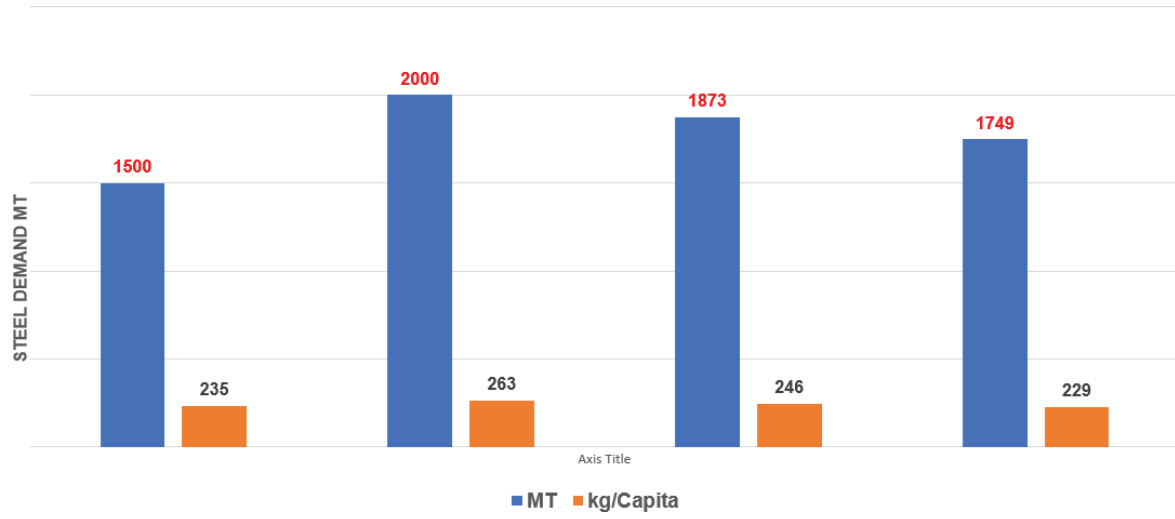
FIGURE 3-13 PROCESS SHARES IN INDIAN STEEL PRODUCTION



**FIGURE 3-14 PROJECTED STEEL DEMAND
(As per NSP)**



**FIGURE 3-15 STEEL DEMAND REDUCTION POTENTIAL
GLOBAL ASU SCENARIOS**



Chapter 4

SUSTAINABILITY REQUIREMENTS

**FIGURE 4-1 WORLD POPULATION (2022)
TOP 10 COUNTRIES**

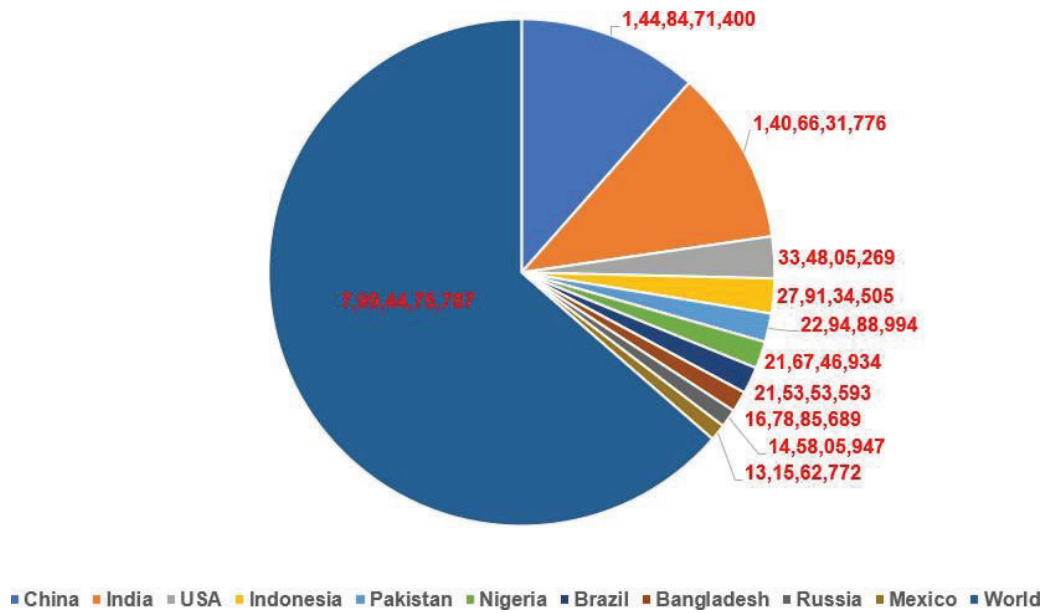


FIGURE 4-2 POPULATION DENSITIES Nos/km2

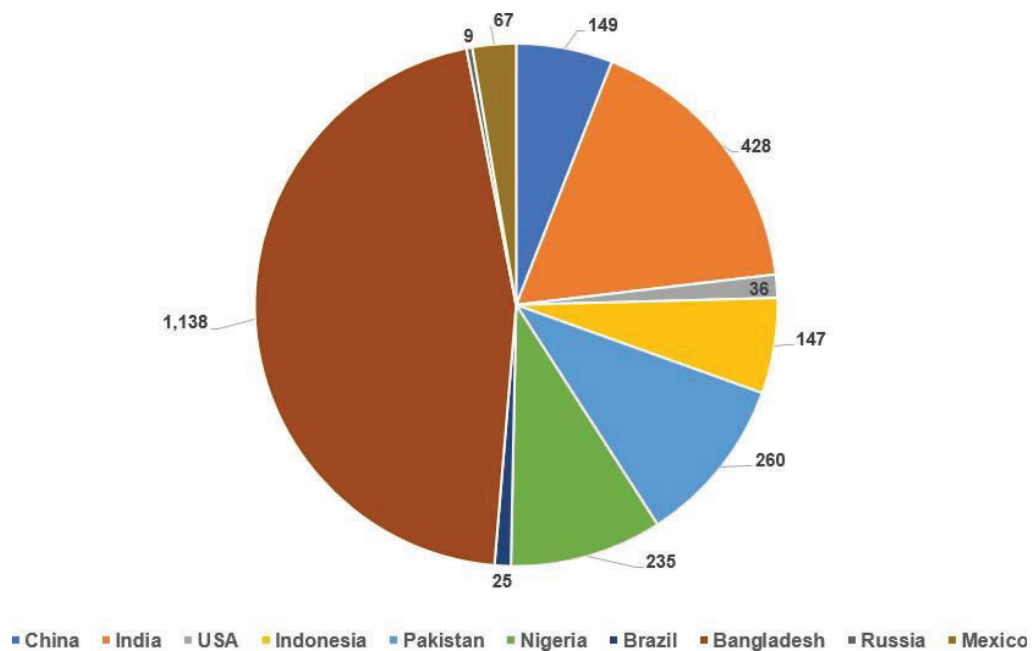


FIGURE 4-3 STEEL INDUSTRY SUSTAINABILITY ELEMENTS

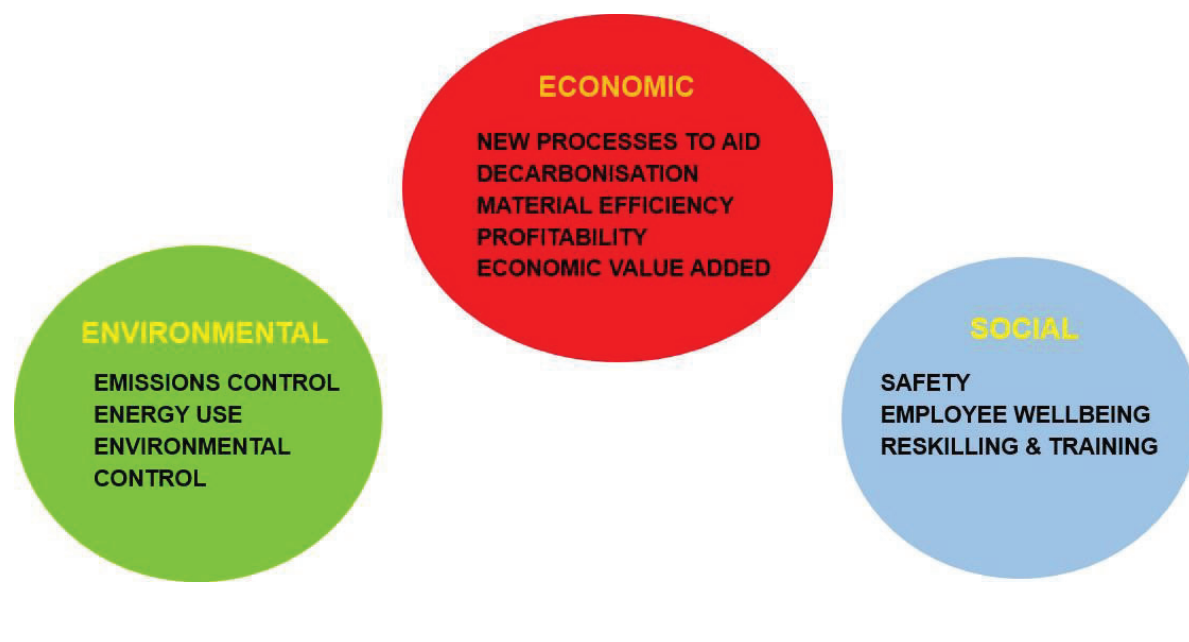


FIGURE 4-4 STEEL IS UNIQUE

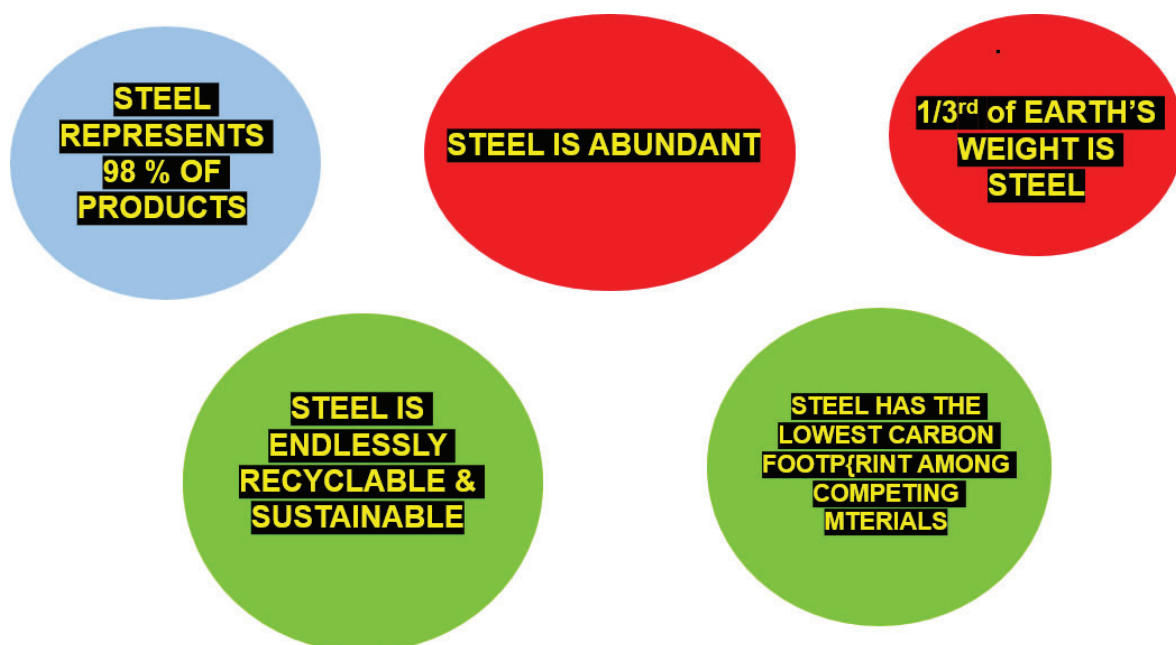


FIG 4-5 DIVERSE PROPERTIES OF STEEL



FIGURE 4-6 STEEL vs OTHER MATERIALS CO2 IMPACT

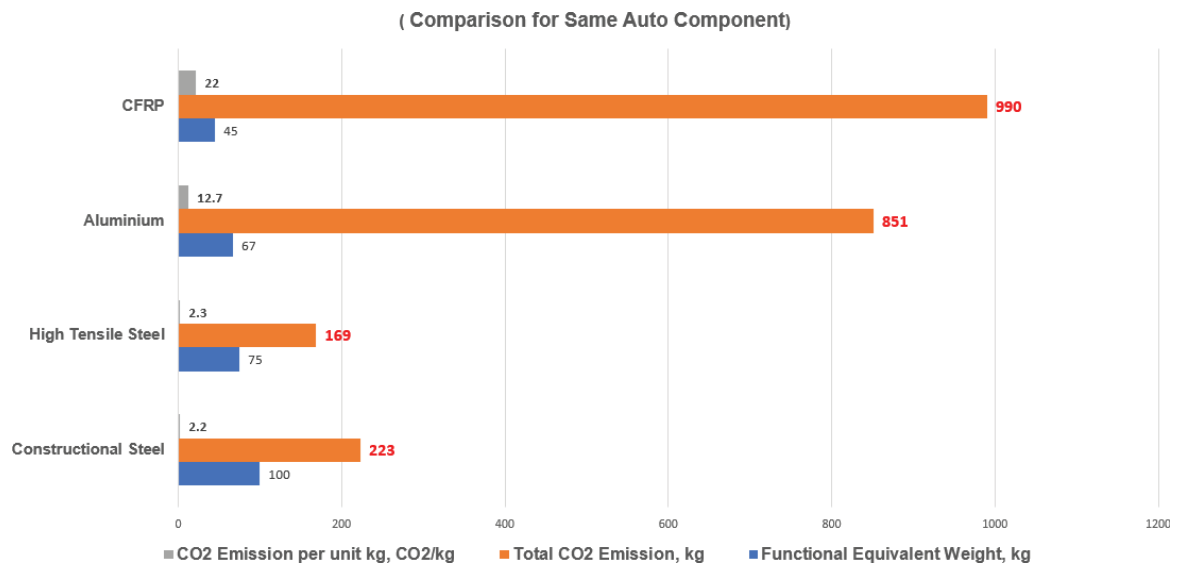
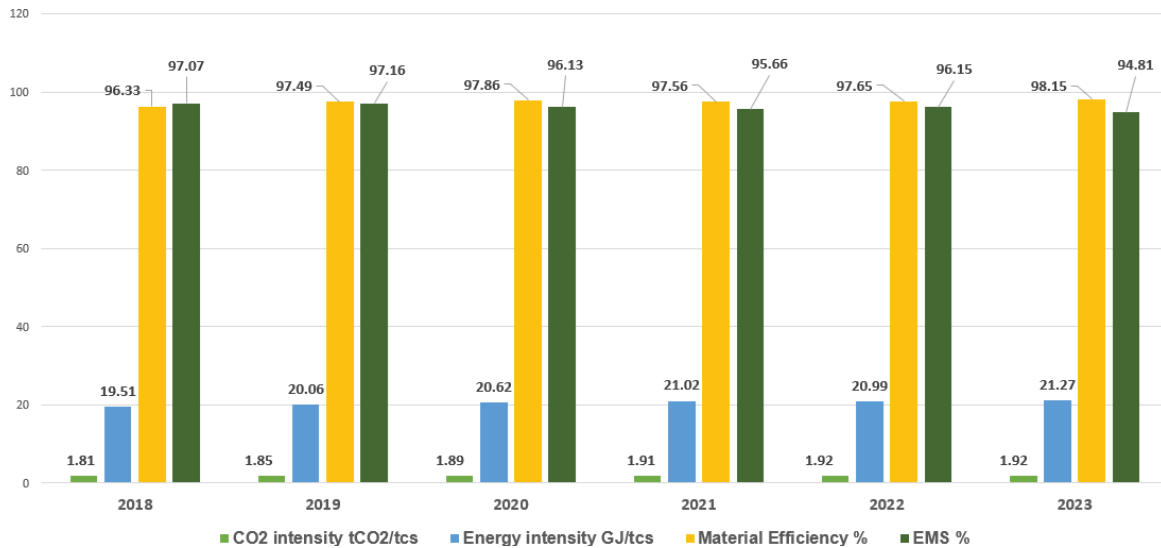


FIG-4-7 WORLD STEEL SUSTAINABILITY INITIATIVES



FIGURE 4-8 STEEL INDUSTRY SUSTAINABILITY ENVIRONMENTAL PERFORMANCE



**FIGURE 4-9 STEEL INDUSTRY SUSTAINABILITY
SOCIAL & ECONOMIC PERFORMANCE**

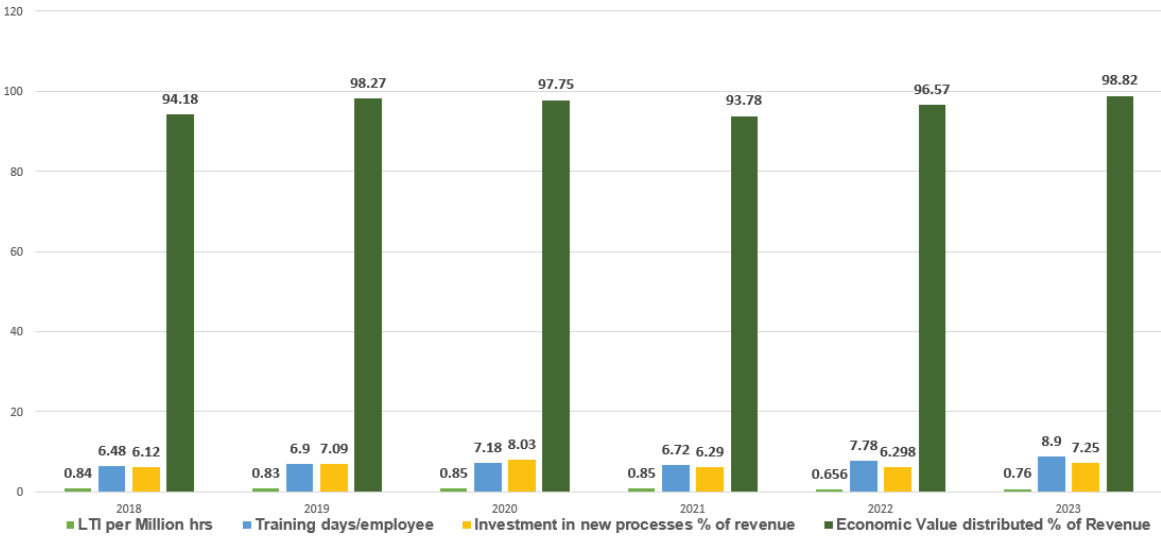


FIG 4- 10 WORLD STEEL SUSTAINABILITY PRINCIPLES



FIG 4- 11 UNSG GOALS & THOSE RELEVANT TO STEEL INDUSTRY

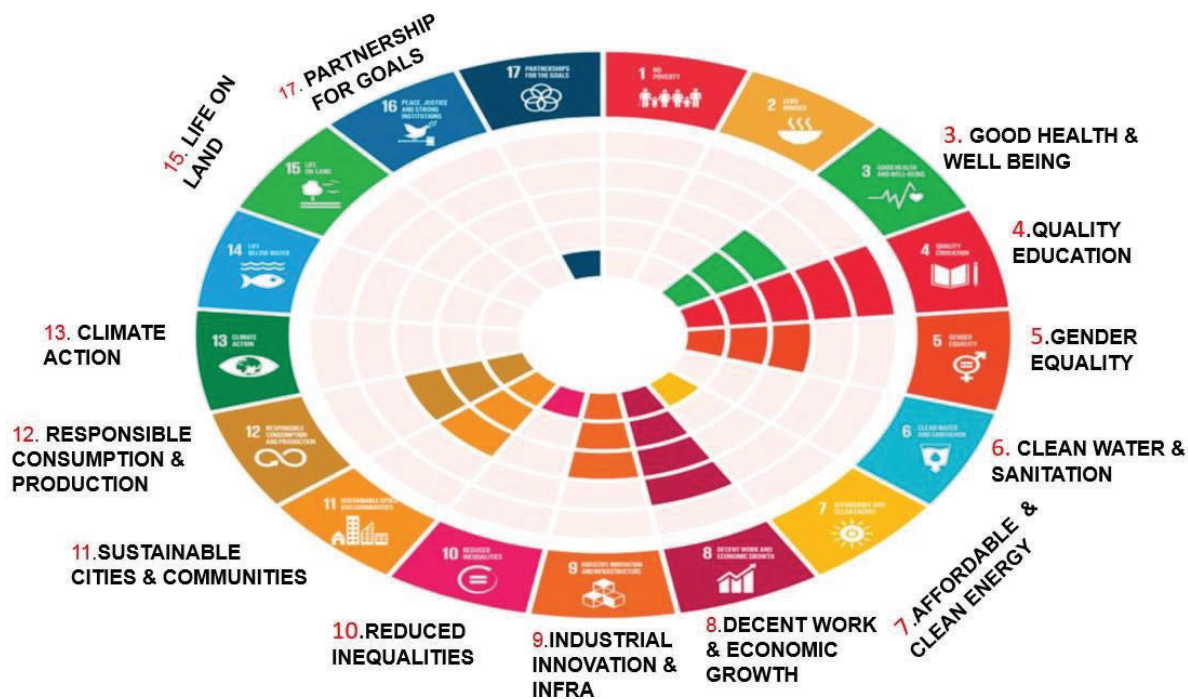
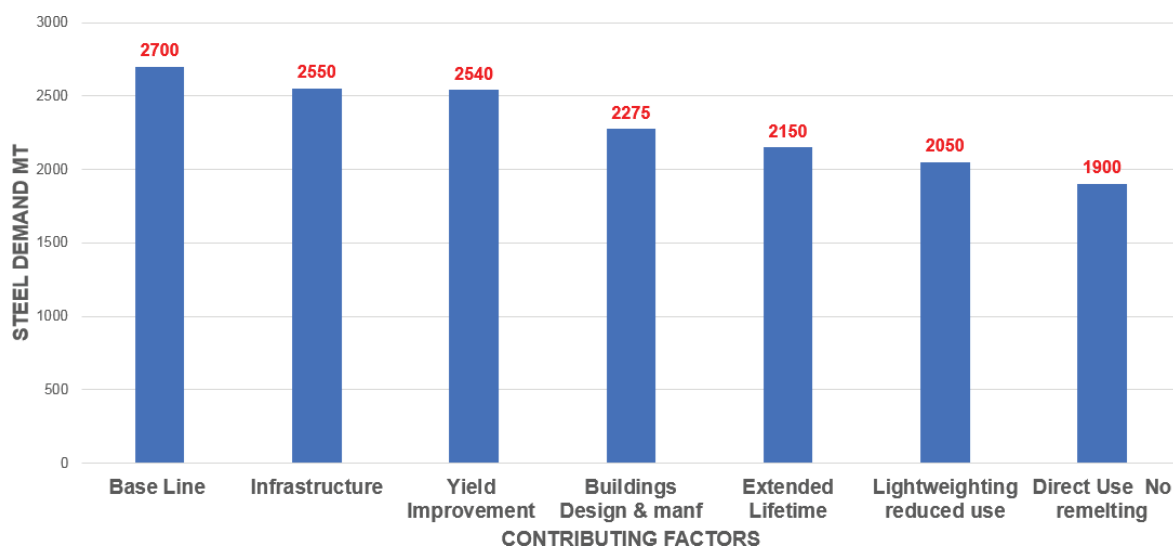
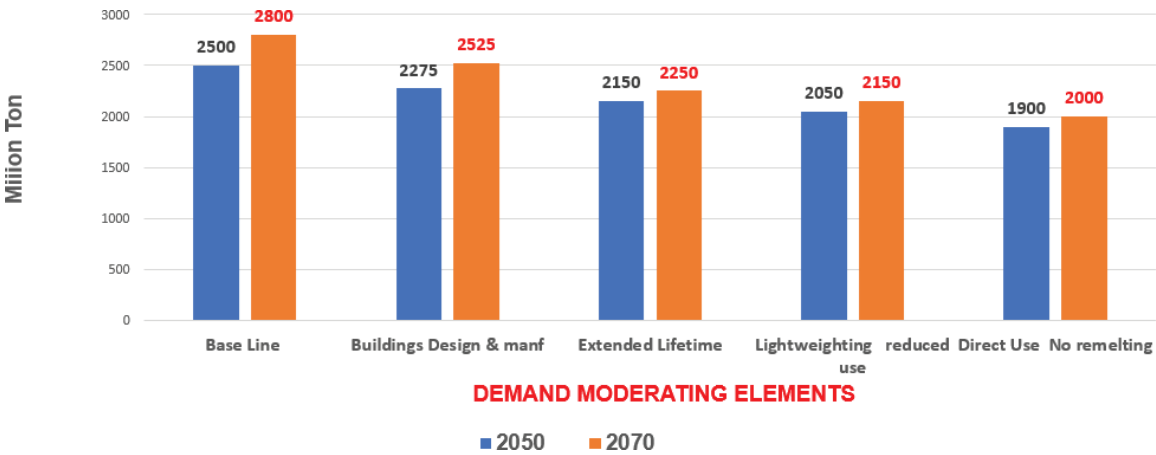


FIGURE 4-12 FACTORS FOR MODERATING STEEL DEMAND



**FIG 4-13 MODERATED STEEL DEMAND
(MATERIAL EFFICIENCY POTENTIAL)**



Chapter 5

CIRCULAR ECONOMY

FIGURE 5- 1 CIRCULAR ECONOMY AT WORK

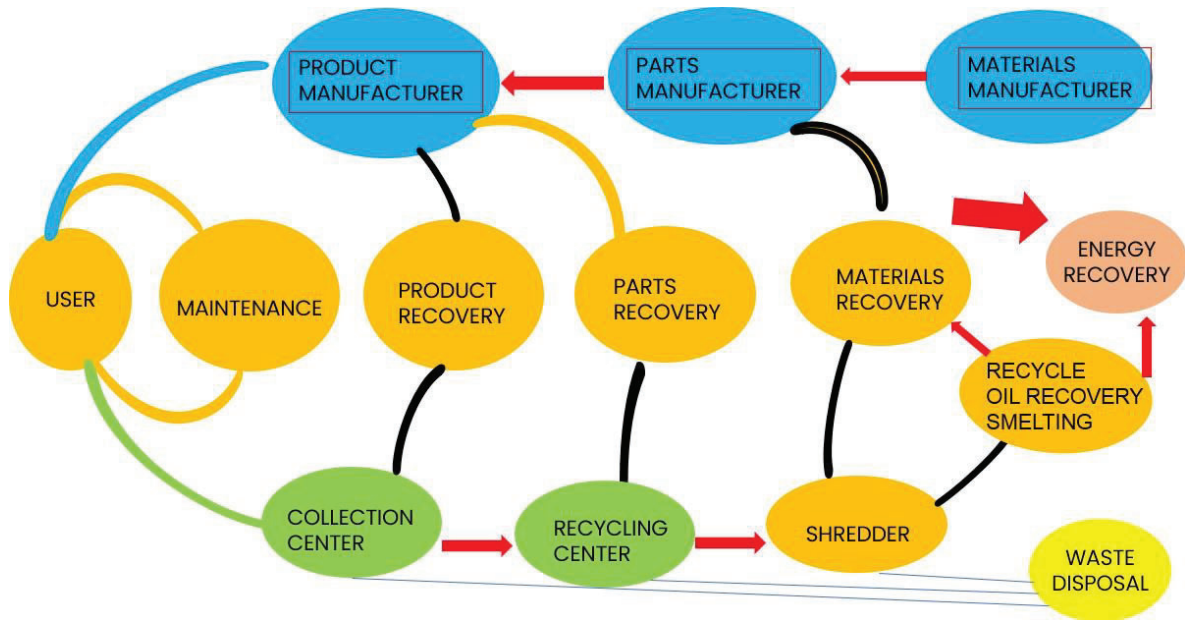


FIG 5-2 CIRCULAR ECONOMY ROADMAP

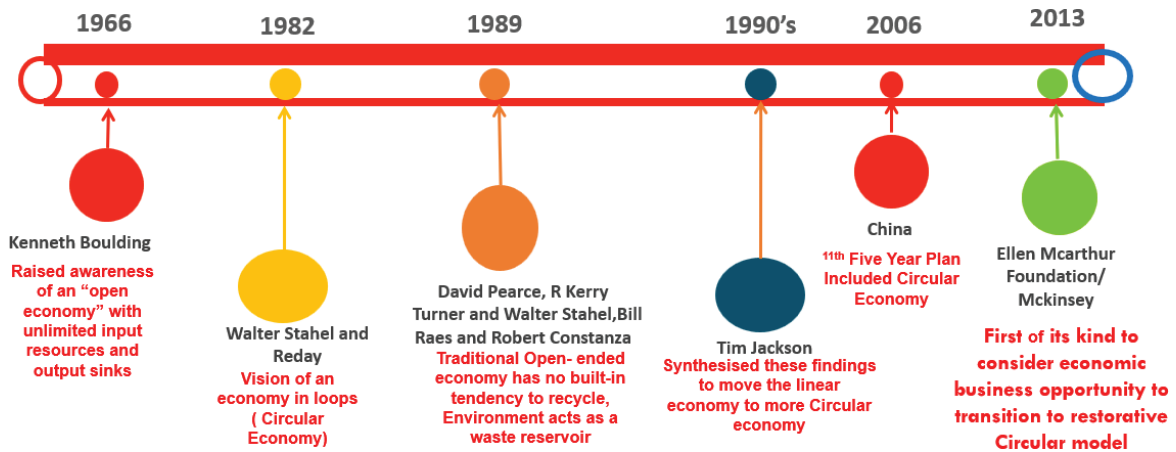


FIG 5- 3 CIRCULAR ECONOMY PRINCIPLES



FIGURE 5- 4 CE ELEMENTS

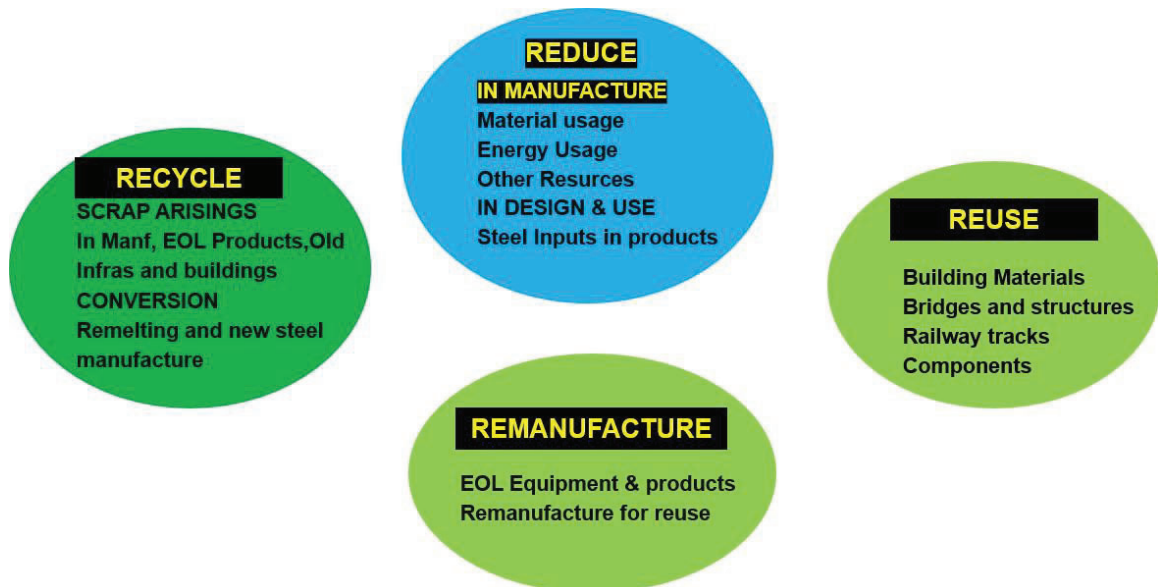


FIG 5 - 5 CIRCULAR ECONOMY ARMS & ROLES

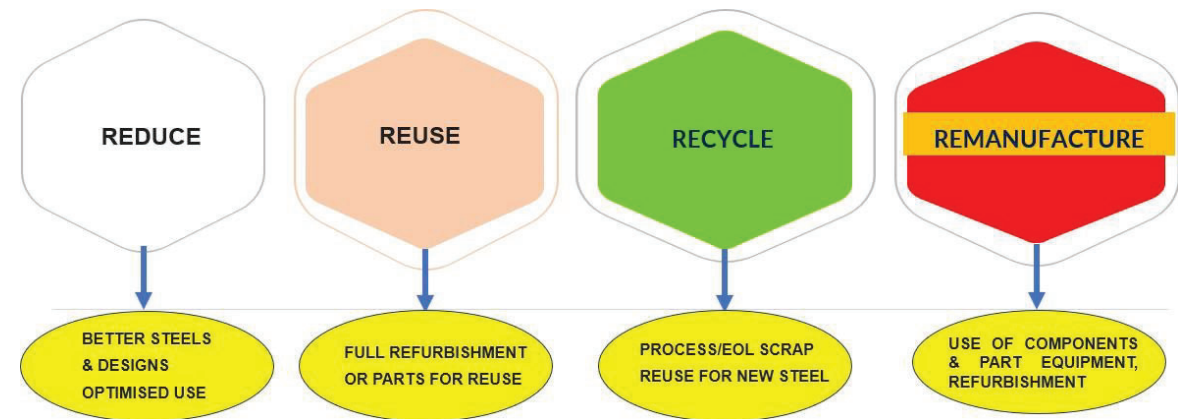


FIGURE 5 -6 TOOLS OF THE CIRCULAR ECONOMY

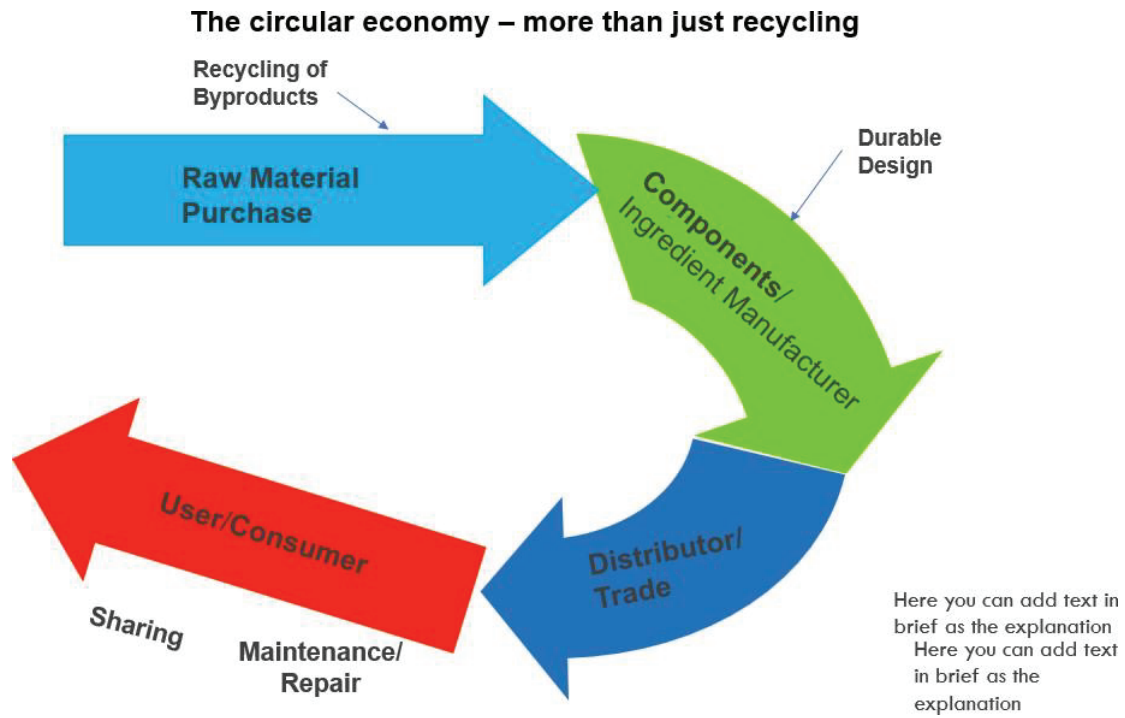


FIGURE 5- 7 CIRCULAR ECONOMY LOOPS

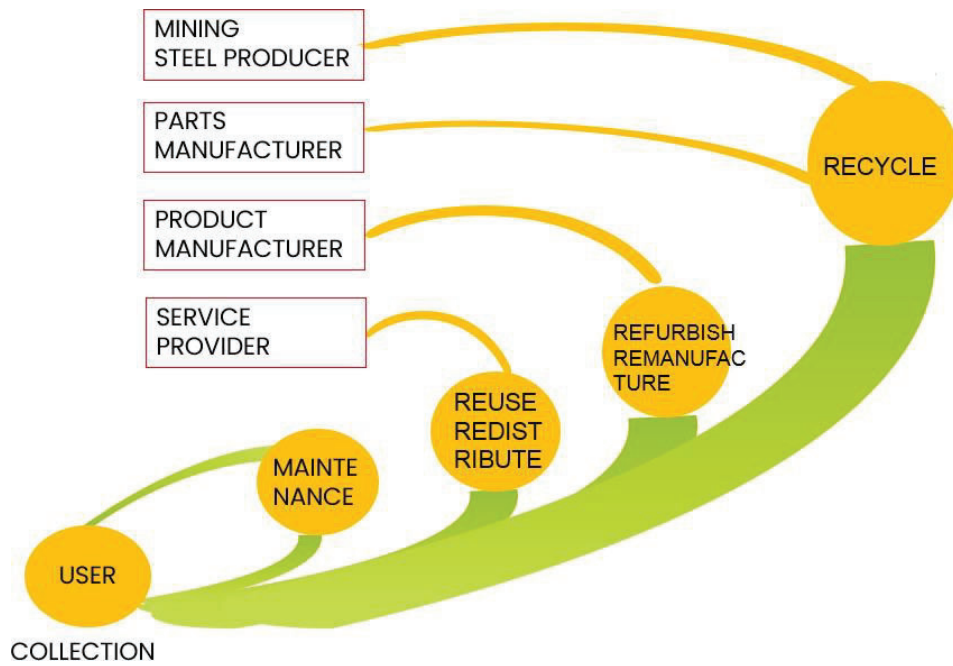


FIG 5-8 CE AND THE STEEL INDUSTRY VALUE CHAIN - IMPACTED AREAS

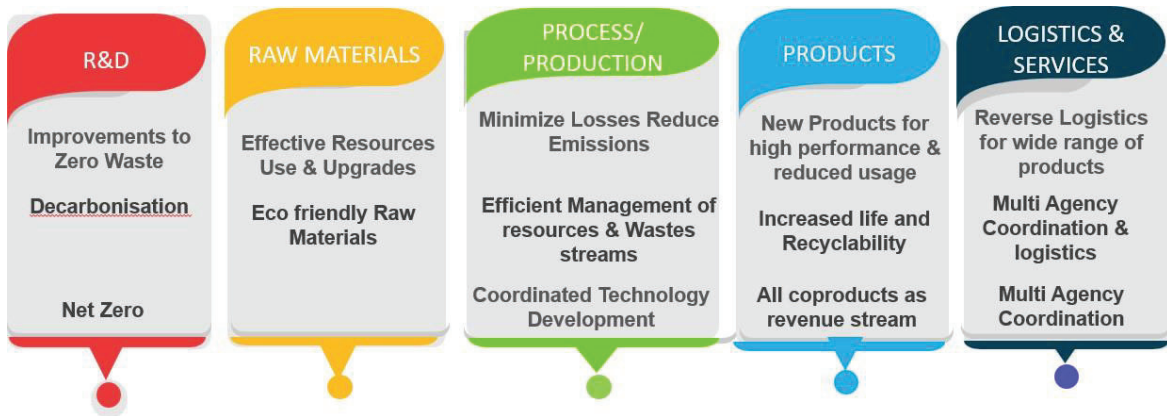


FIG 5-9 CE IMPACTS STEEL DEMAND VIA MULTIPLE CHANNELS

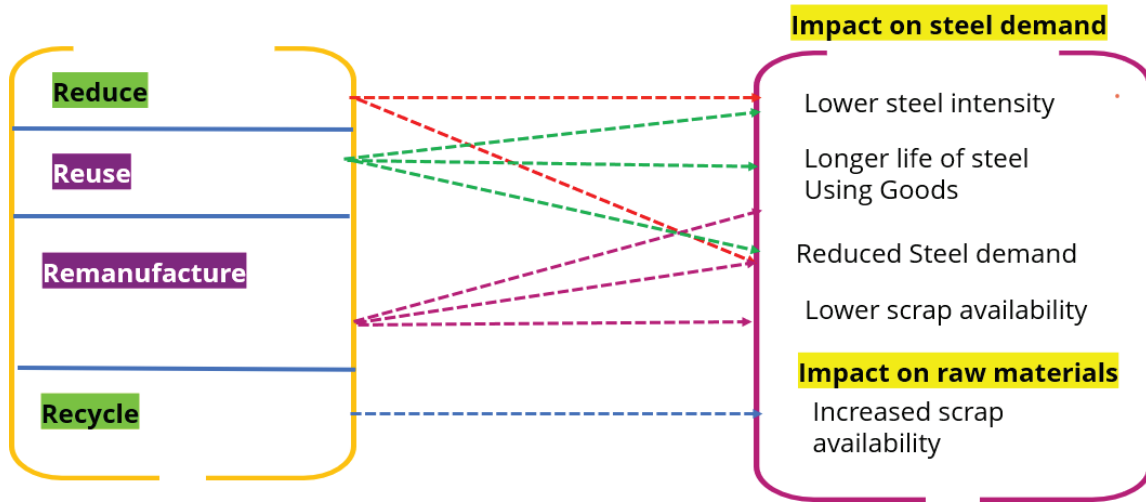


FIG-5- 10 CIRCULAR ECONOMY BENEFITS

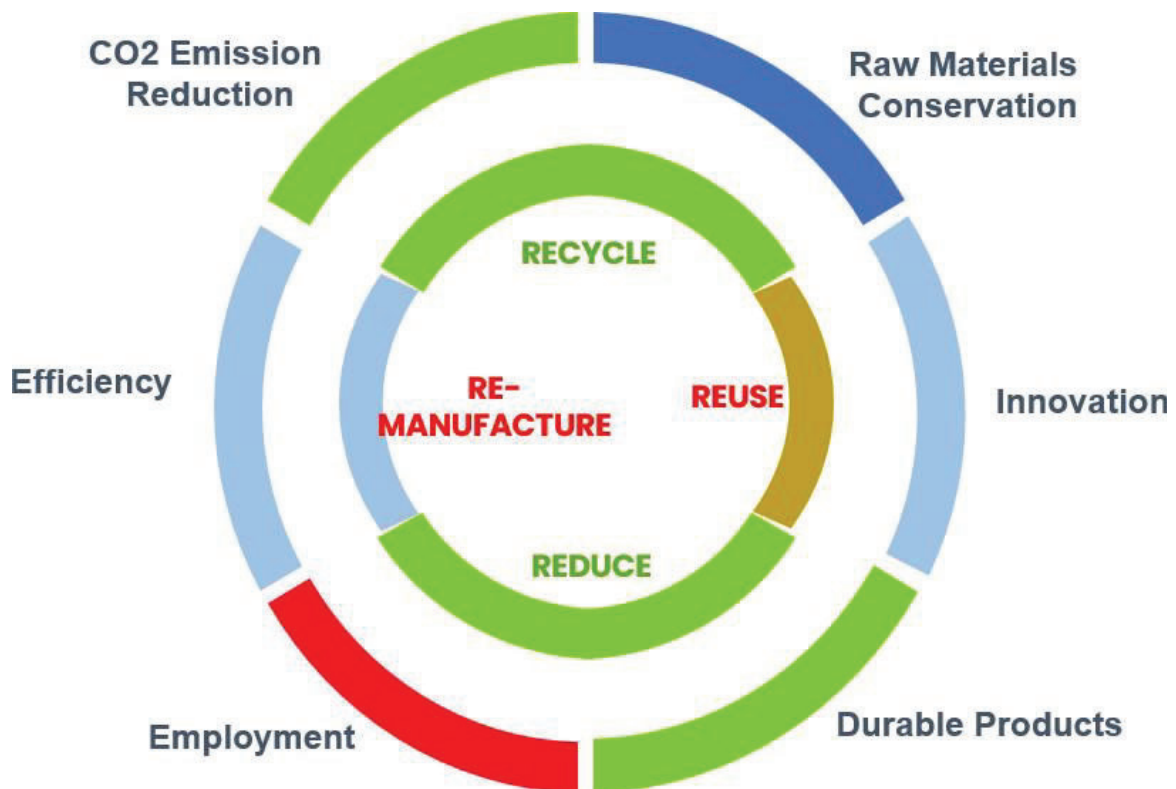


FIGURE 5- 11 STEEL THE PERMANENT MATERIAL IN CIRCULAR ECONOMY

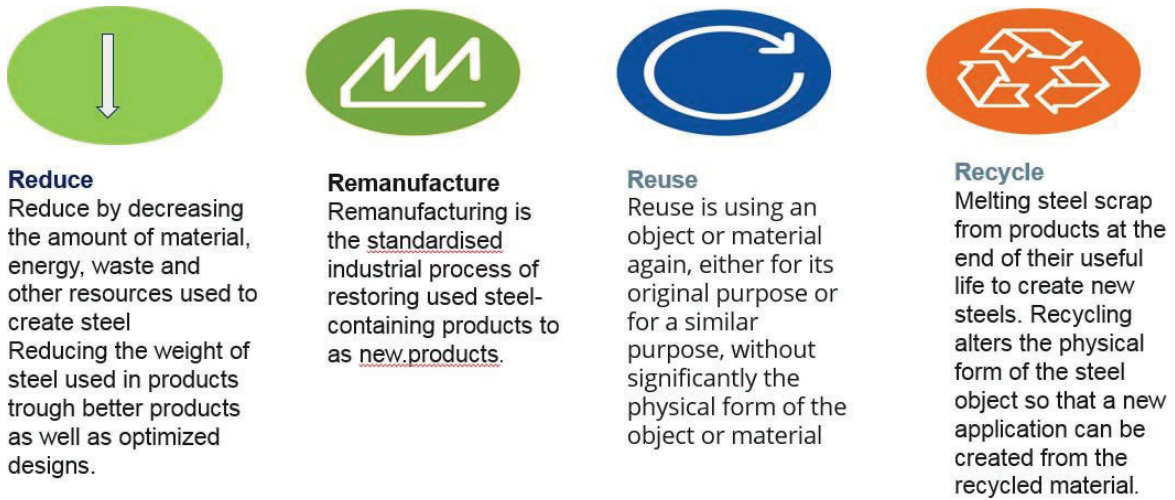


FIG 5-12 GLOBAL RESOURCE EXTRACTION TREND

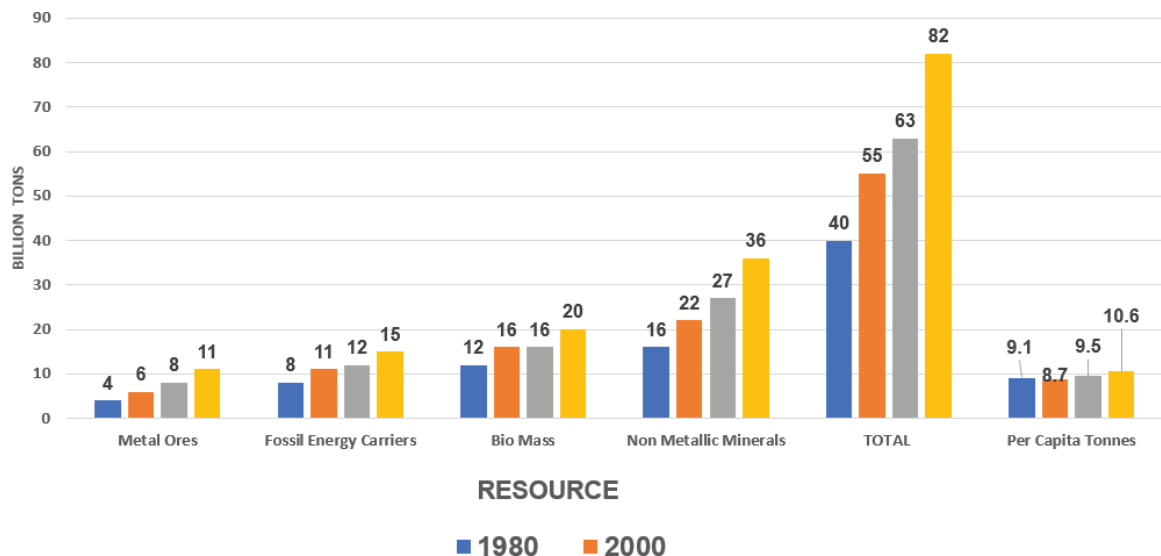


FIG-5- 13 CIRCULAR ECONOMY AND STEEL INDUSTRY 4 R's

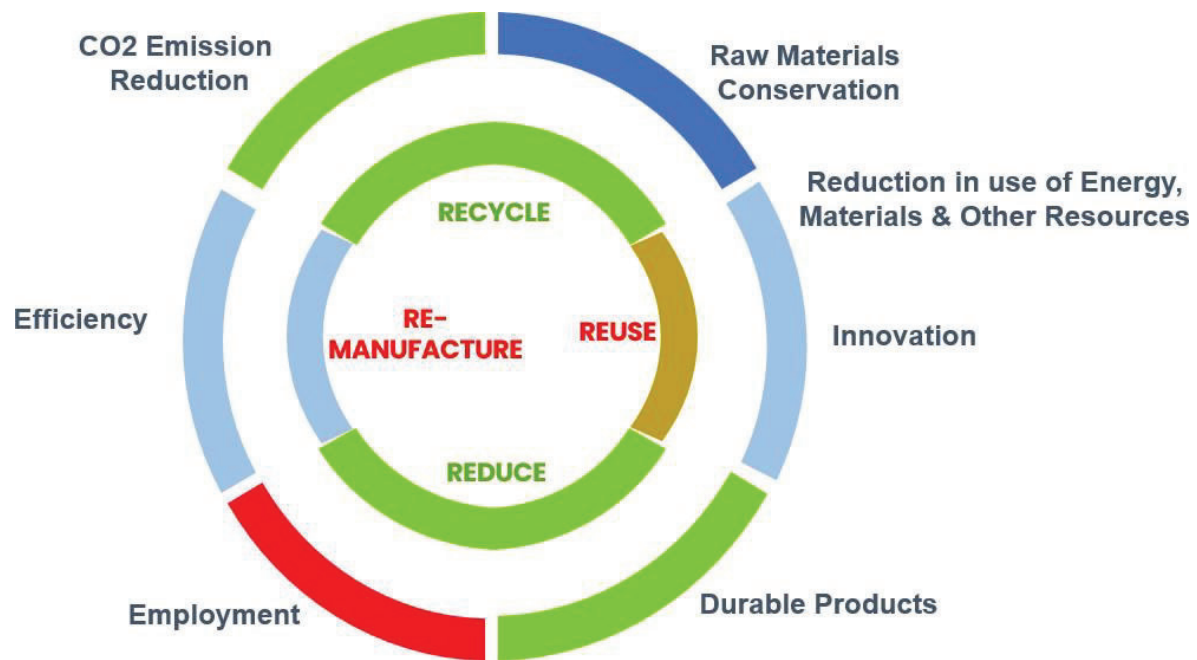


FIG-5- 14 CE AND STEEL INDUSTRY 4 R's REDUCE



FIG-5- 15 CE AND STEEL INDUSTRY 4 R's REUSE

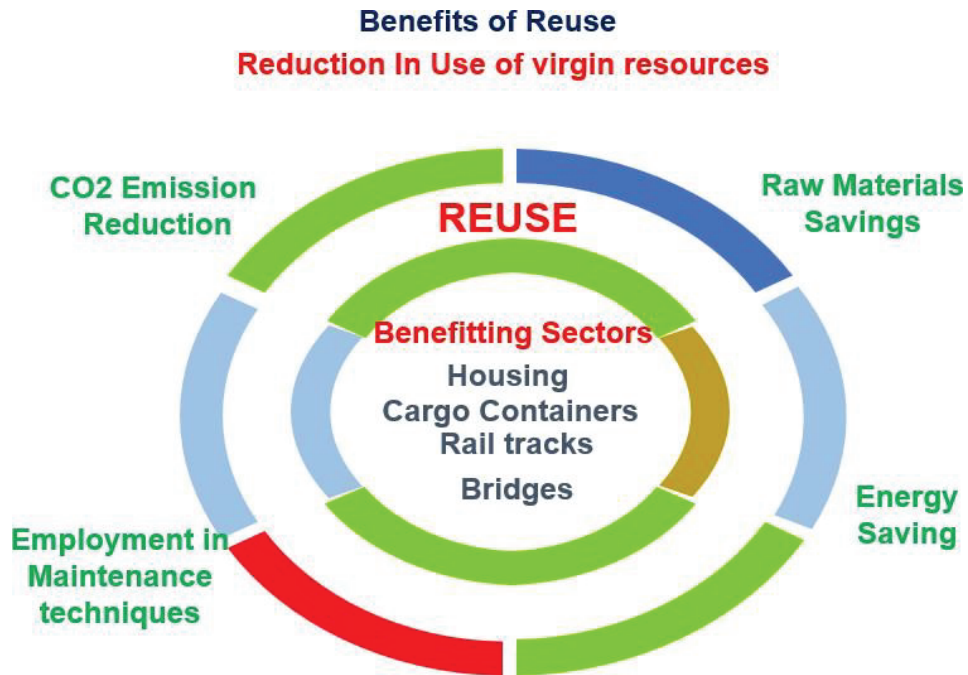


FIG-5- 16 CE AND STEEL INDUSTRY 4 R's REMANUFACTURE

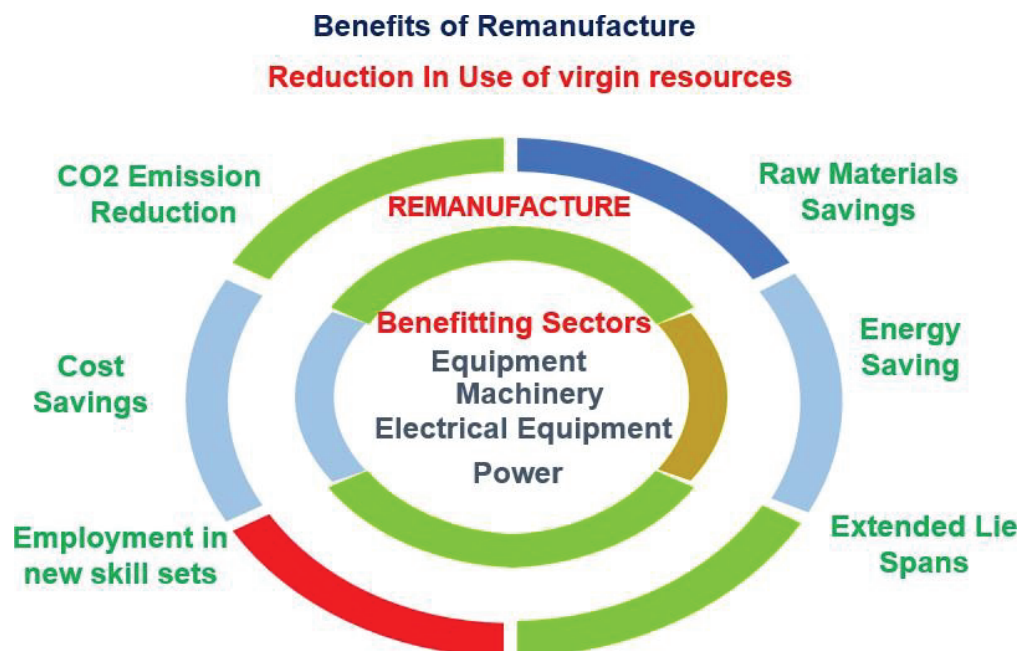


FIG-5- 17 CE AND STEEL INDUSTRY 4 R's RECYCLING



FIG 5-18 SLAG RECOVERY RATES

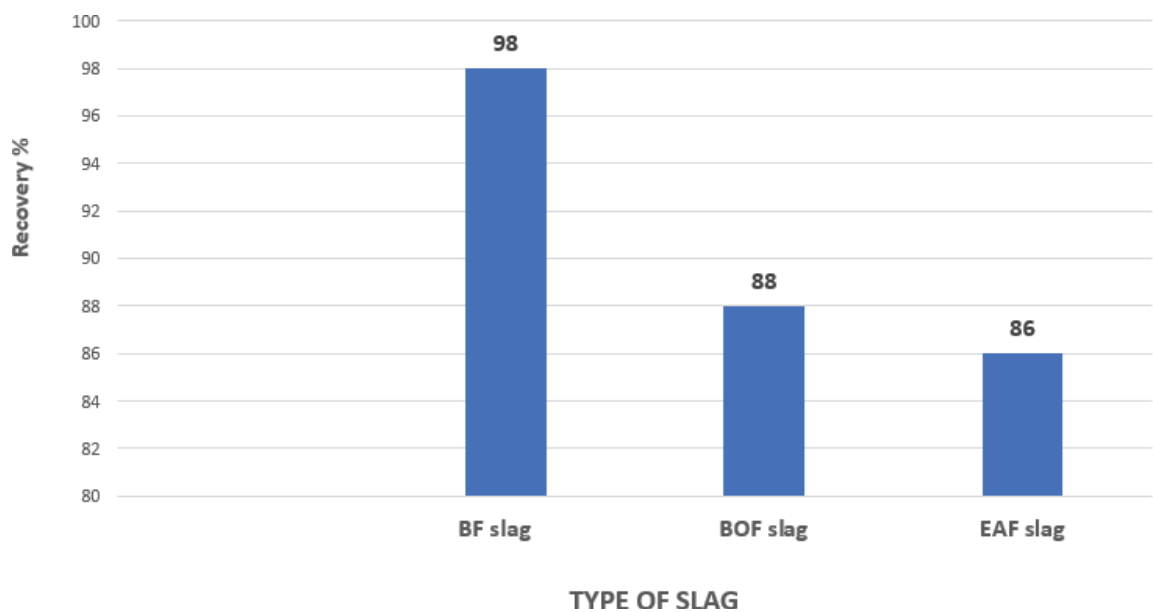
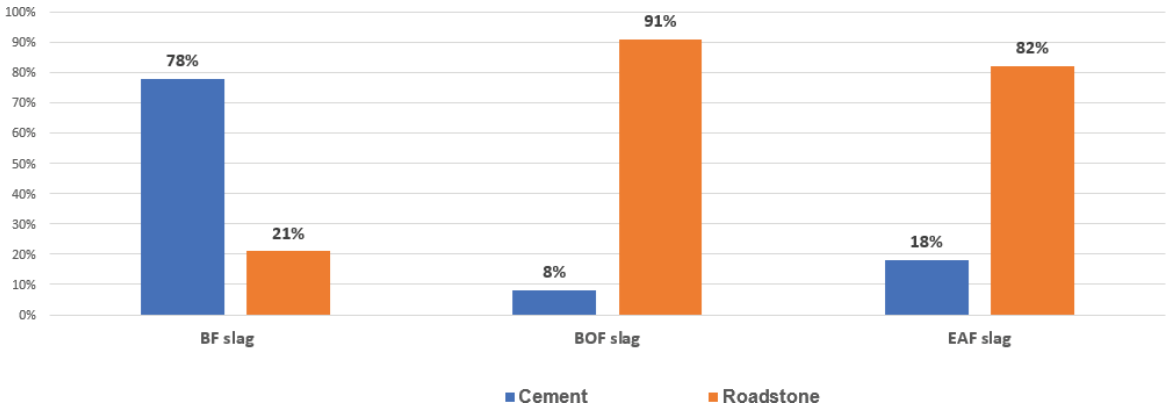


FIG 5-19 USES OF RECOVERED SLAG



Chapter 6

LIFE CYCLE PERSPECTIVE

FIG 6 – 1 STEEL AND LIFE CYCLE

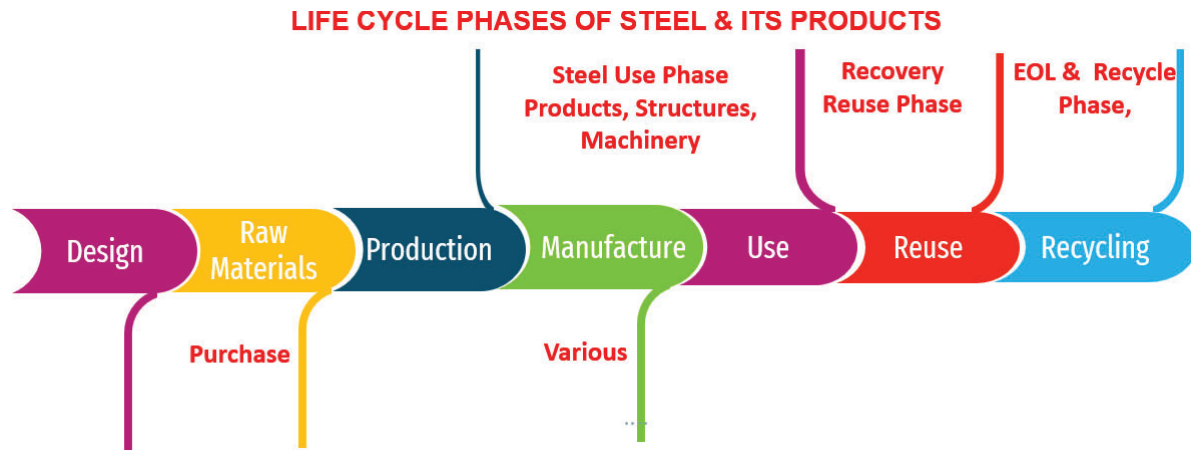


FIG 6 – 2 LIFE CYCLE ELEMENTS

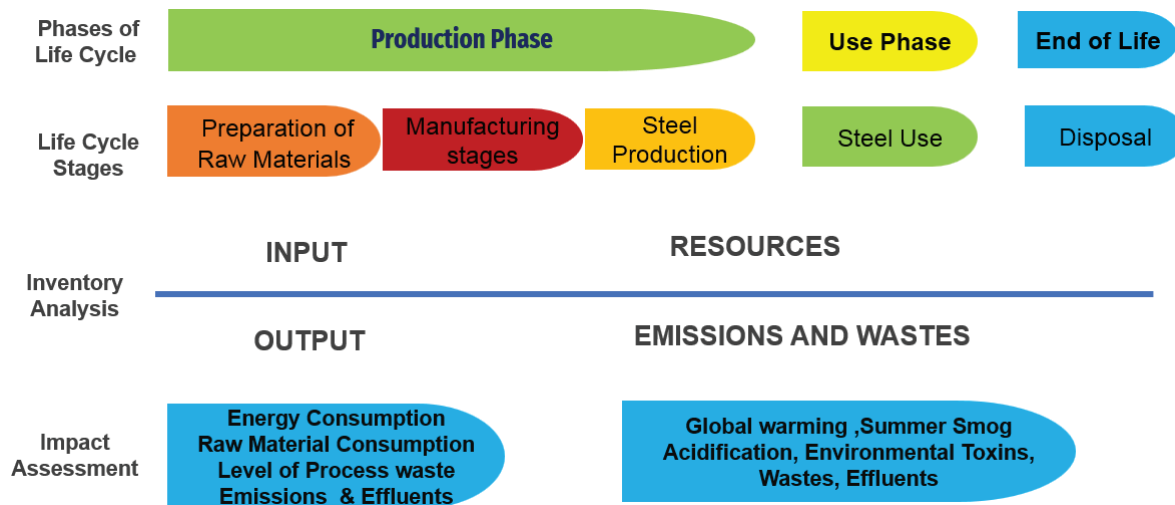


FIG-6-3 STEEL LIFE CYCLE

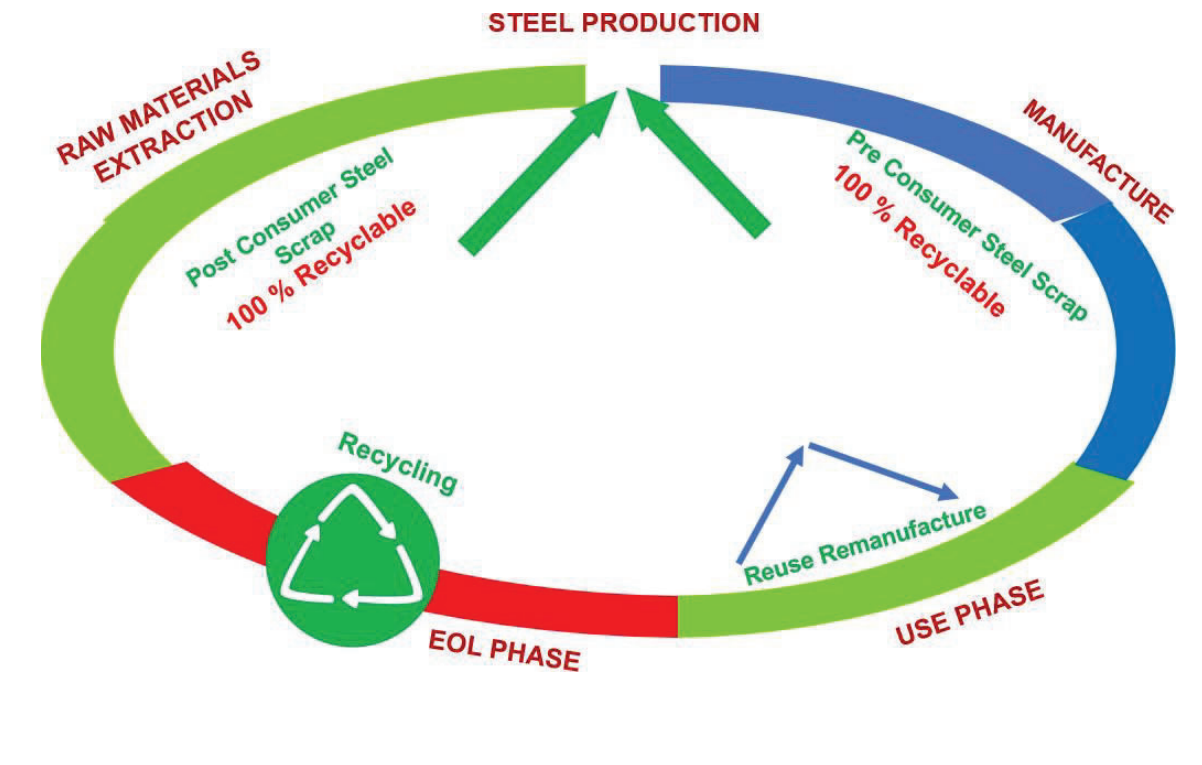
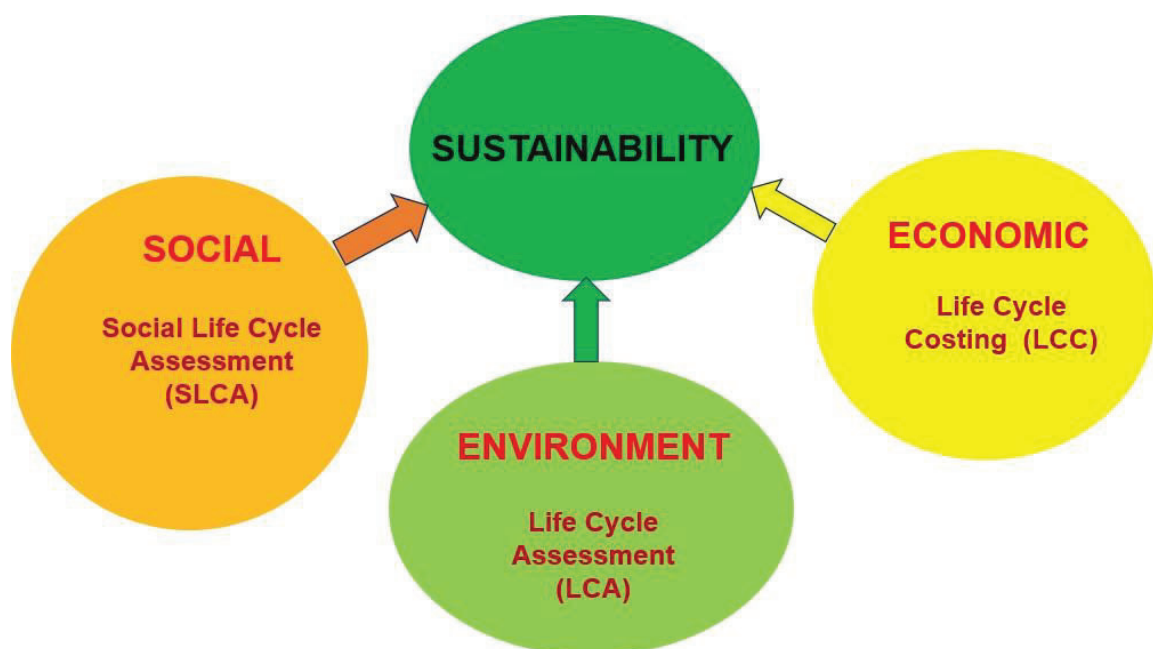
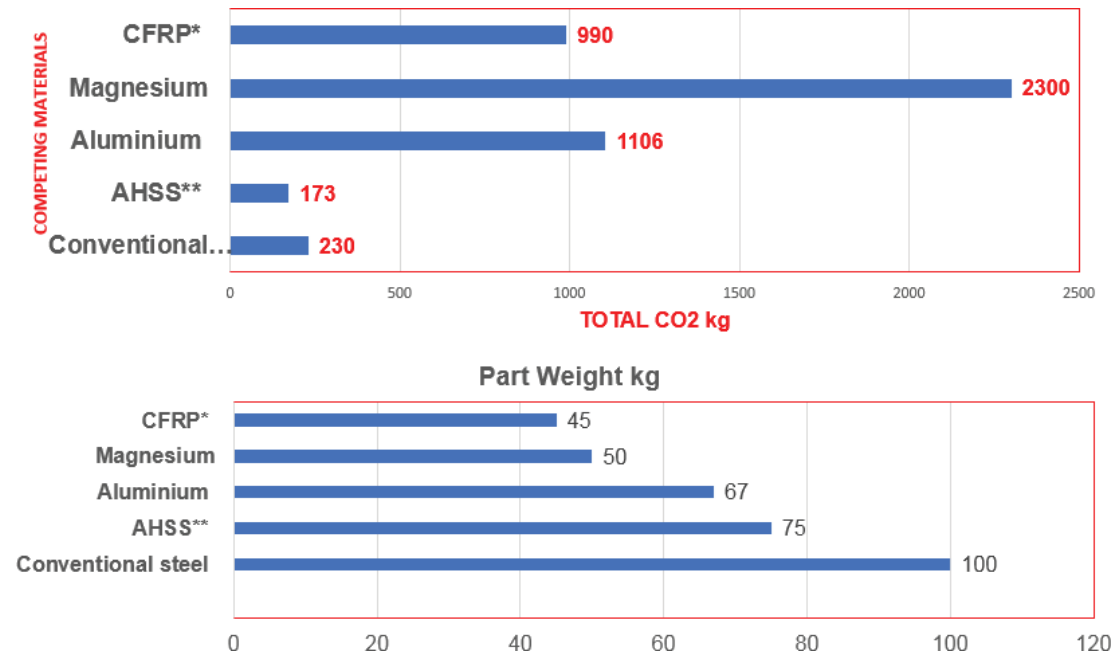


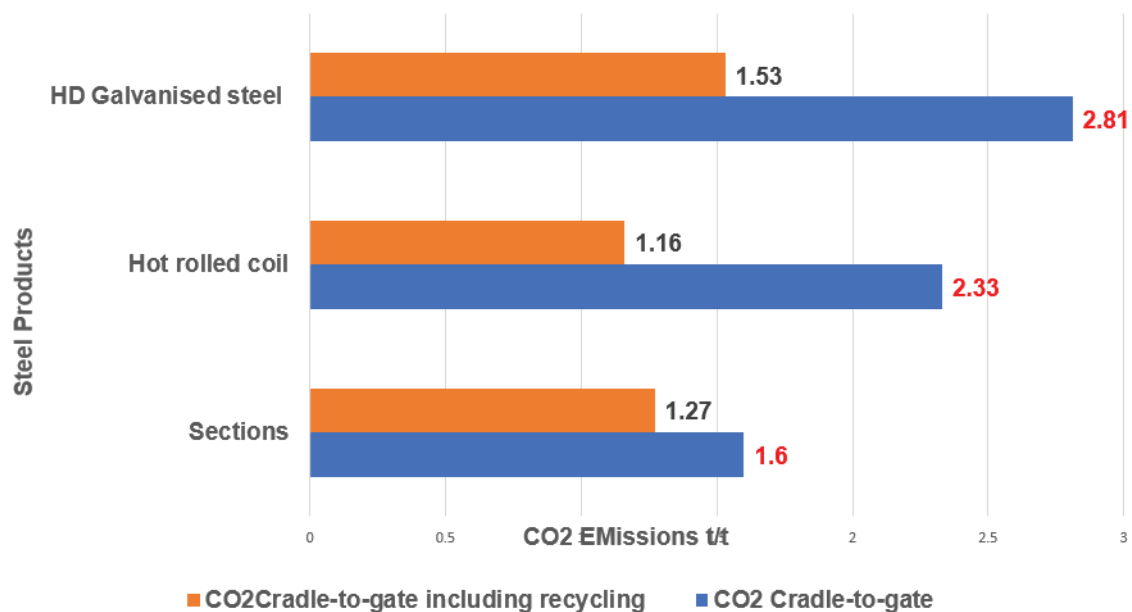
FIG 6-4 LCA & SUSTAINABILITY



**FIG 6- 5 AUTO COMPONENT PRODUCTION
GHG EMISSIONS WITH DIFFERENT MATERIALS**



**FIG 6-6 LIFE CYCLE CO2 IMPACT OF STEEL PRODUCTS
Cradle to Gate vs Cradle to Gate with Recycling**



Chapter 7

STATUS OF STEEL TECHNOLOGIES & PROCESSES

FIG 7-1 STEELMAKING PROCESS ROUTES

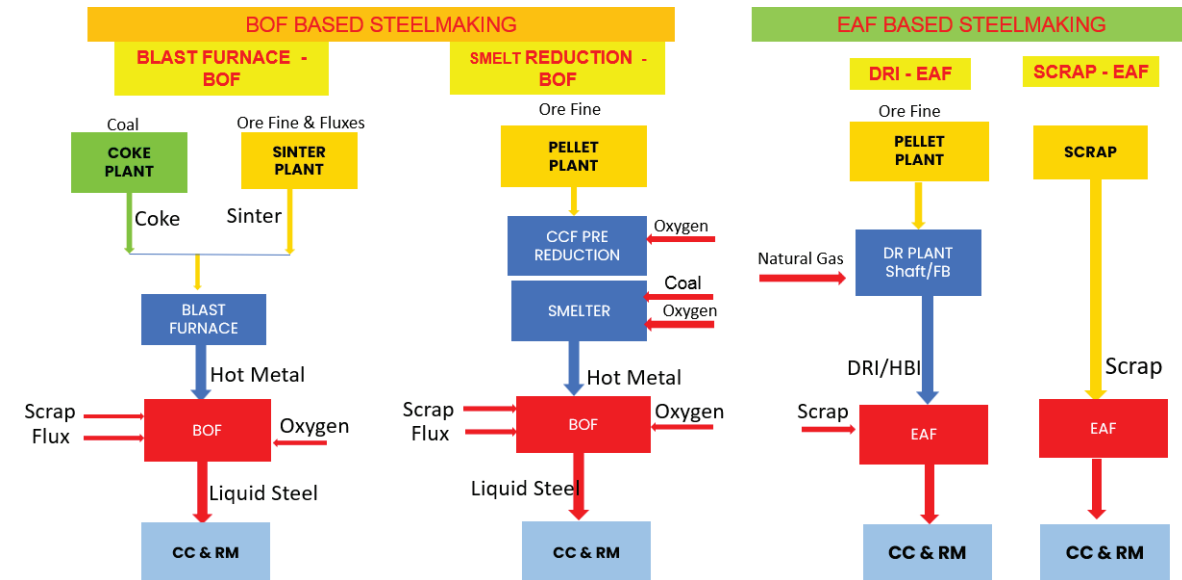


FIGURE 7-2 GLOBAL PROCESS SHARES IN STEELMAKING
 {Steel Production 1884 Million Tons (2022)}

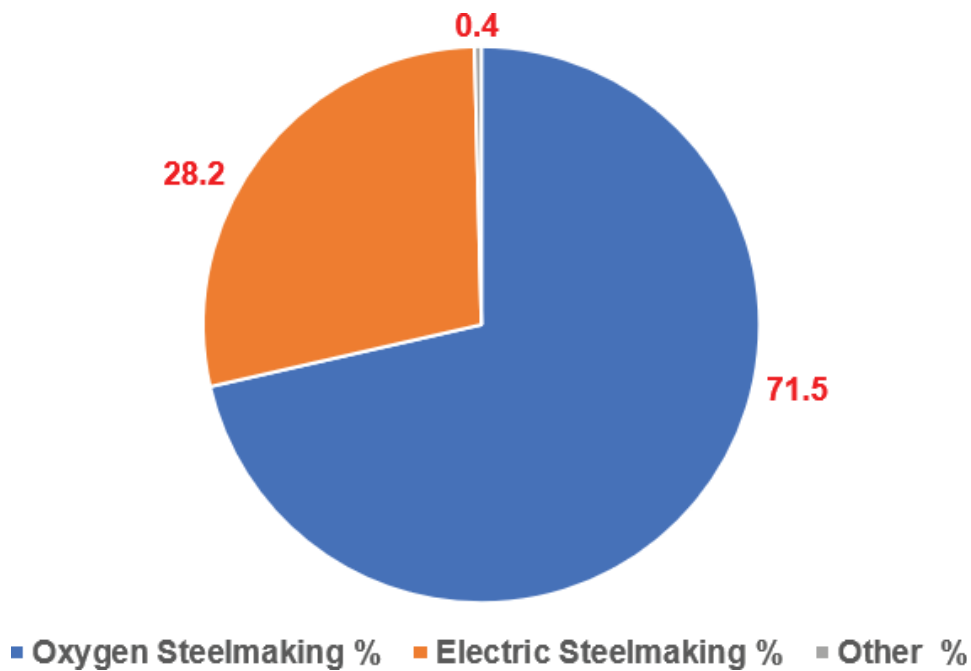


FIGURE 7-3 GLOBAL BF CAPACITY STATUS

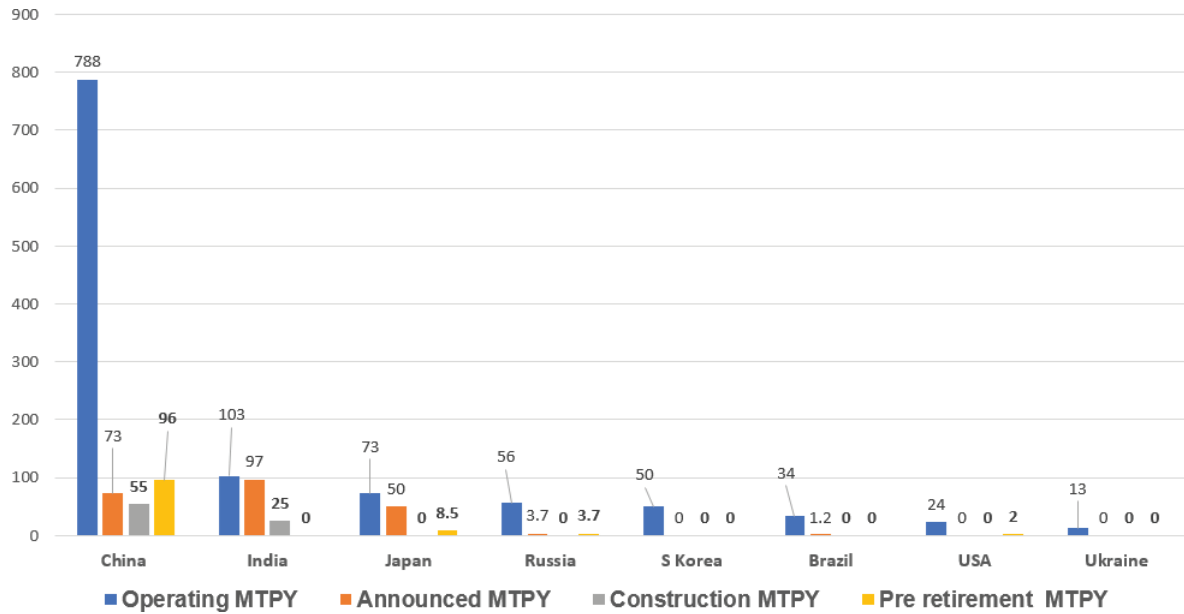


FIGURE 7-4 GLOBAL BF NO OF UNITS

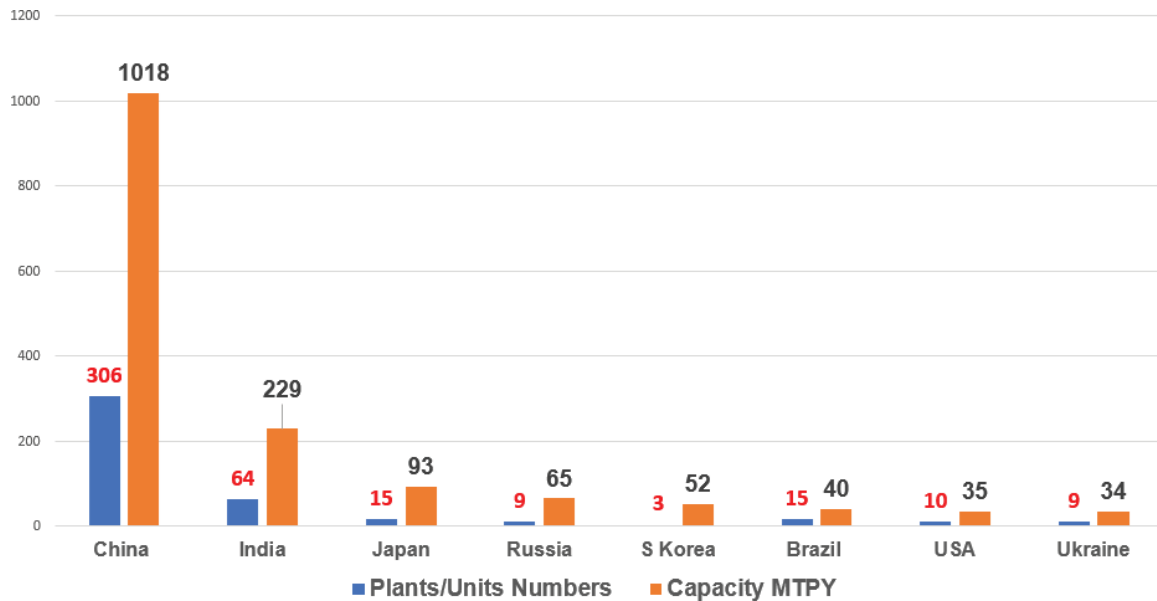


FIGURE 7-5 GLOBAL DRI PRODUCTION

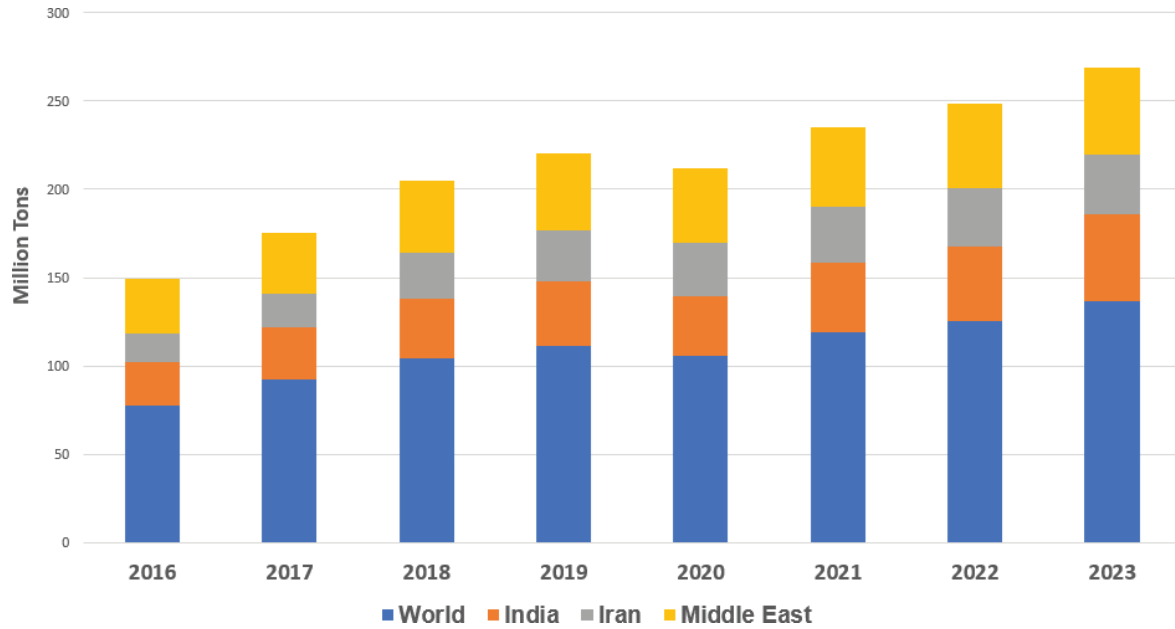


FIGURE 7-6 GLOBAL DRI PROCESS SHARES

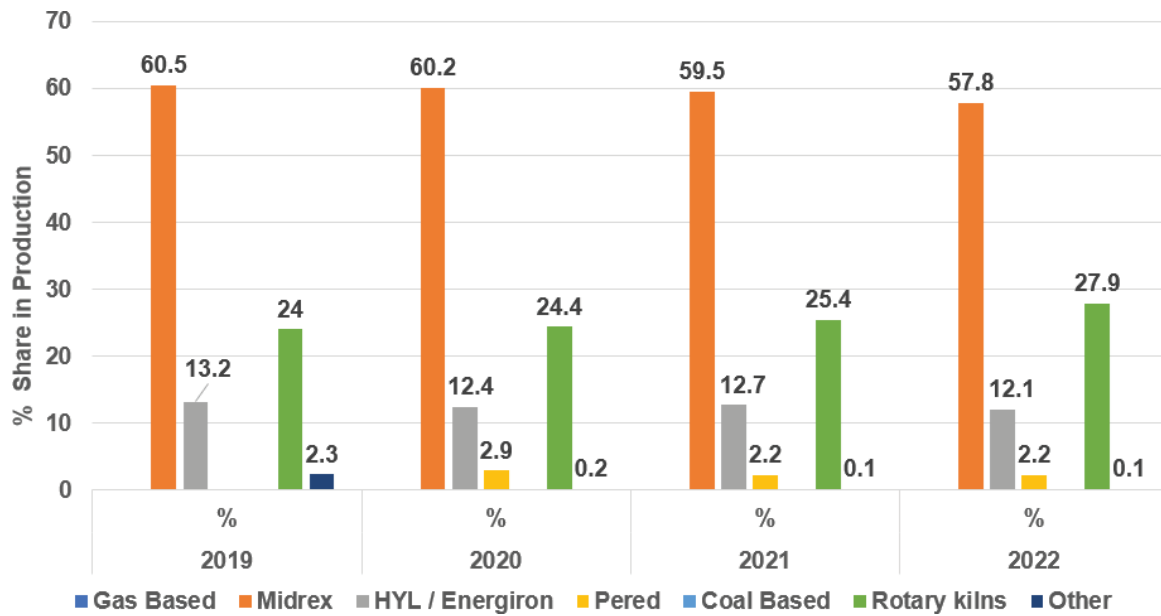


TABLE 7-7 BOF SHARE IN GLOBAL STEEL PRODUCTION

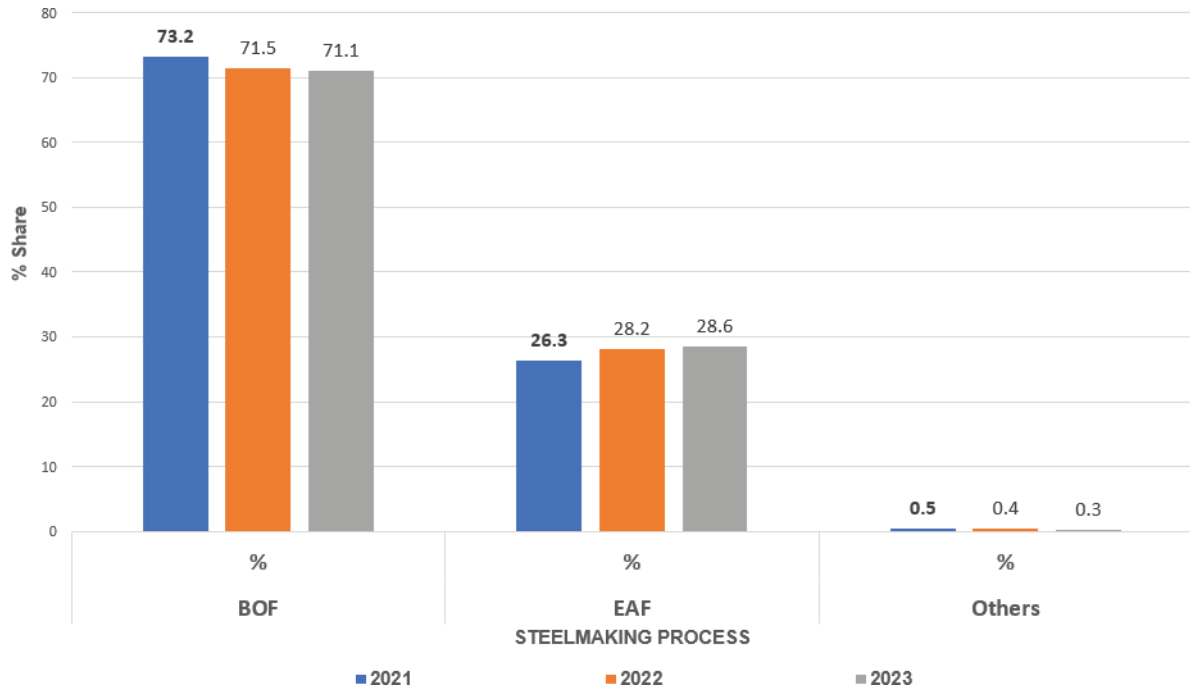


FIG 7-8 STEEL MAKING DEVELOPMENTS CHRONOLOGY

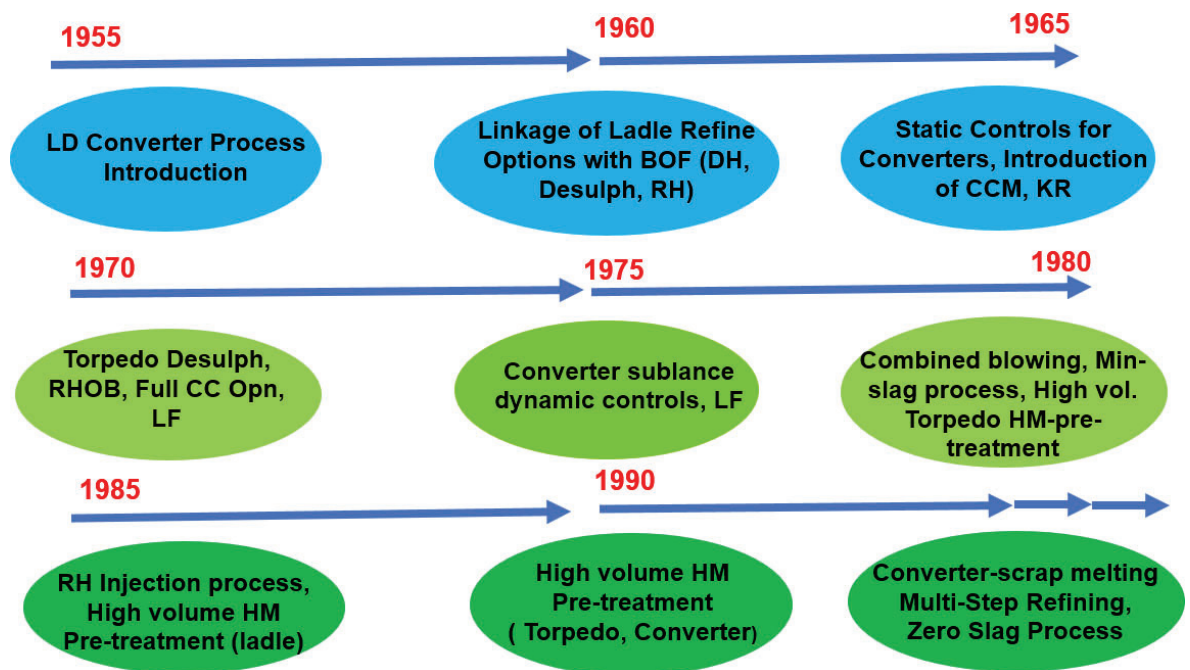


FIG 7-9 MULTI-REFINING PROCESSES

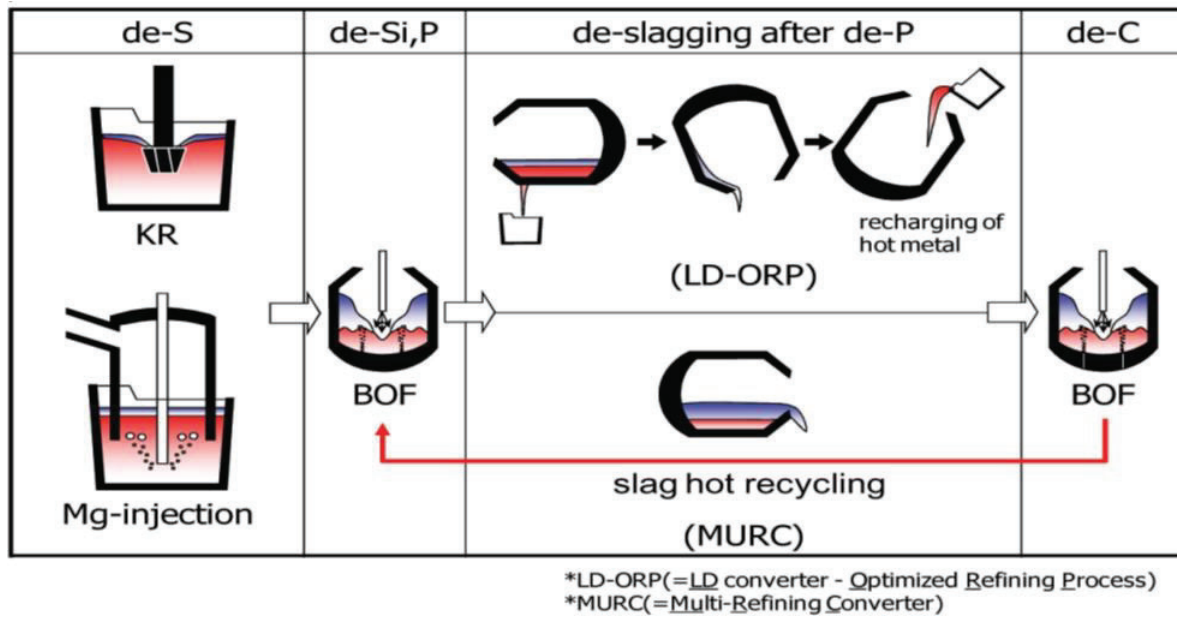


FIG 7- 10 EAF PERFORMANCE IMPROVEMENTS

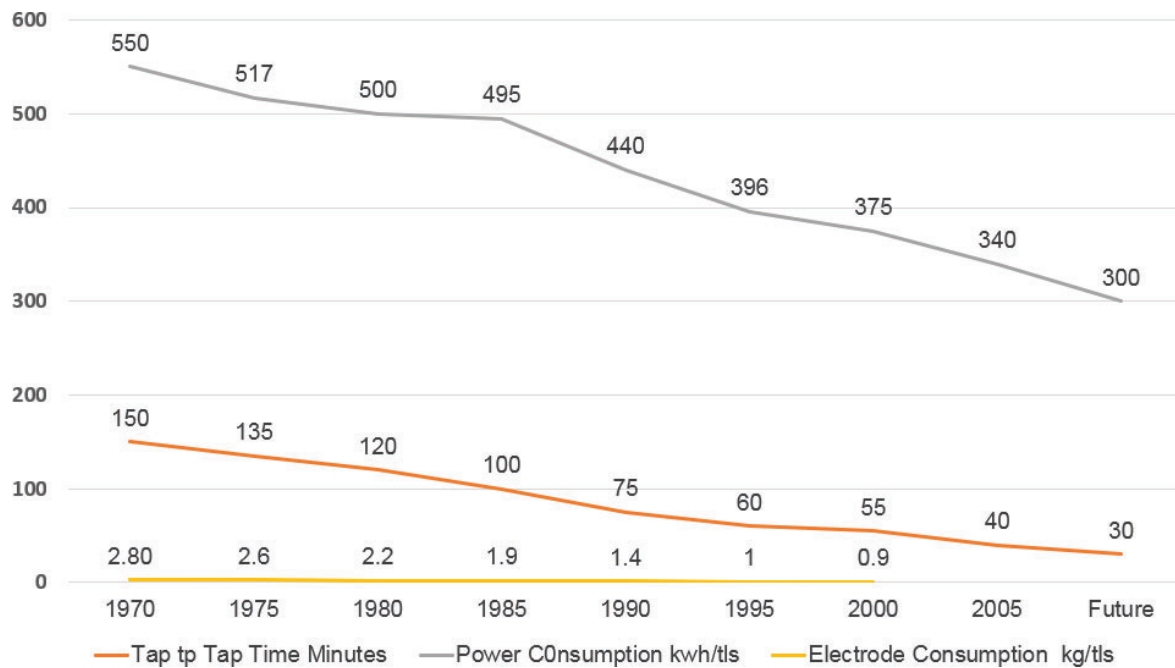


FIGURE 7-11 EAF ENERGY INPUT-OUTPUT

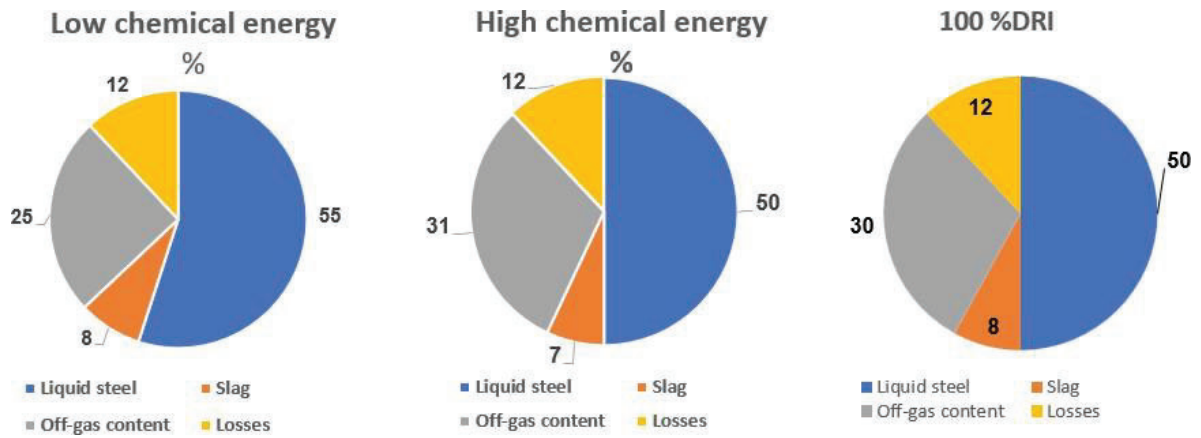


FIGURE 7-12 EAF PROCESS MILESTONES (1970-2010 & BEYOND)

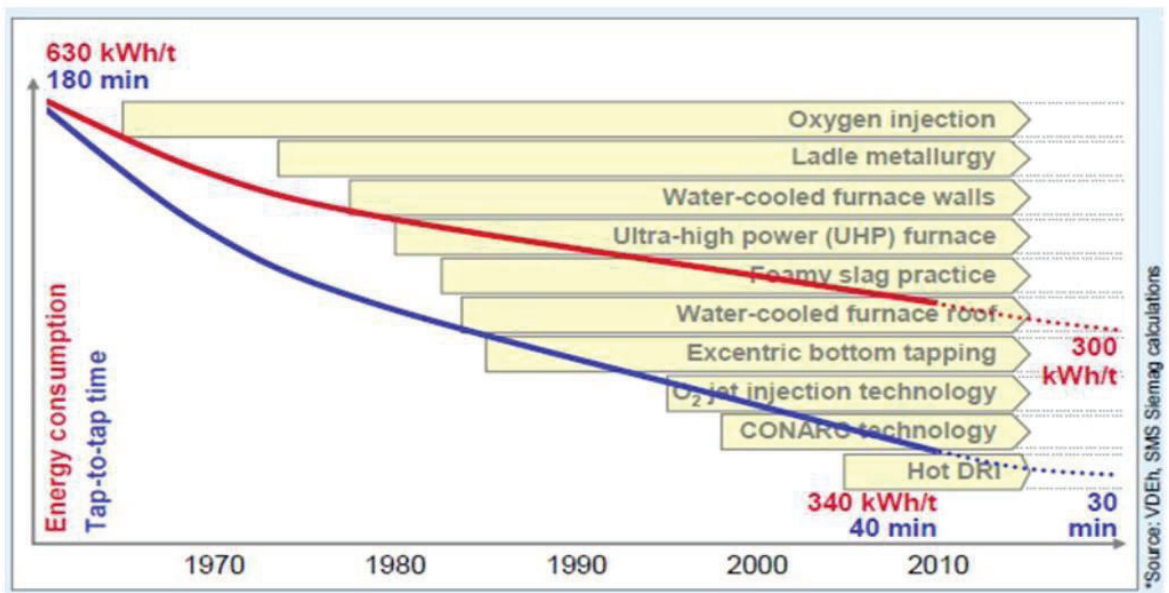


FIGURE 7-13 FUTURE EAF FEATURES

	Conventional EAF	Future EAF
Furnace size	150 t	150 t
Furnace volume	180 m3	280 m3
Volume per ton capacity, cum/t	1.2	Near 2
Scrap charge, nos	2 buckets	1 bucket Mandatory
Bucket size	150 m3	Suit single charge
Transformer	1,000kVA/t, 150MVA	1,500kVA/t, 225MVA
Utilization of chemical energy		
Oxygen gas burners	3	3
Refined combined burners (RCB)	3	6
Carbon injectors	2	5
Post combustion injectors		5

FIG 7-14 SECONDARY STEELMAKING PROCESS OPTIONS

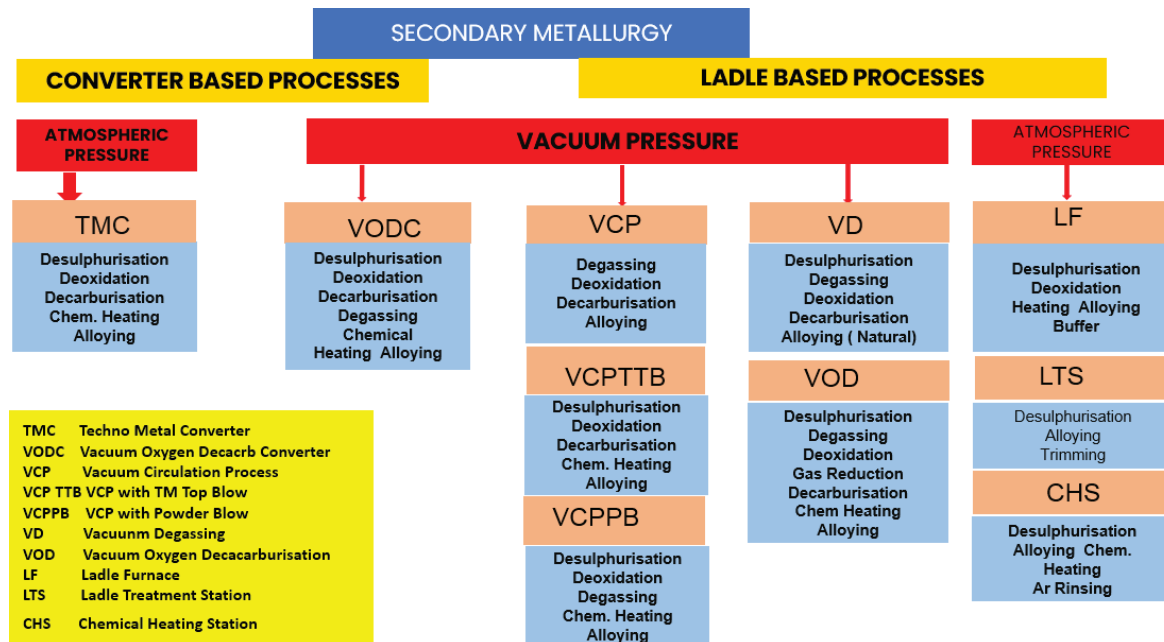


FIGURE 7-15 COMPACT STRIP PRODUCTION (CSP) CONVENTIONAL

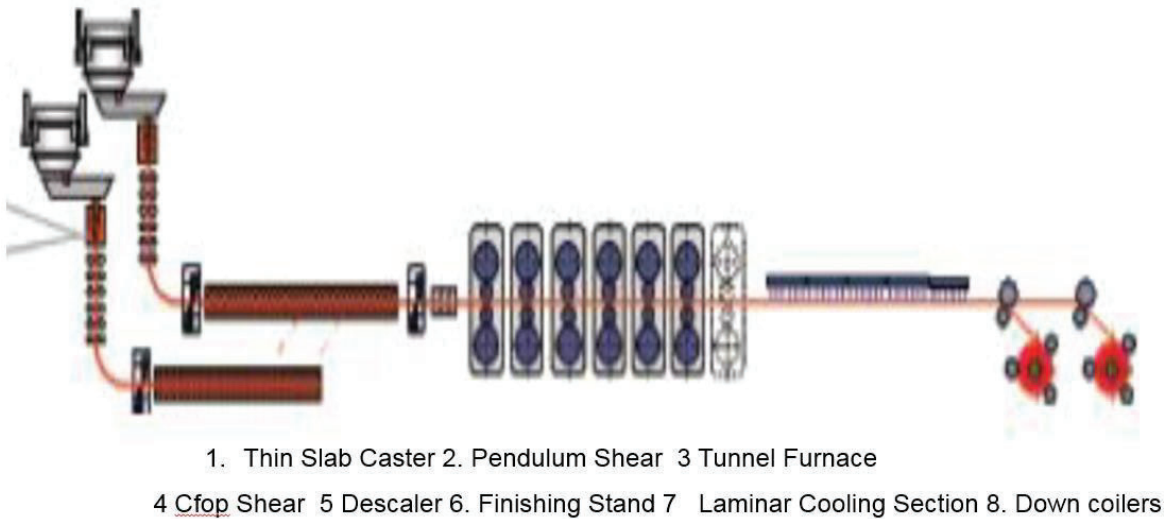


FIGURE 7- 16 CSP FLEX

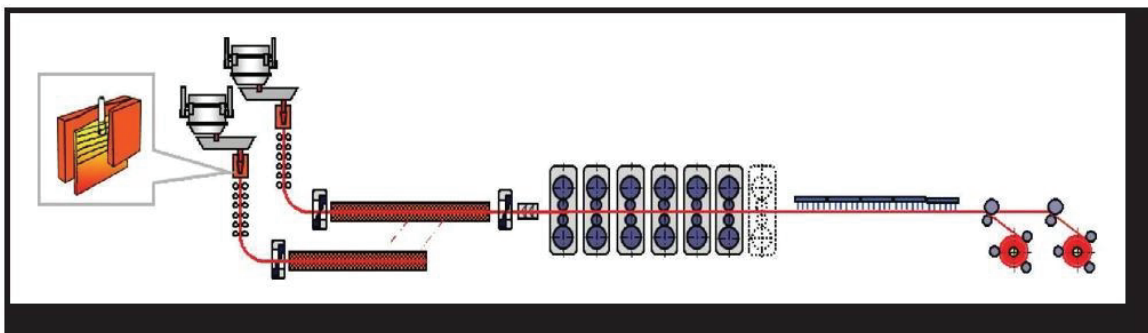
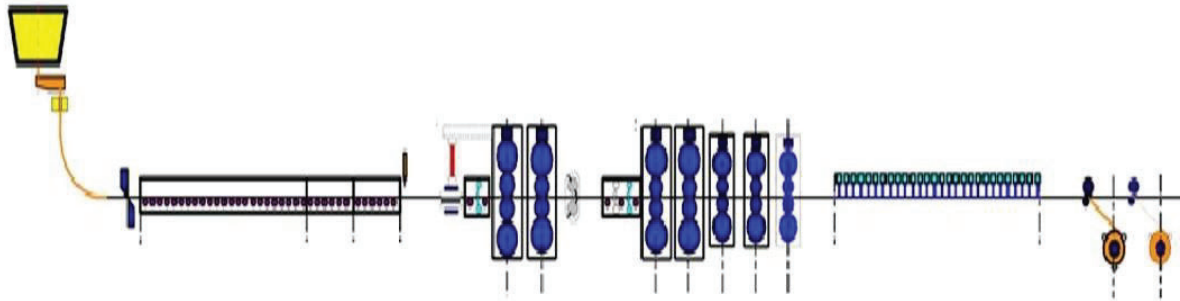
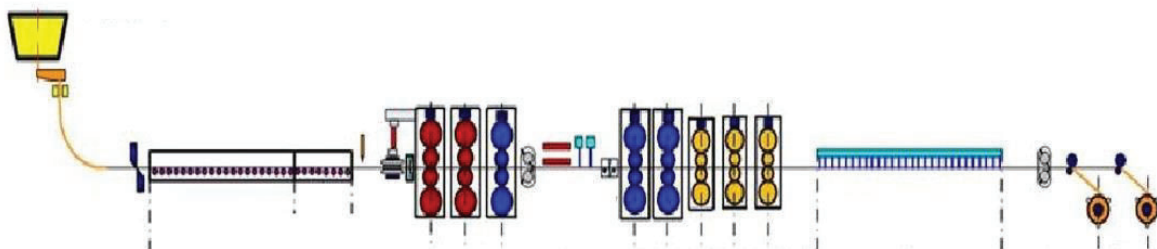


FIGURE 7-17 QUALITY STRIP PRODUCTION (QSP)



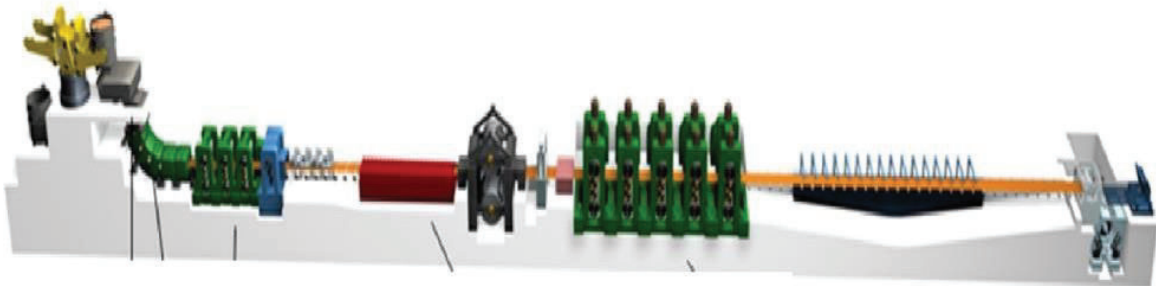
1. Thin Slab Caster 2. Pendulum Shear 3 Tunnel Furnace
- 4 Crop Shear 5 Descaler 6. Finishing Stand 7 Laminar Cooling Section 8. Down coilers

FIGURE 7-18 QSP DUE



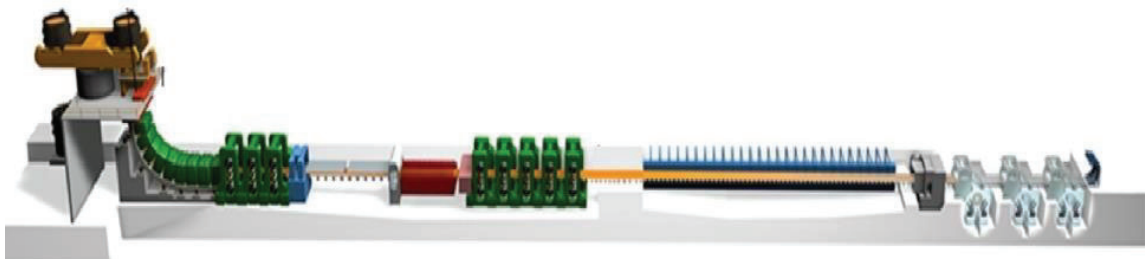
1. Thin Slab Caster 2Pendulum Shear 3.Tunnel Furnace 4, High Reduction Stands 5.Crop Shear
6. Induction Heater 7. Descaler 8. Finishing Stands 9. Laminar Cooling System.
10. High Speed Shear 11. Down coilers

FIGURE 7-19 IN-LINE STRIP PRODUCTION (ISP)



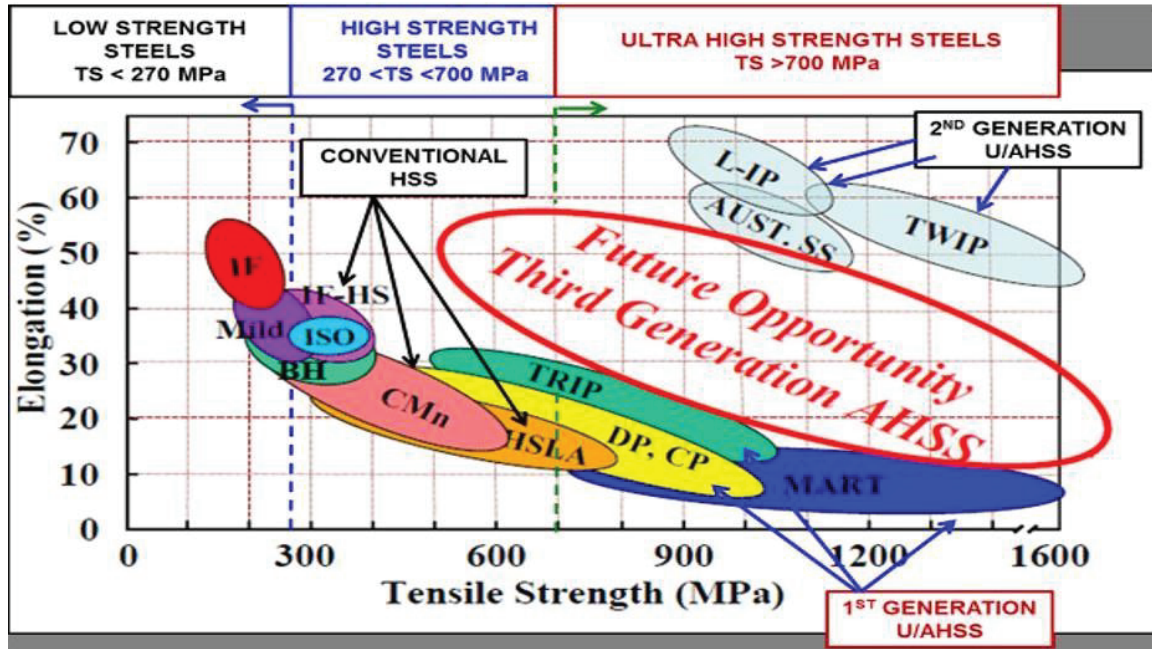
1. Thin Slab Caster 2. High Reduction Mill 3. Induction Heater 4. Cremona Furnace
5. Descaler 6. Finishing Mill 7. Laminar Cooling Section 8. Down coilers
-

FIGURE 7- 20 ARVEDI ESP



1. Thin Slab Caster 2. High-Reduction Mill 3. Induction Heating 4. Finishing Mill
5. Laminar Cooling Section 6. Flying Shear 7. Down coilers

FIGURE 7-21 STEEL PRODUCT-UPGRADES TO U/AHSS



Chapter 8

STEEL AND ENERGY USE

FIG 8-1 ENERGY SOURCES IN STEEL PRODUCTION

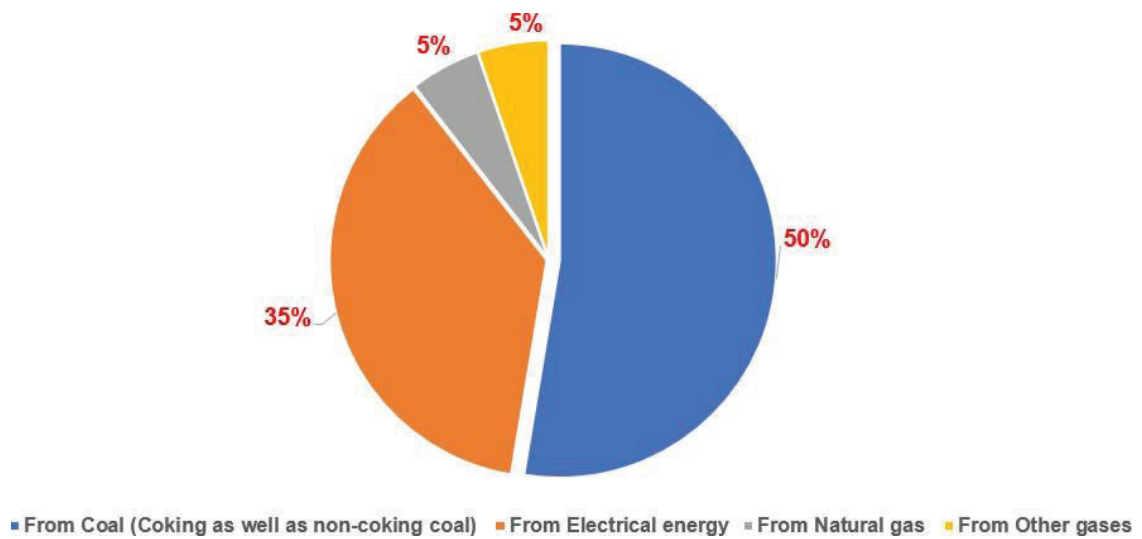


FIG 8-2 ENERGY END USE IN STEEL PRODUCTION

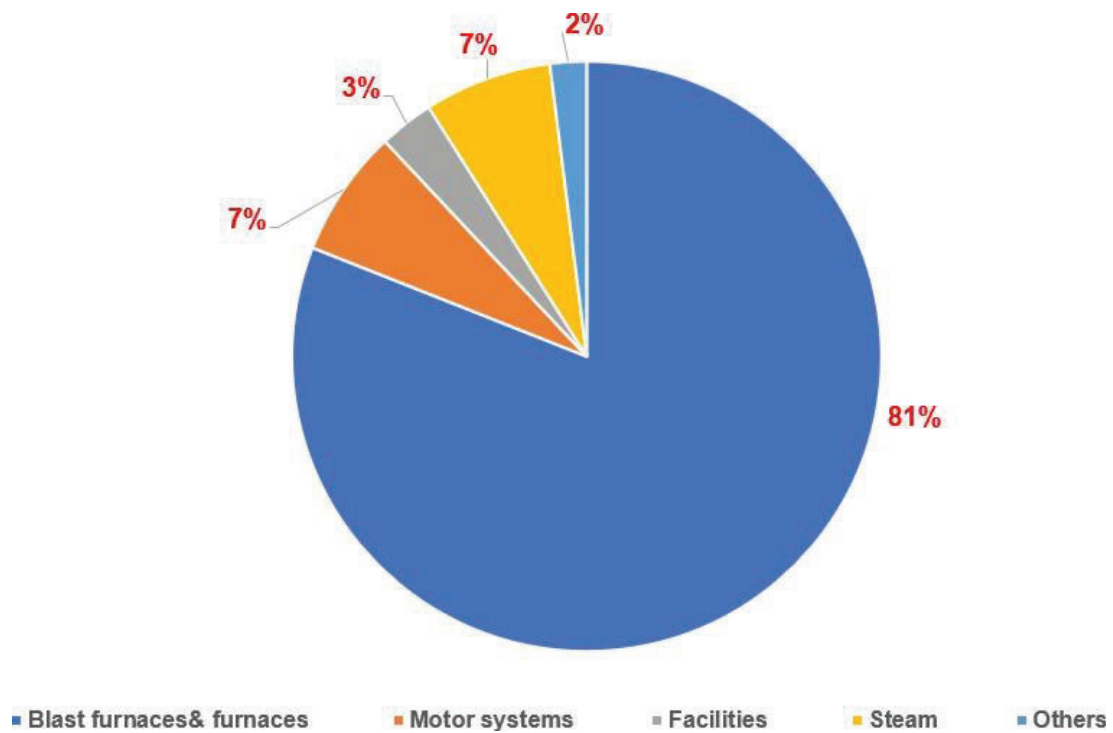


FIG 8-3 PROCESS STAGE-WISE ENERGY INTENSITIES

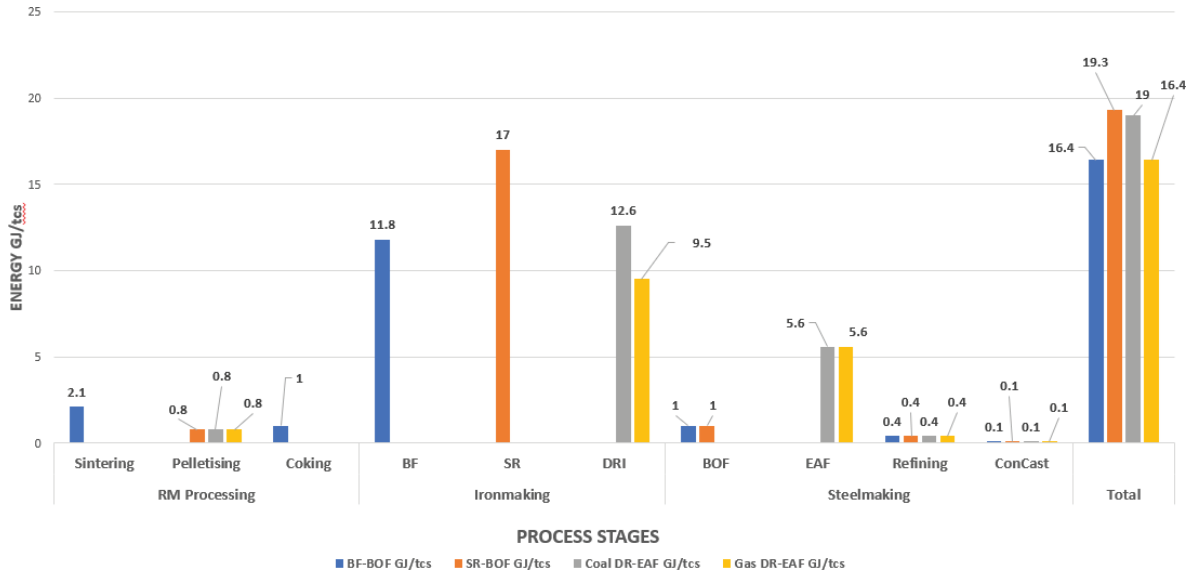


Fig 8-4 BF-BOF STAGewise ENERGY SHARE %

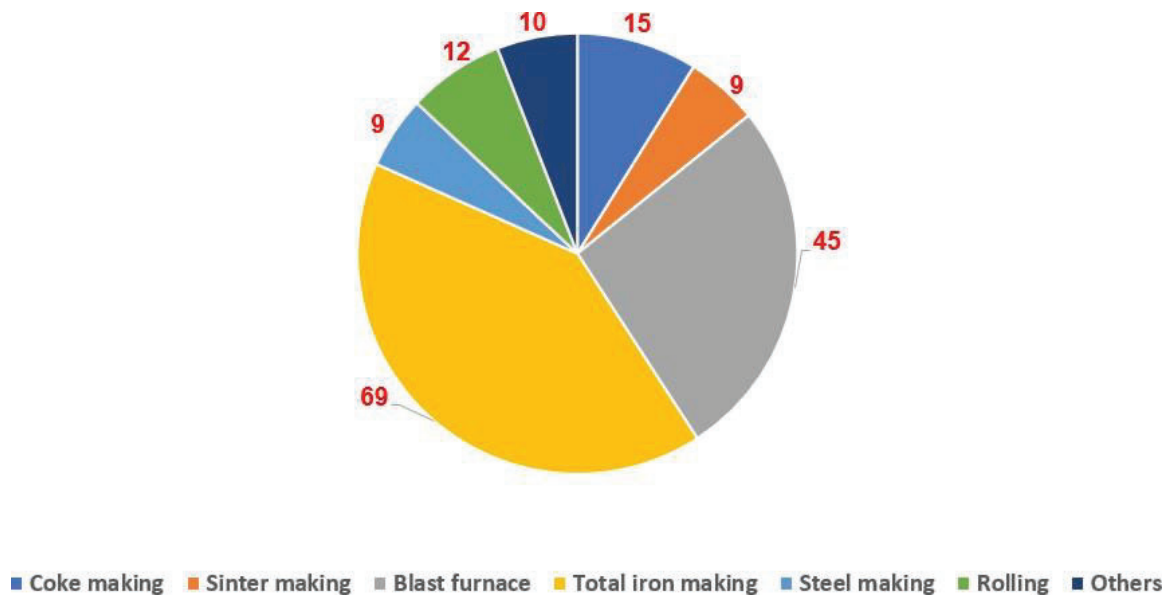


Fig 8-5 DR-EAF STAGEWISE ENERGY SHARE %

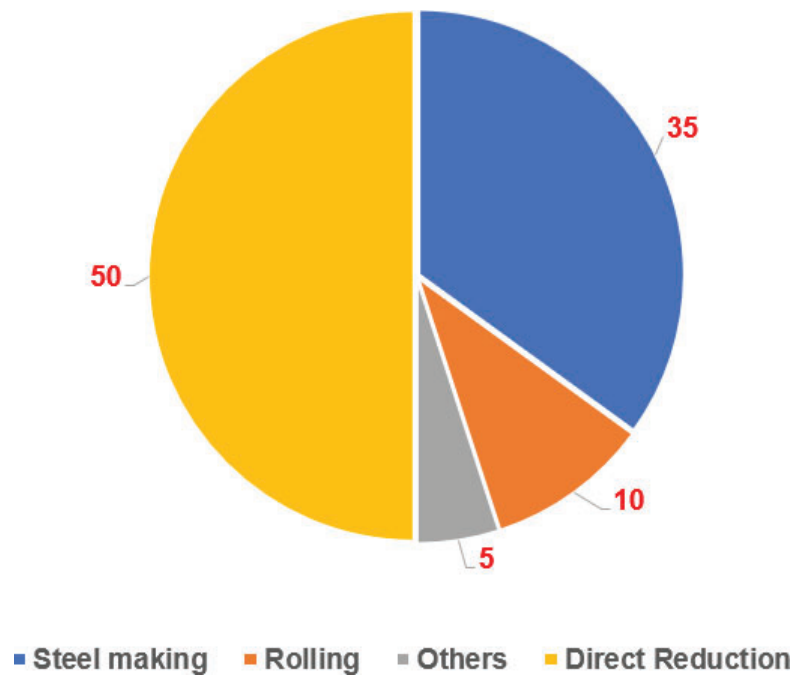


Fig 8-6 SCRAP-EAF STAGEWISE ENERGY SHARE%

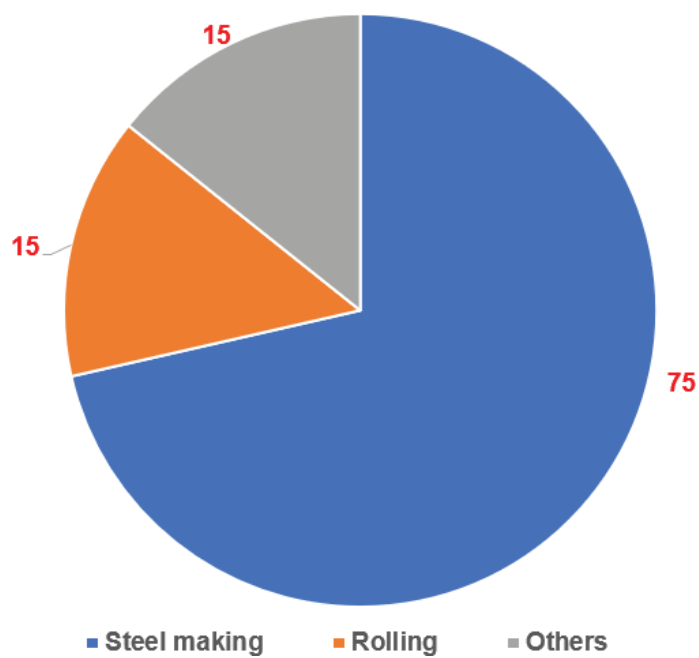


FIG 8-7 STEEL INDUSTRY REDUCTION IN ENERGY USE
Energy Consumption Index

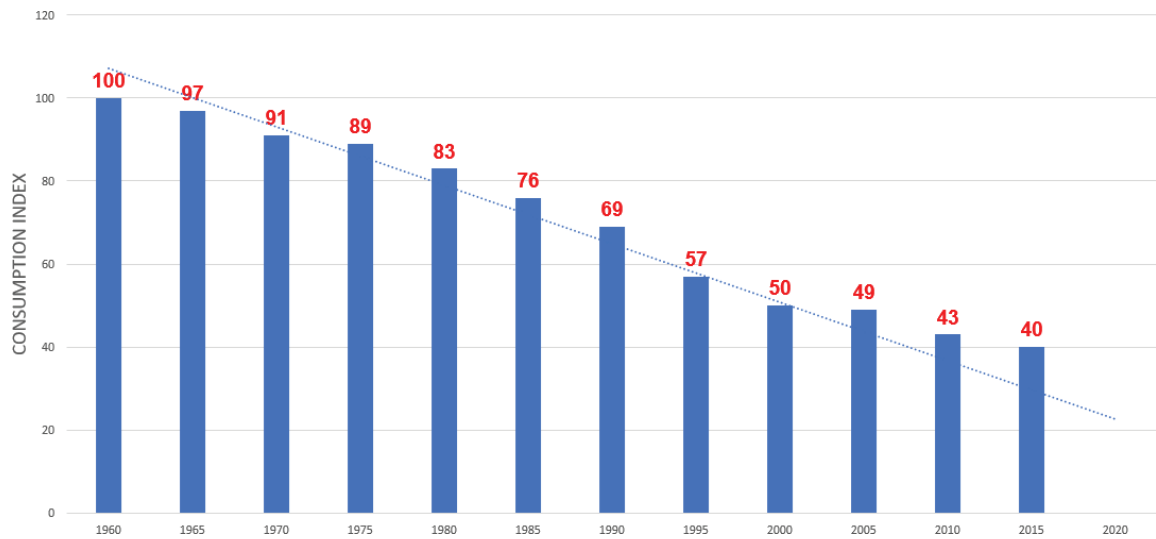


FIG 8-8 ENERGY DISTRIBUTION IN STEELMAKING

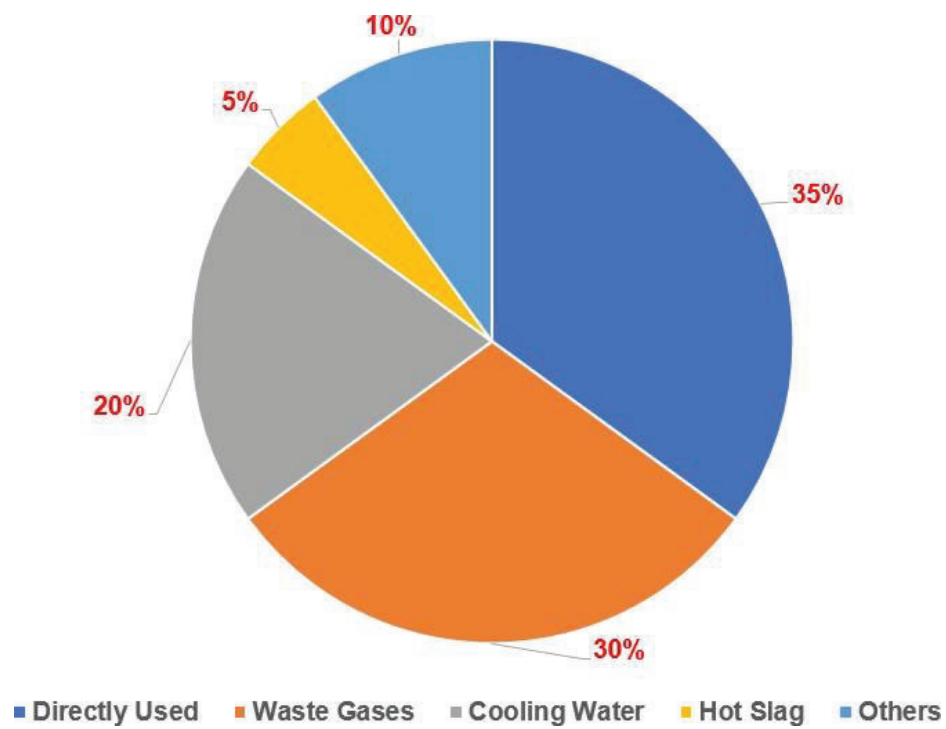


FIG 8- 9 WH RECOVERY POTENTIAL AREAS IN STEEL PLANTS

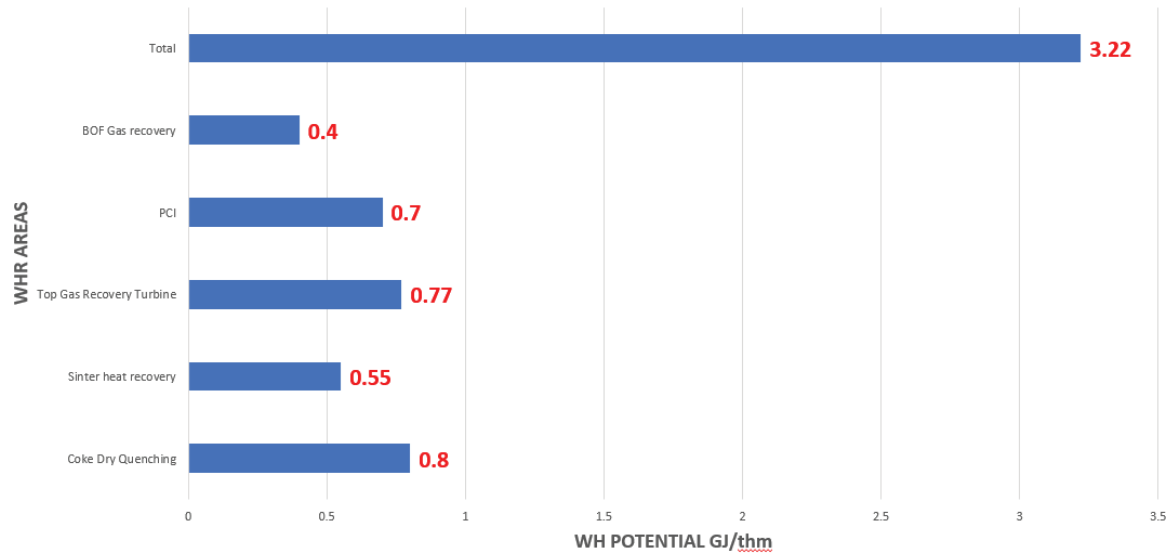


FIG 8-10 ENERGY SAVINGS IN CASTING AND IN-LINE ROLLING

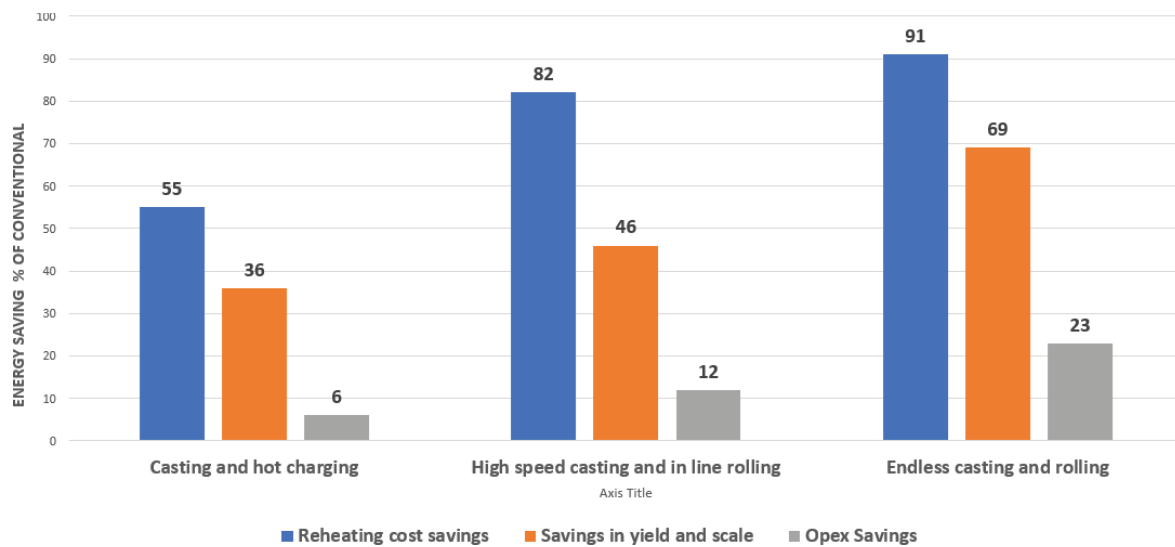


FIG 8-11 IMPACT OF METALLICS ON ENERGY CONSUMPTION FOR STEELMAKING (Kwh/tls)

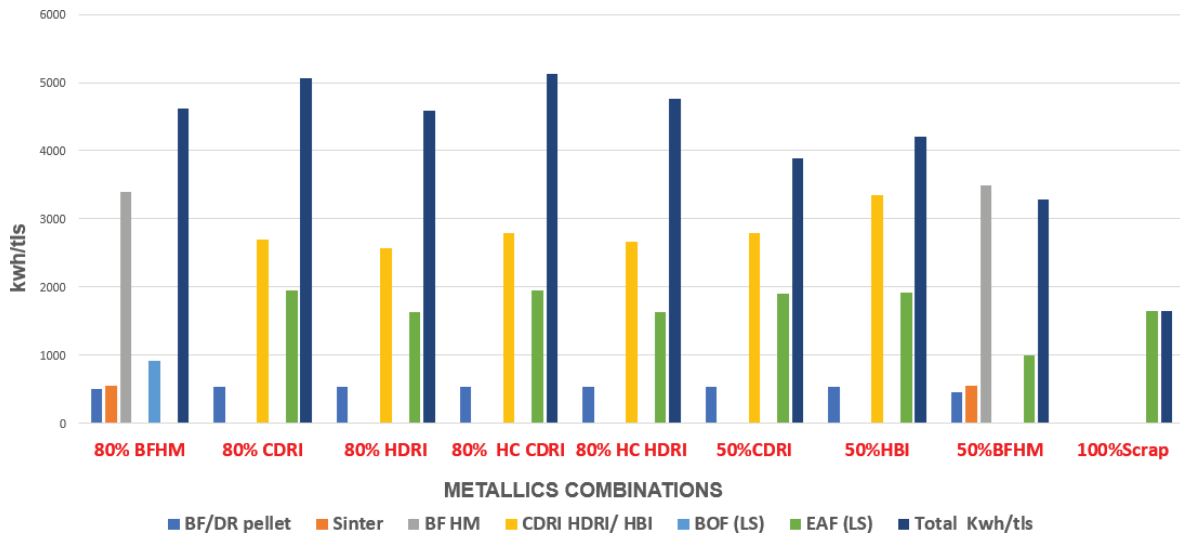
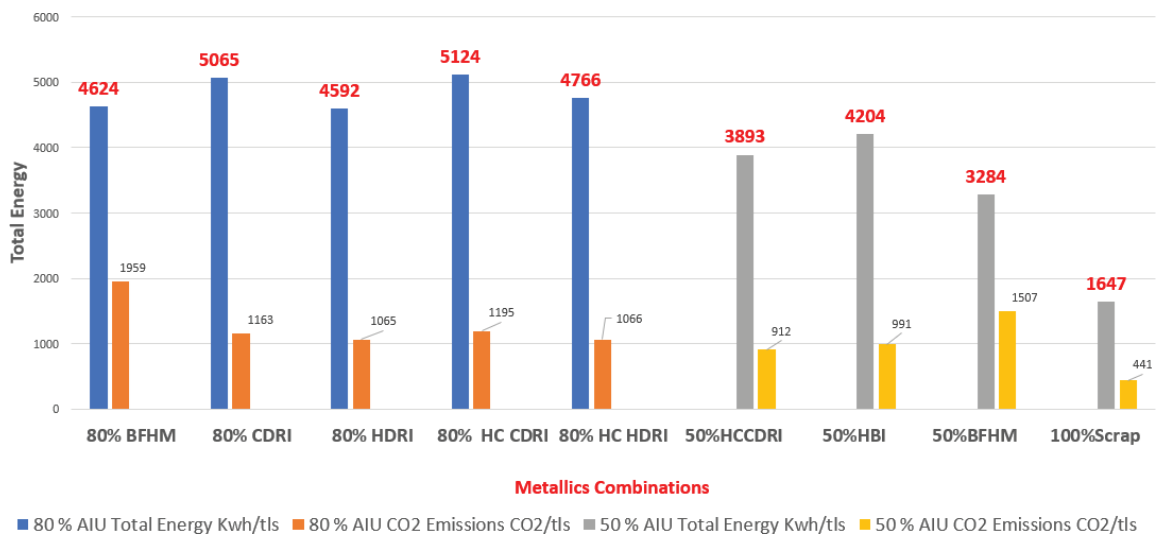


FIG 8-12 IMPACT OF METALLICS ON ENERGY FOR STEELMAKING AND CO2 EMISSIONS



Chapter 9

STEEL AND ENVIRONMENT

FIG 9 - 1 STEEL INDUSTRY ENVIRONMENTAL CONTROL JOURNEY

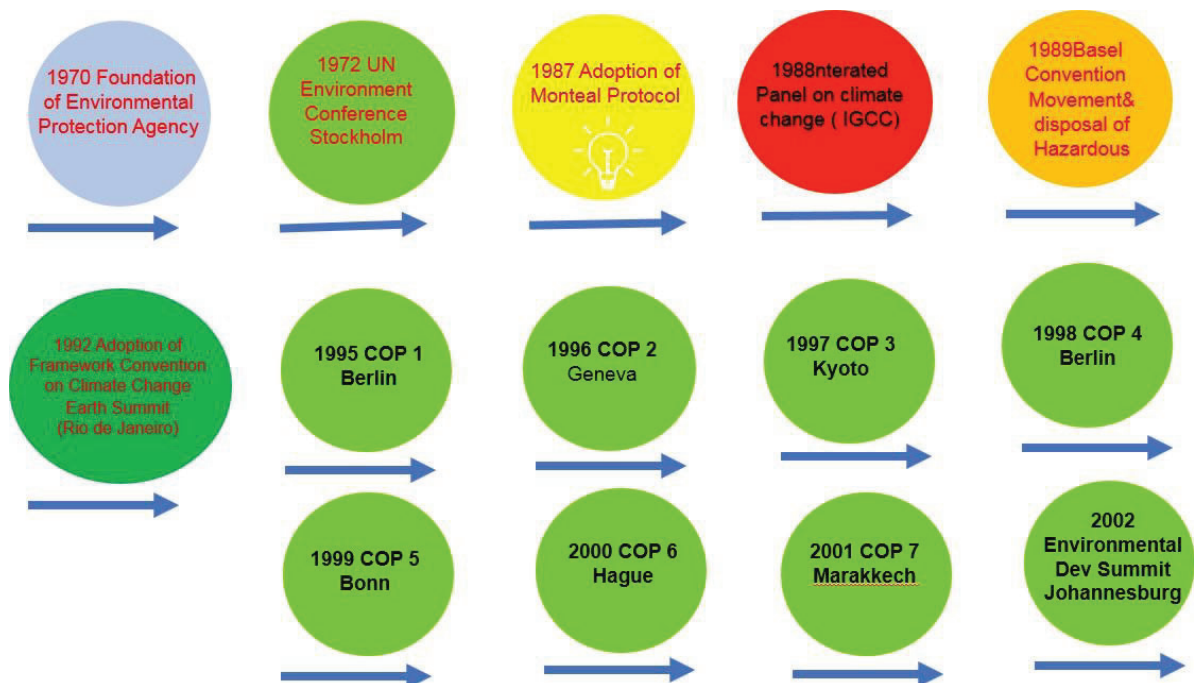


FIGURE 9-2 WASTE ARISINGS IN COKE MAKING

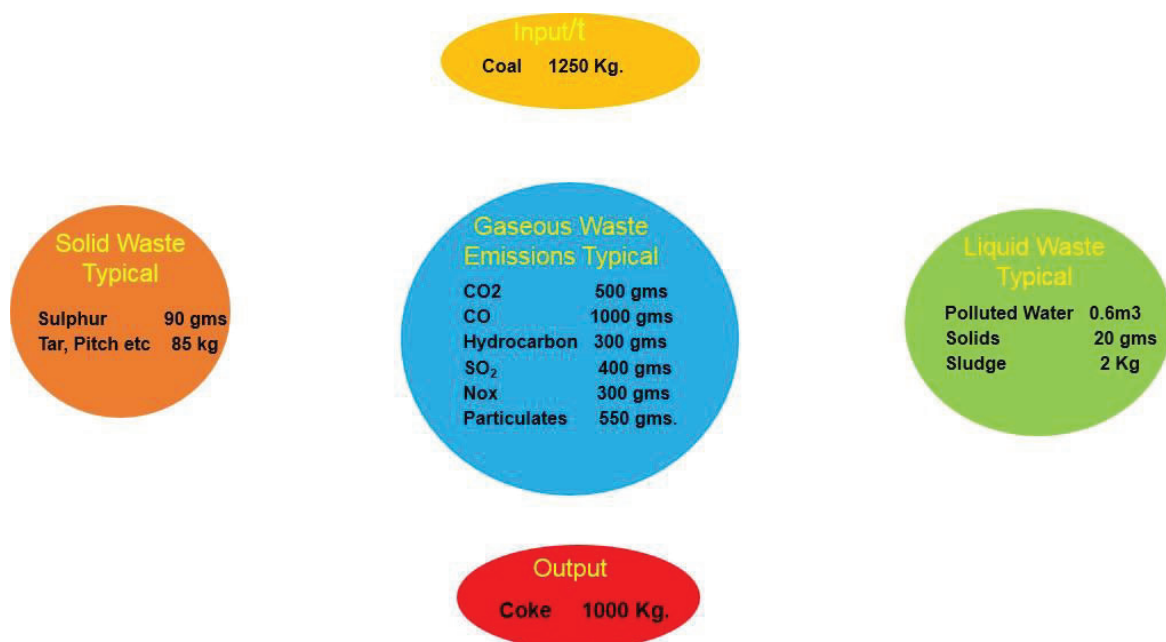


FIGURE 9-3 WASTE ARISING IN SINTERING



FIGURE 9-4 WASTE ARISING IN BF IRONMAKING

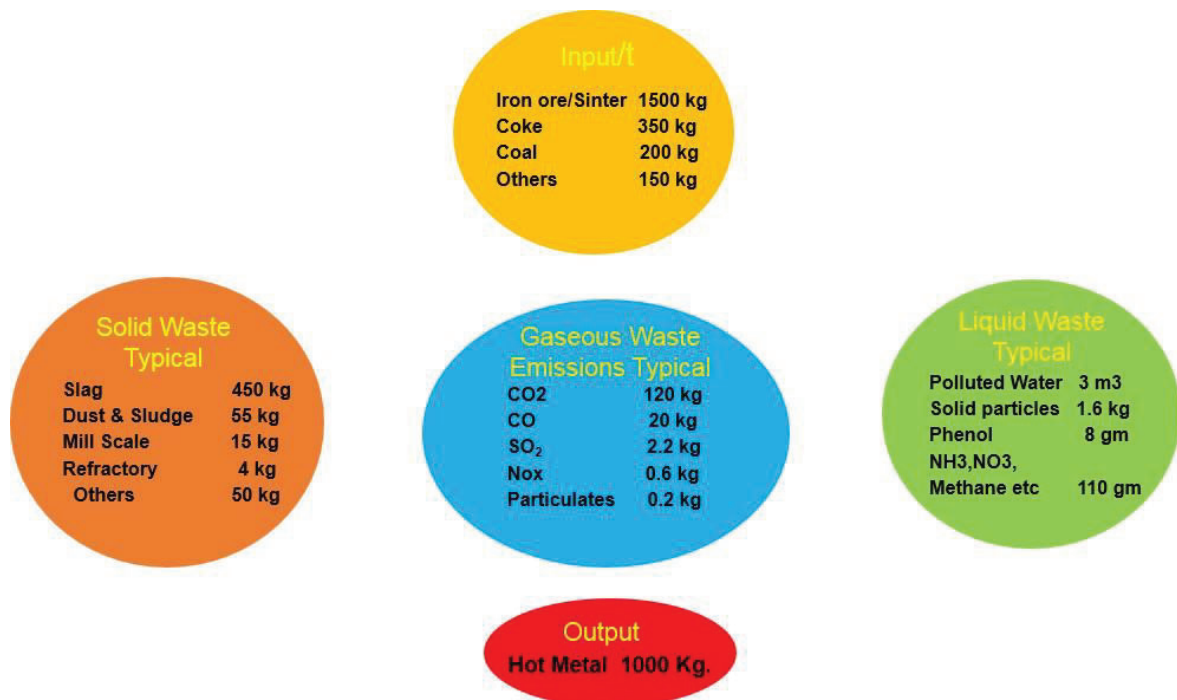


FIGURE 9-5 WASTE ARISING IN BOF STEELMAKING

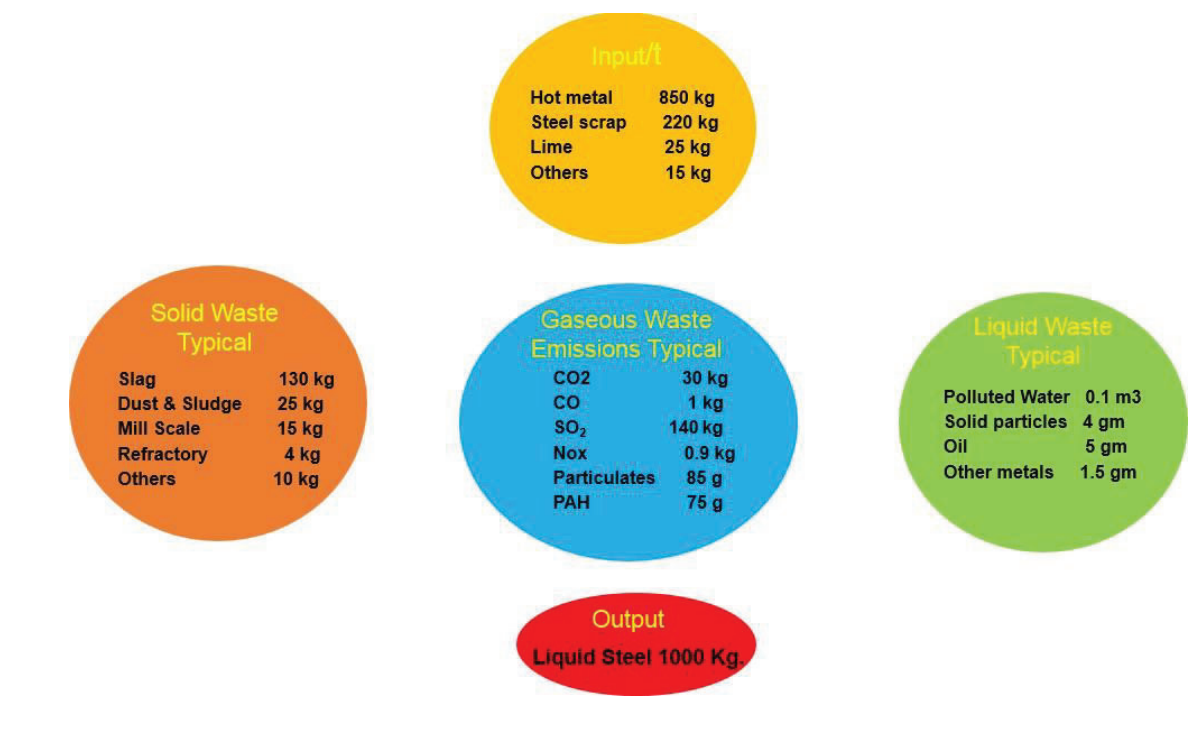


FIGURE 9-6 WASTE ARISING IN EAF STEELMAKING

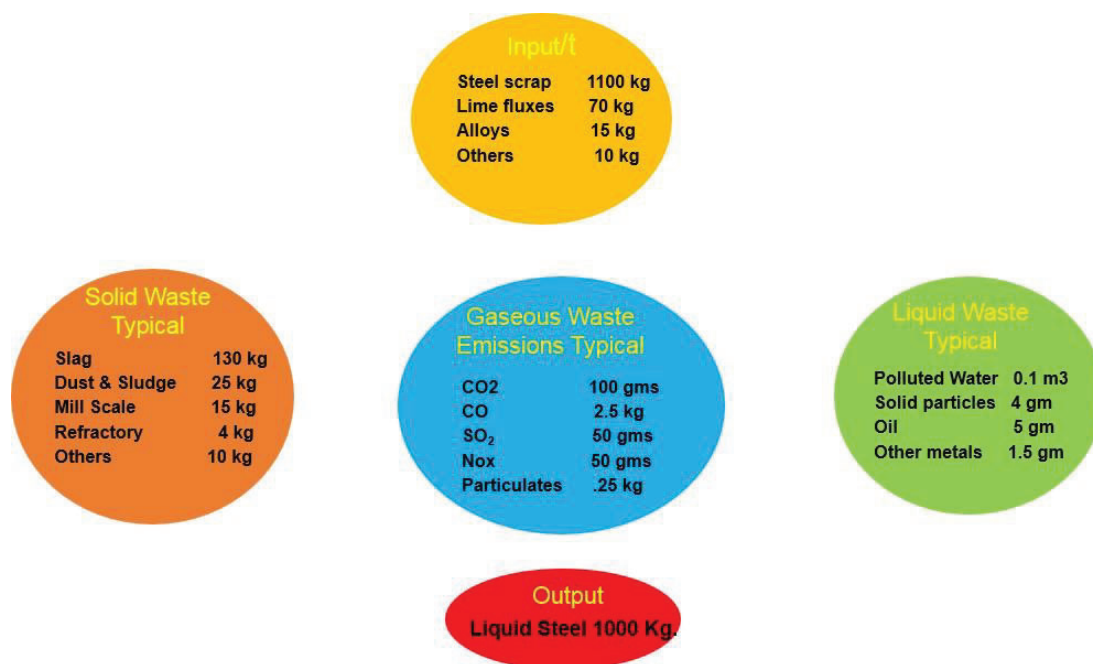


FIGURE 9-7 WASTE ARISING IN STEEL PROCESSING

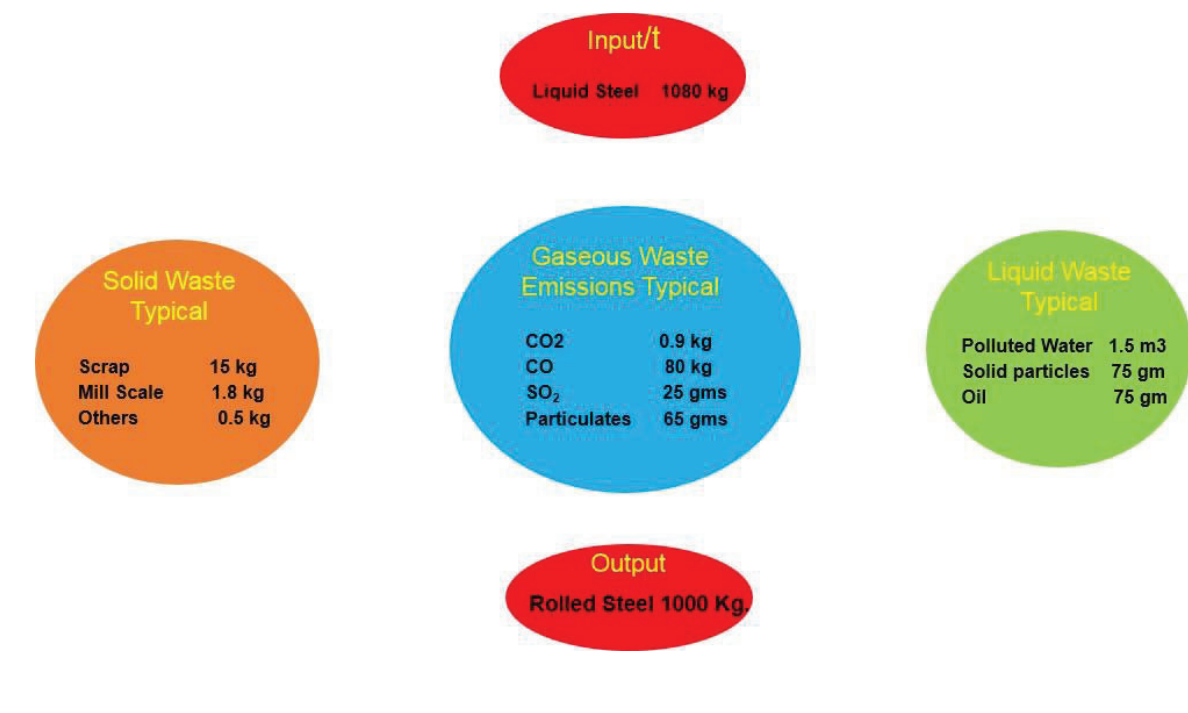


FIG 9-8 WASTE ARISING IN INTEGRATED STEEL PRODUCTION

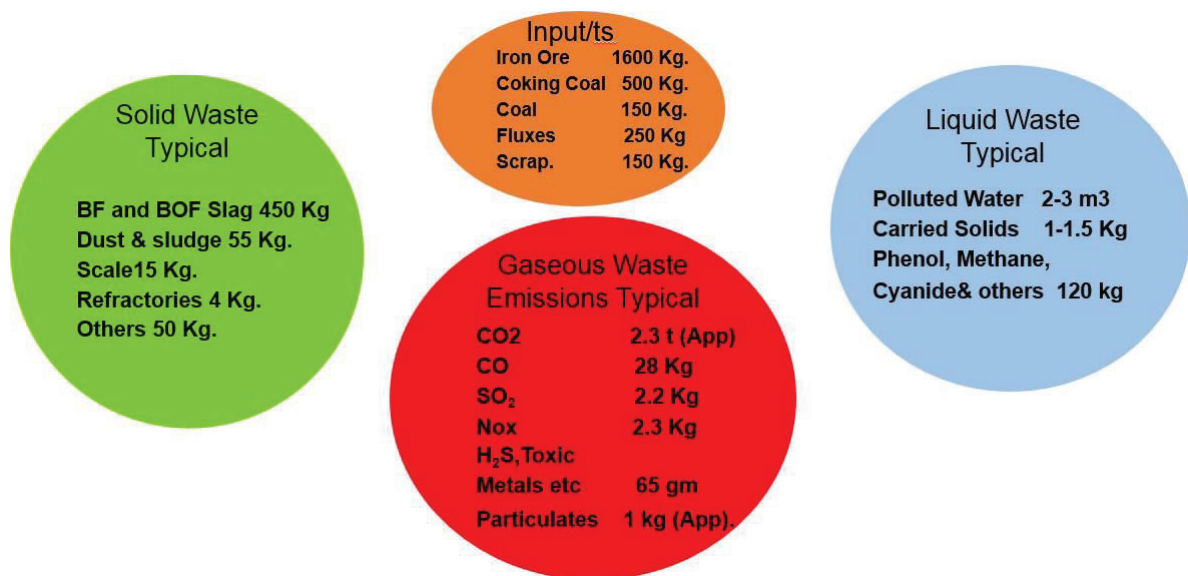


FIG 9-9 WASTE ARISING IN EAF BASED STEEL PRODUCTION

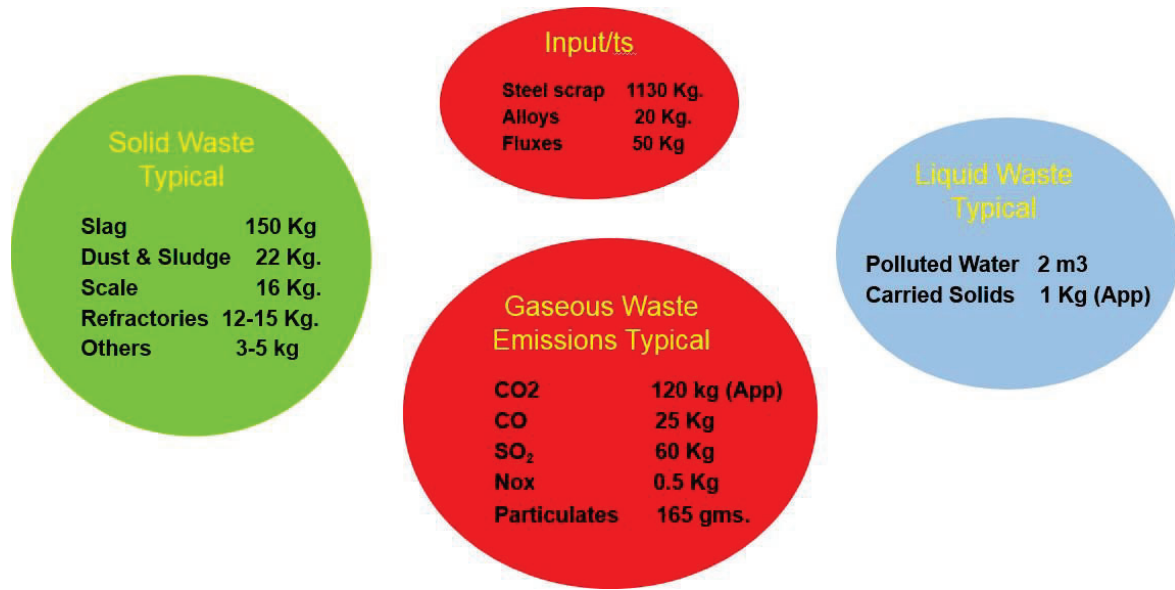


FIG 9-10 CO₂ EMISSION'S SHARE IN BF-BOF ROUTE %

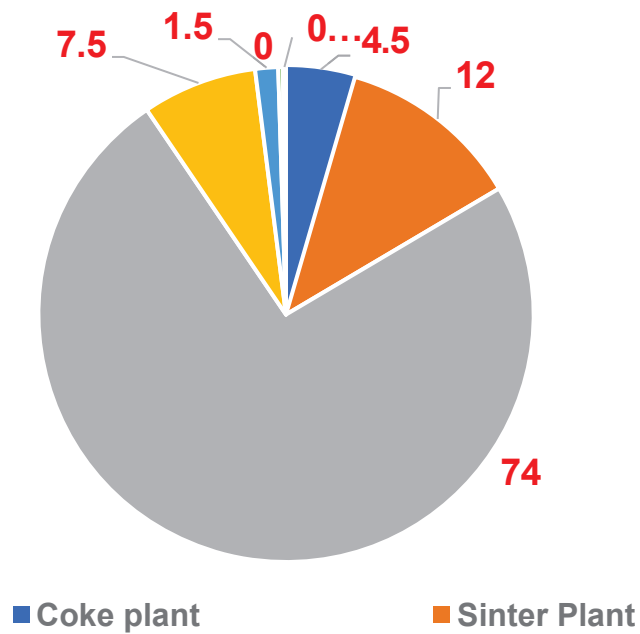
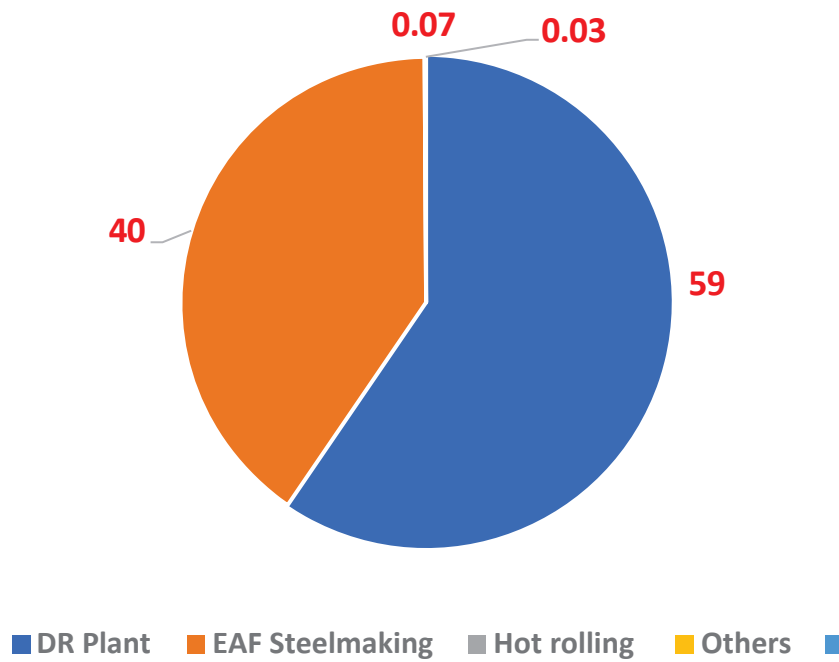


FIG 9-11 CO2 EMISSION'S SHARE IN DRI-EAF ROUTE %



**FIG 9-12 CO2 Impact Steel VS Competing materials
(Comparison for Same Auto Component)**

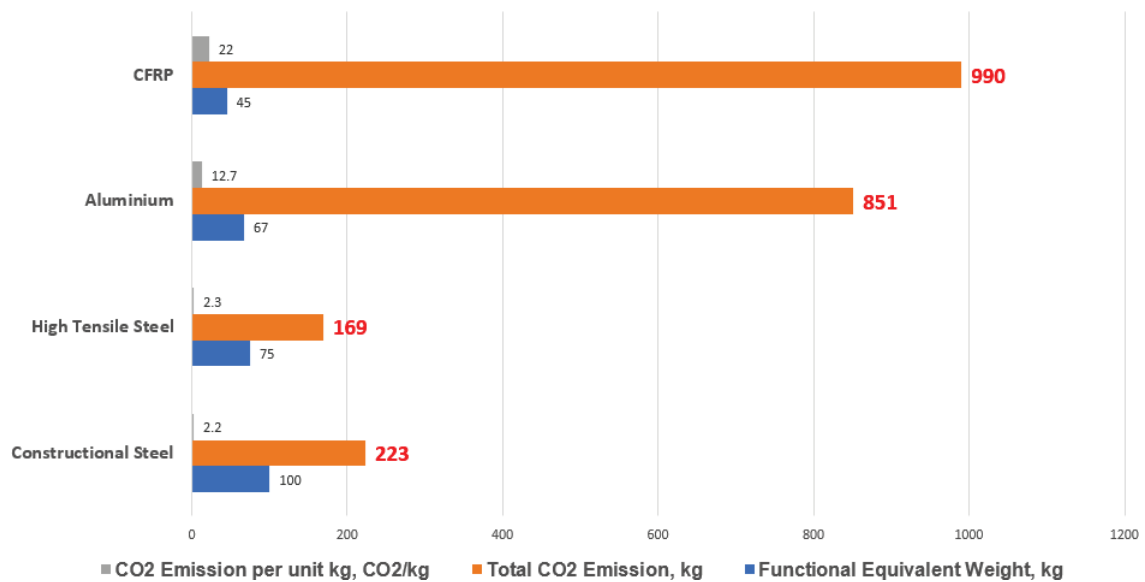


FIGURE 9-13 PROCESS DEVELOPMENTS AND ENV IMPACTS

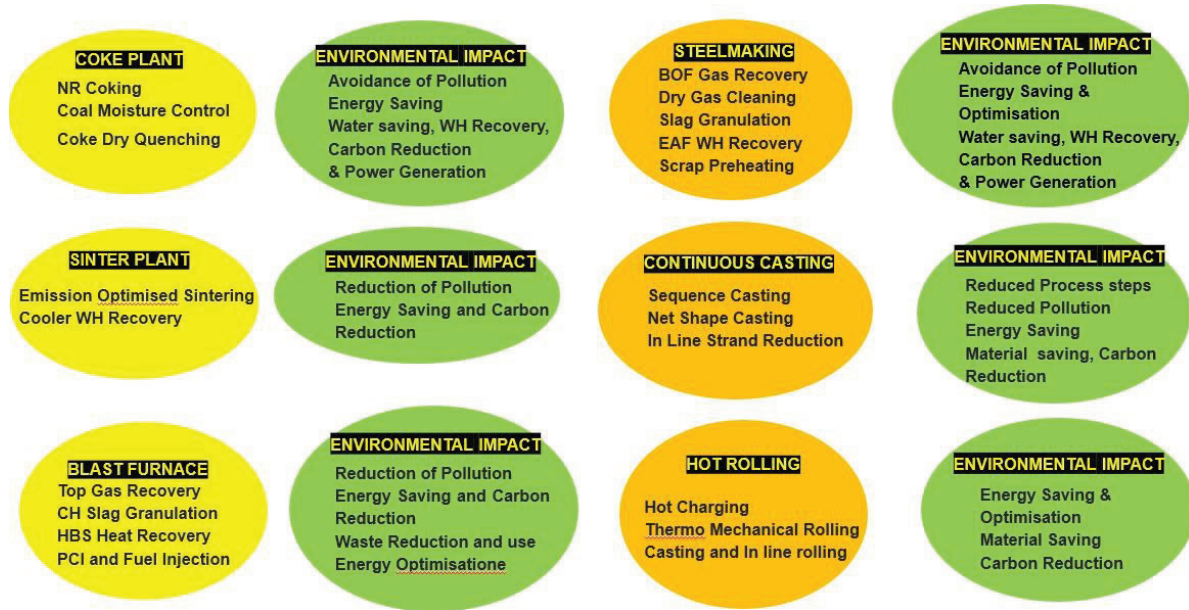


Fig 9-14 STEEL INDUSTRY ENERGY & MATERIAL RECYCLING INITIATIVES

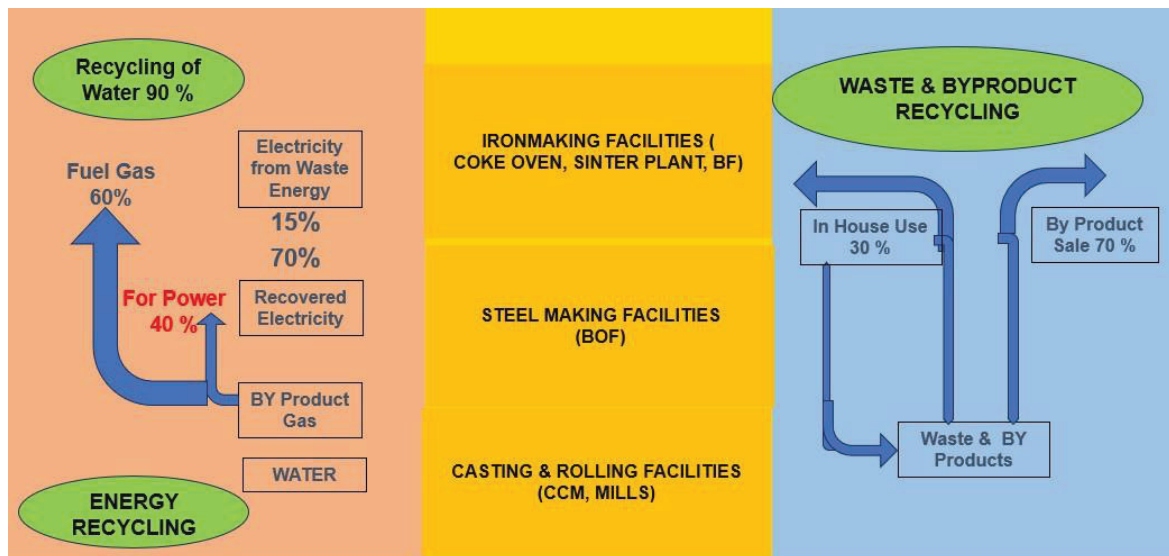


FIGURE 9-15 ECO PRODUCTS AND ENV IMPACTS



FIG 9- 16 WASTE AND BYPRODUCT RECYCLING LEVELS

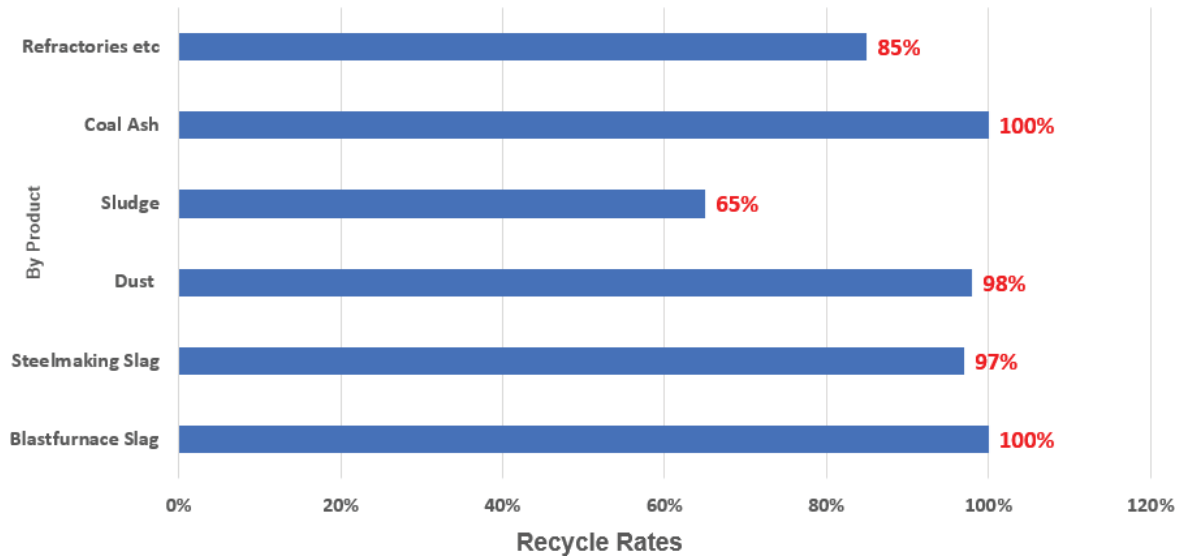
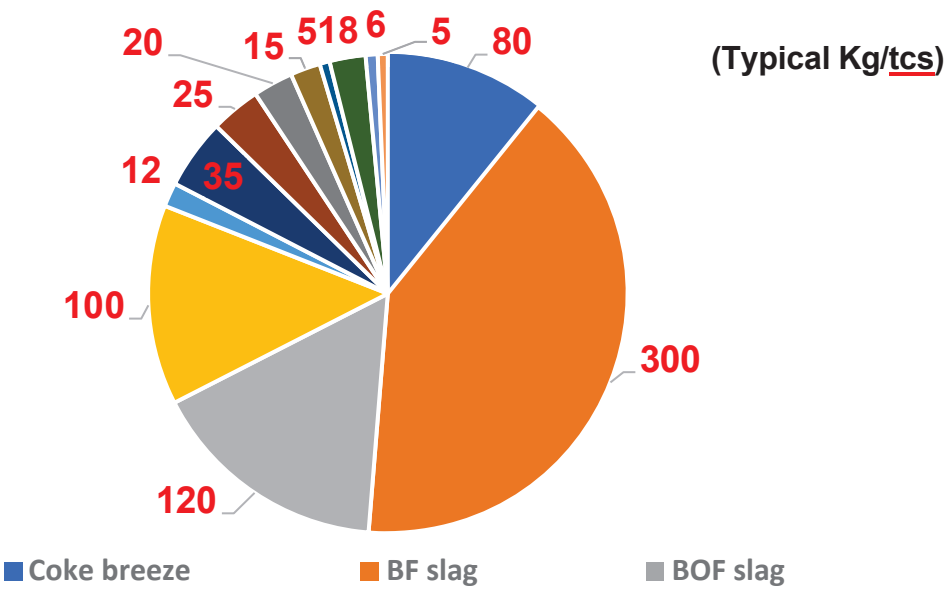


FIG 9-17 SOLID WASTES GENERATED IN STEELMAKING



Chapter 10

EMERGING TECHNOLOGIES

FIGURE 10-1 PROMISING HOT METAL TECHNOLOGIES

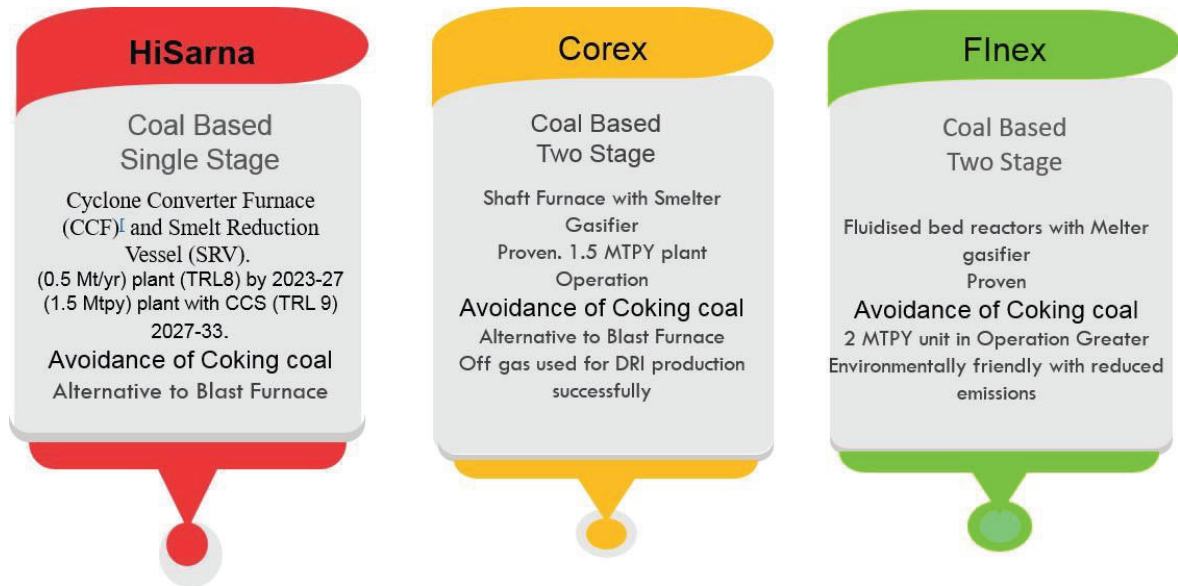


FIGURE 10-2 PROMISING DR TECHNOLOGIES

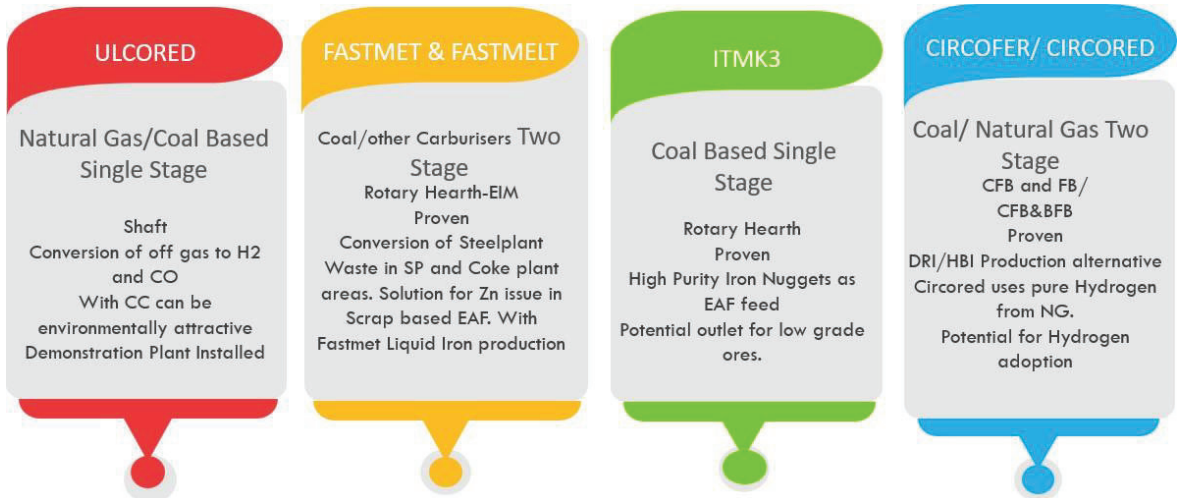


FIG 10- 3 EMERGING TECHNOLOGIES TRL STATUS INDICATIVE (2020-2050)

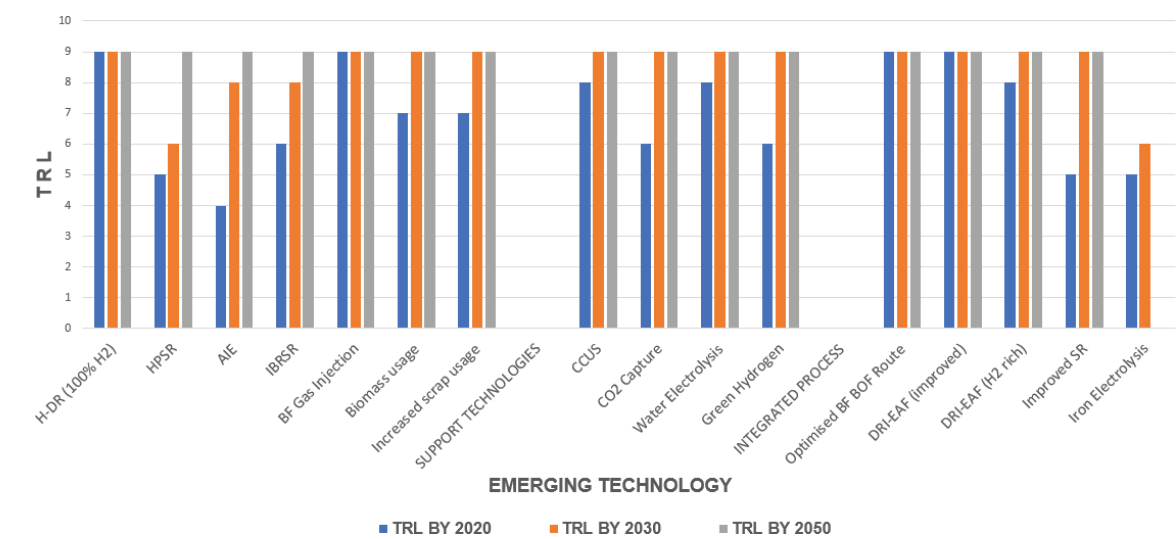


FIG 10 - 4 HYBRIT vs BF ENERGY CONSUMPTION



FIG 10-5 EMERGING TECHNOLOGIES PROJECTS IN STEEL INDUSTRY

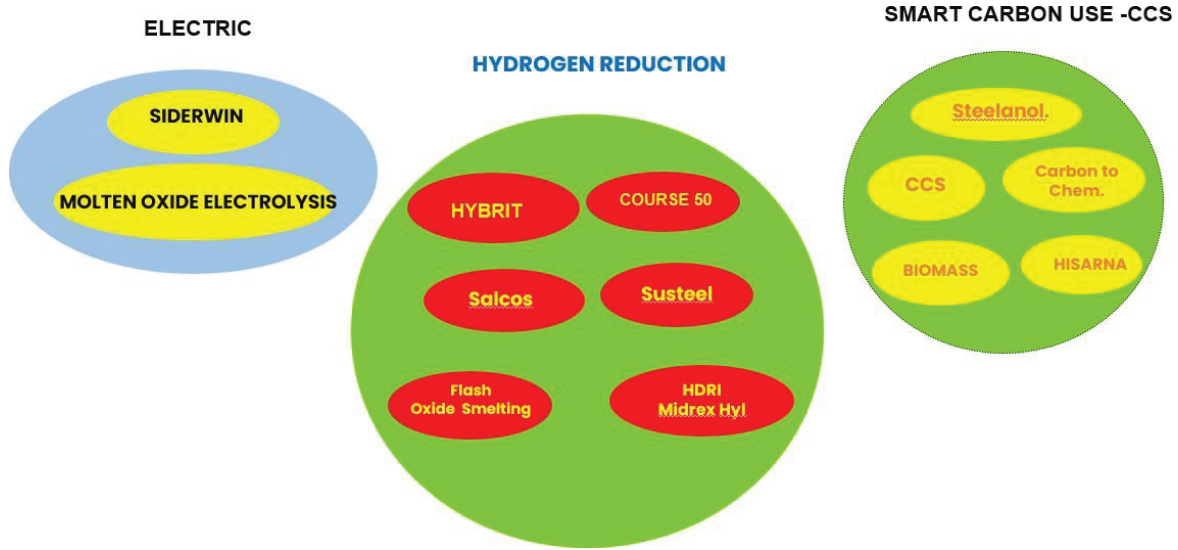
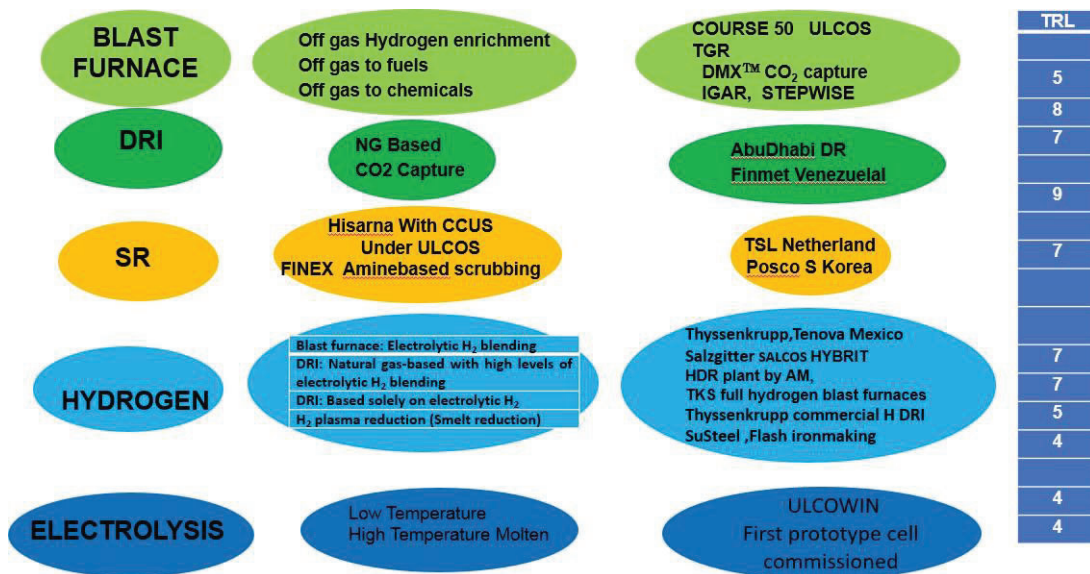


FIGURE 10-6 CURRENT STATUS OF VARIOUS OPTIONS



Chapter 11

DECARBONISATION AND INDIAN STEEL INDUSTRY

FIGURE 11-1 INDUSTRY ACTIONS ON CLIMATE IMPACT REDUCTION

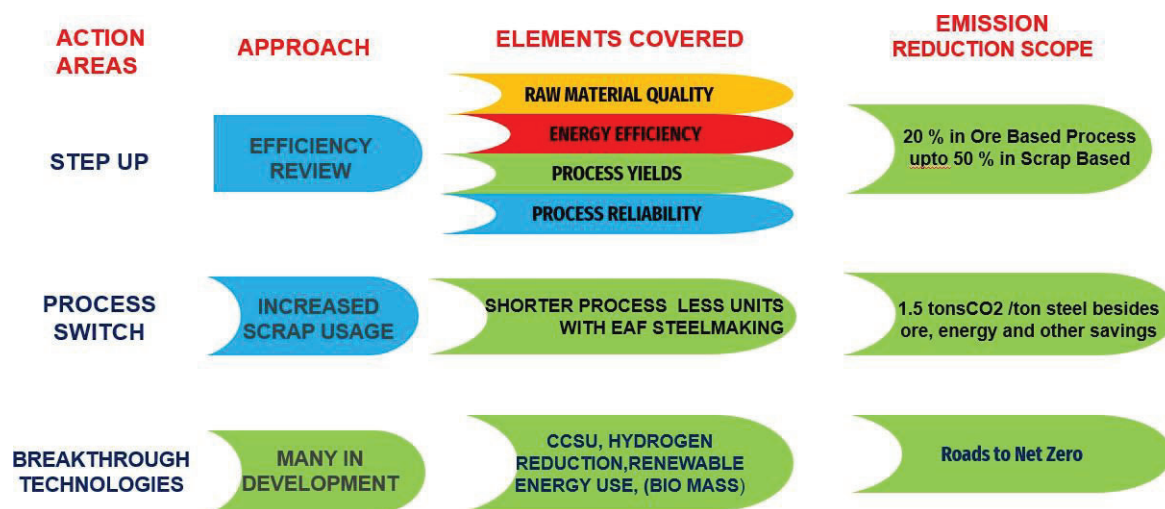


FIGURE 11-2 TREND IN ENERGY USE IN STEEL PRODUCTION

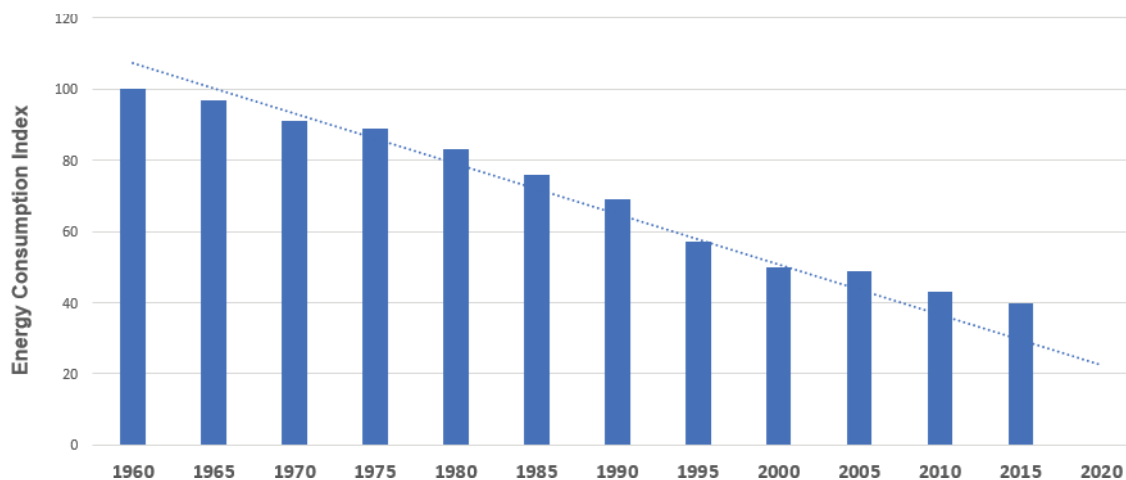


FIGURE 11-3 CO₂ EMISSION TREND IN STEELMAKING

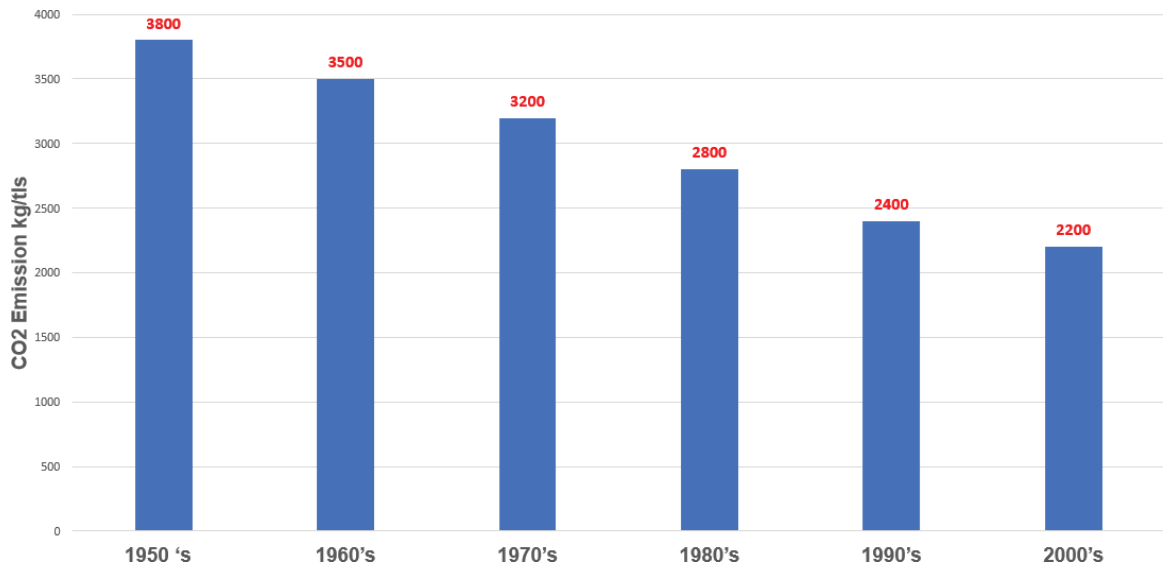


FIGURE 11-4 CO₂ Emissions in BF-BOF ROUTE %

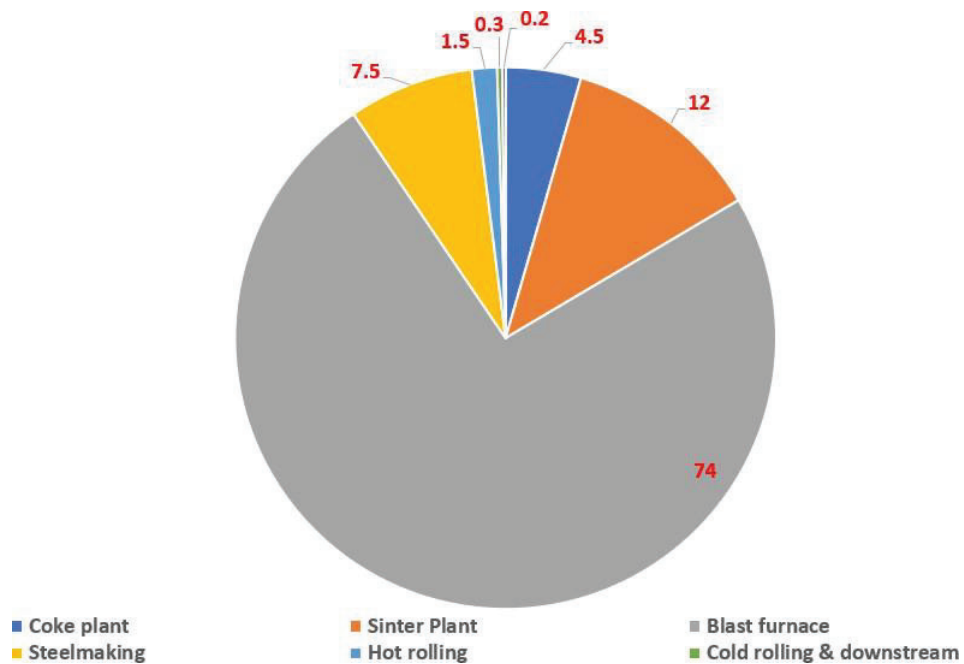


FIGURE 11-5 PROCESS ROUTE/METALLICS WISE CO2 Typical kg/t steel

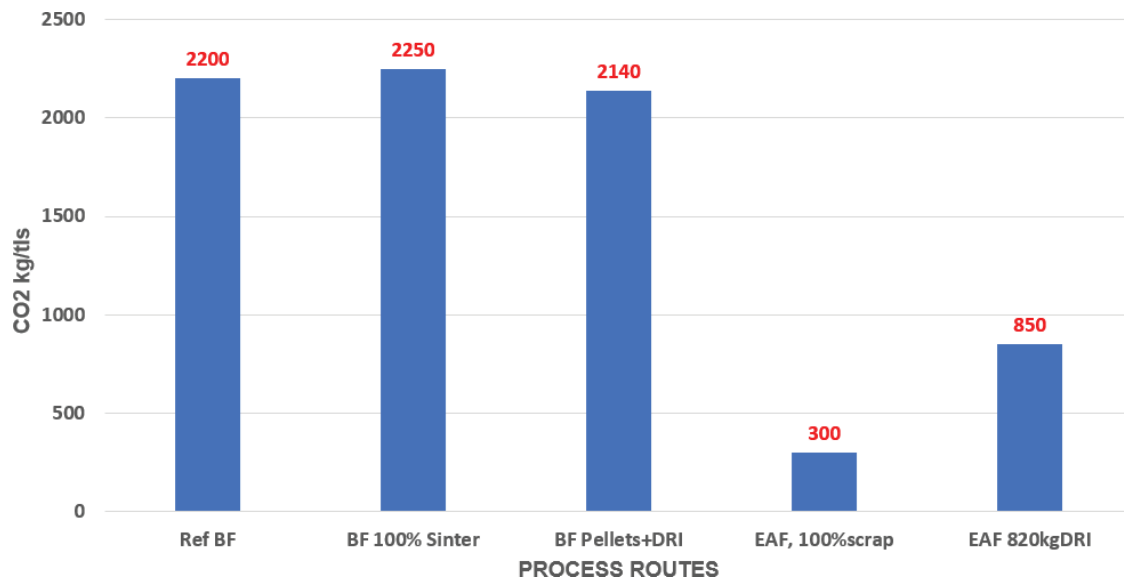


FIGURE 11-6 IMPACT OF NNC-INLINE ROLLING ON ENERGY USE

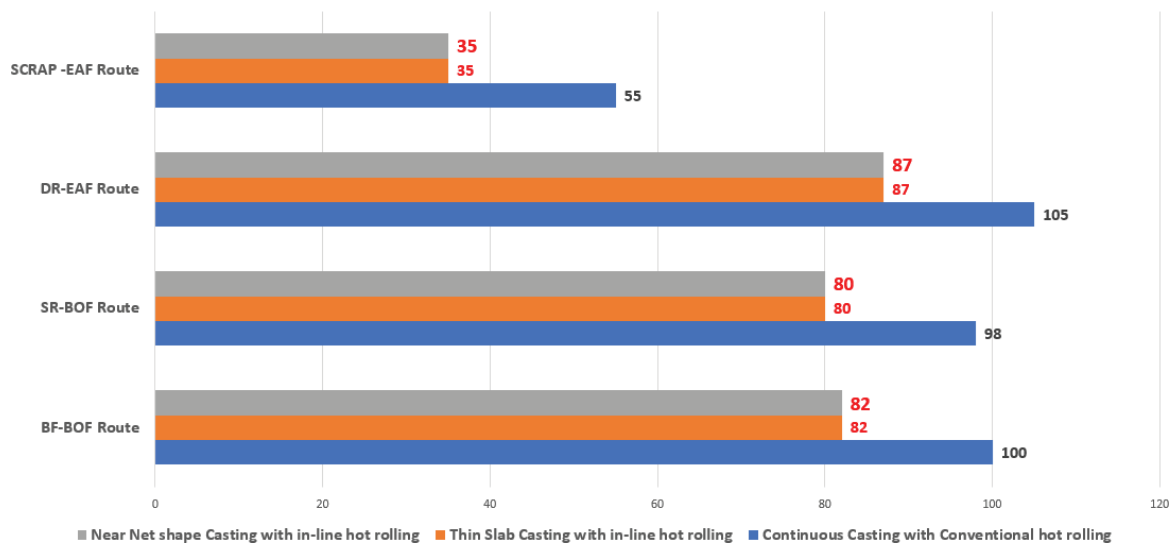


FIGURE 11-7 IMPACT OF NNC_INLINE ROLLING ON CO2 EMISSIONS

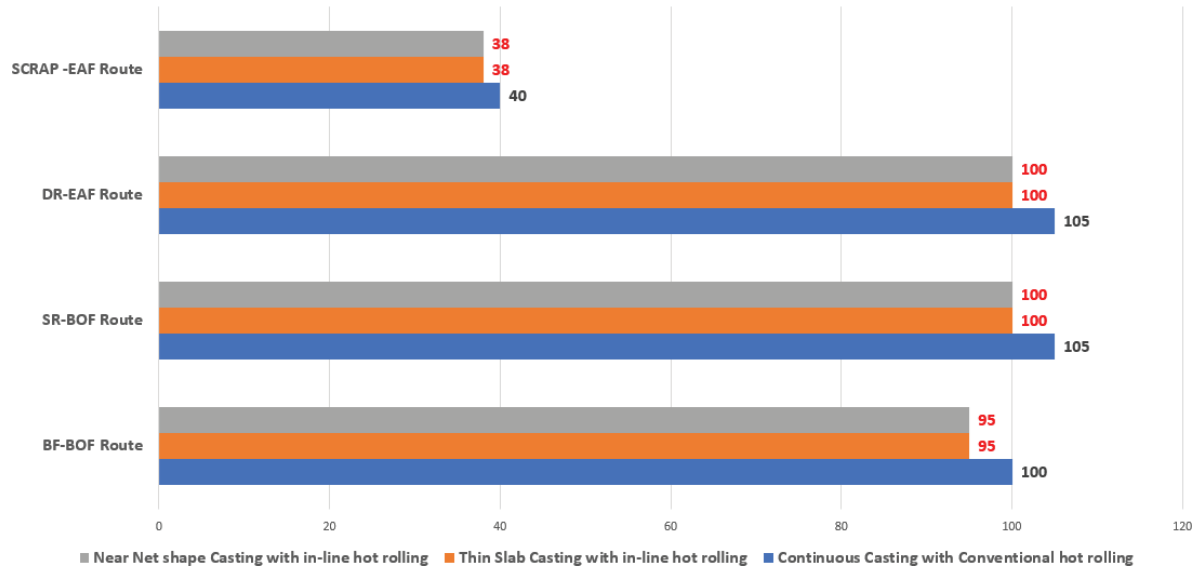


FIGURE 11- 8 CCU (CARBON CAPTURE AND UTILIZATION): CO2 RECYCLING

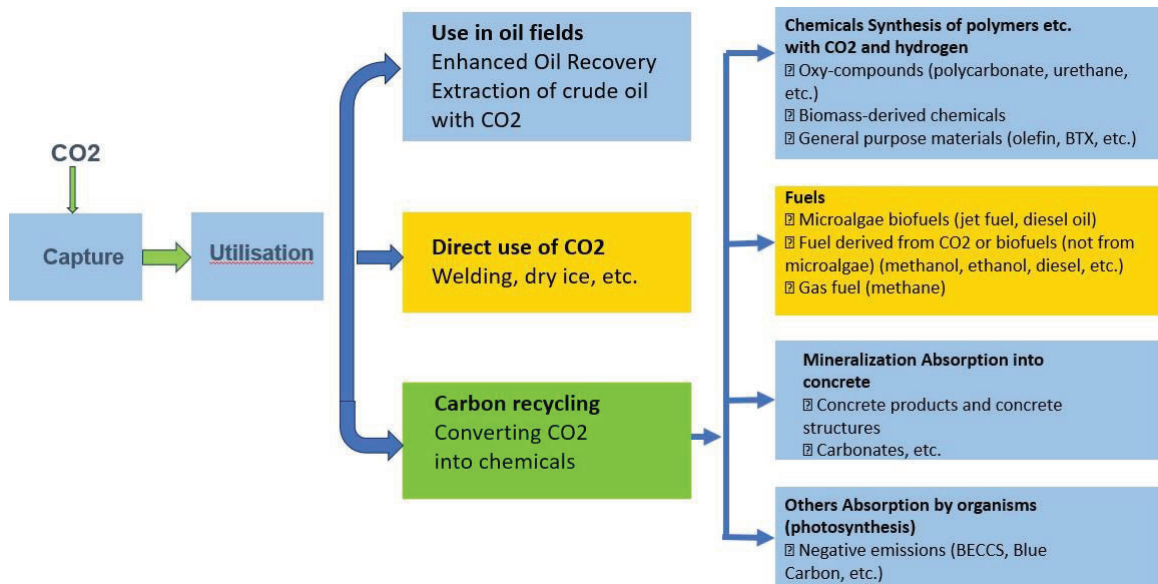


FIGURE 11-9 TECHNOLOGY PATHWAYS FOR CARBON REDUCTION IN STEEL INDUSTRY

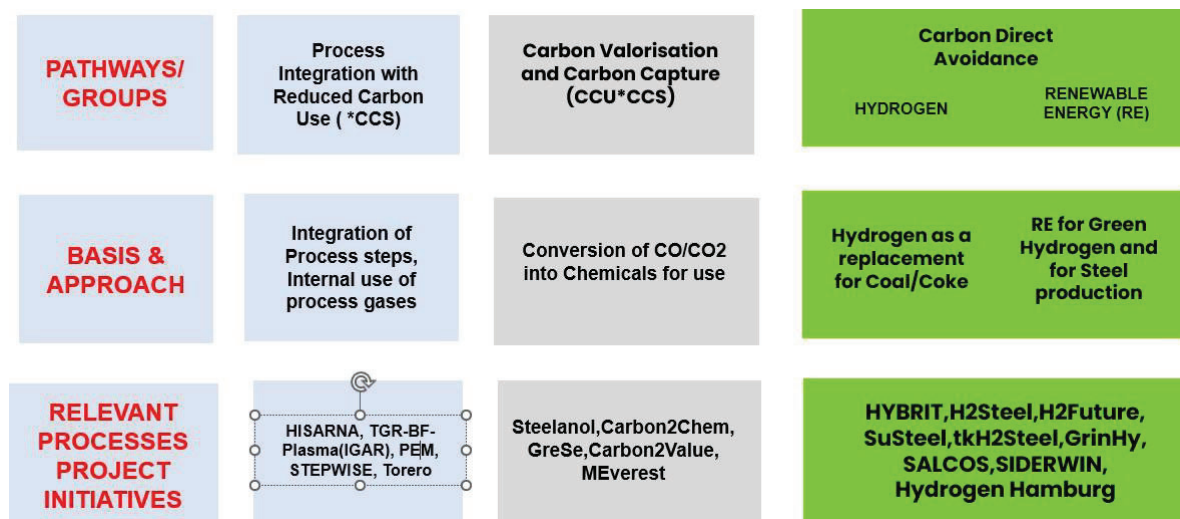


FIGURE 11-10 DECARBONISATION PROJECTS IN STEEL INDUSTRY

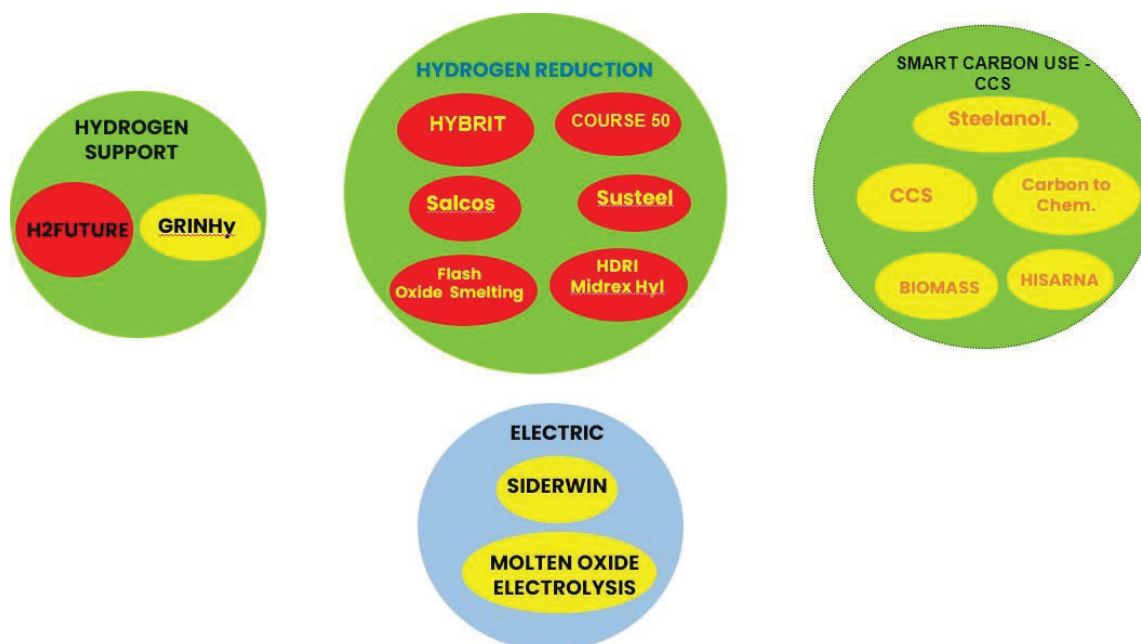


FIGURE 11- 11 STEEL NET-ZERO ACTIONS & TECHNOLOGY STATUS

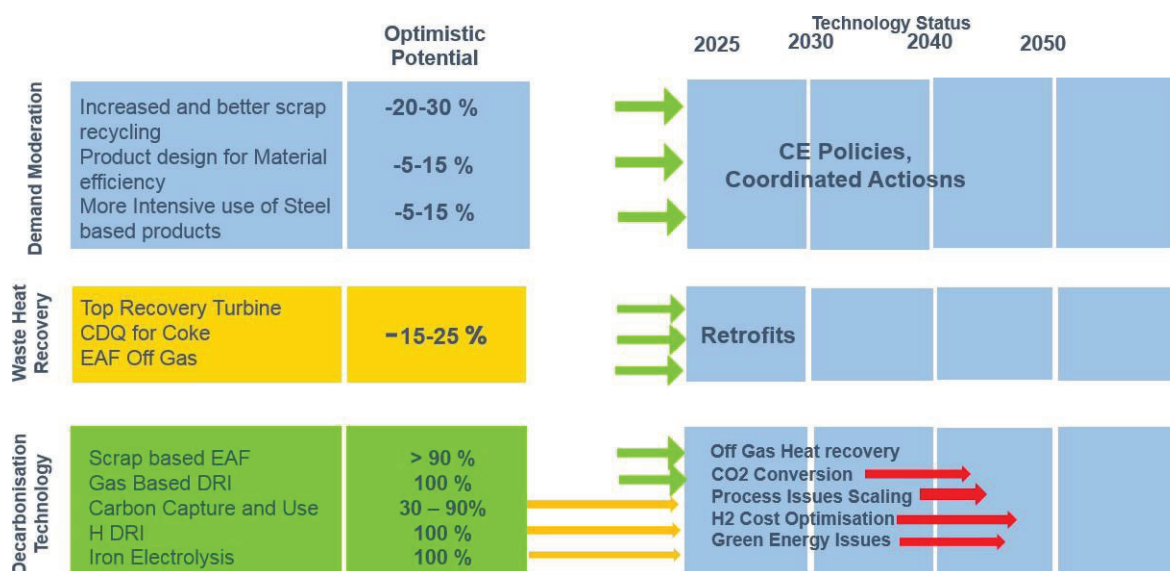


FIGURE 11- 12 AVENUES FOR DECARBONISATION INDIAN CONTEXT

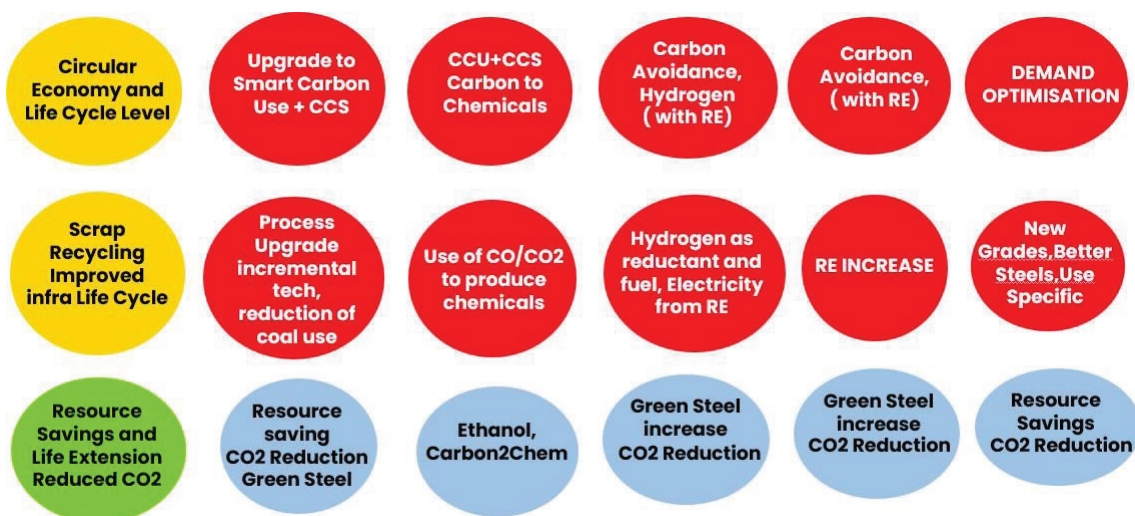


FIGURE 11- 13 INDIAN STEEL DECARBONISATION INTEGRATED APPROACH

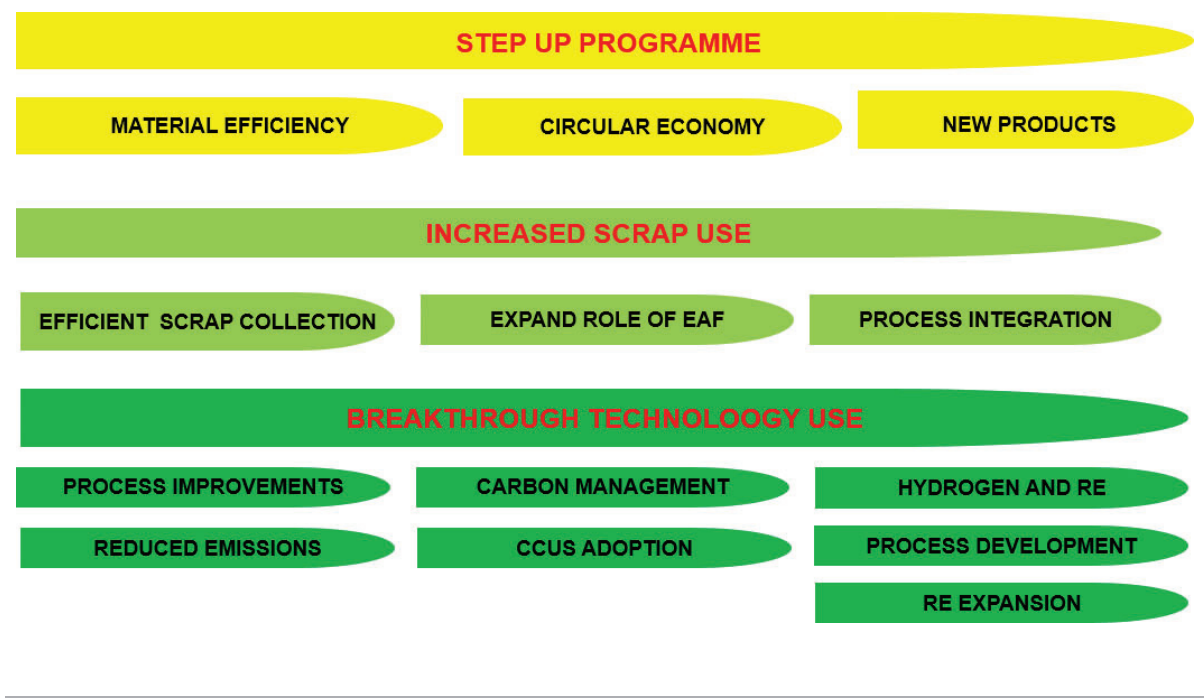


FIGURE 11-14 POTENTIAL EOL SCRAP AVAILABILITY BY 2050

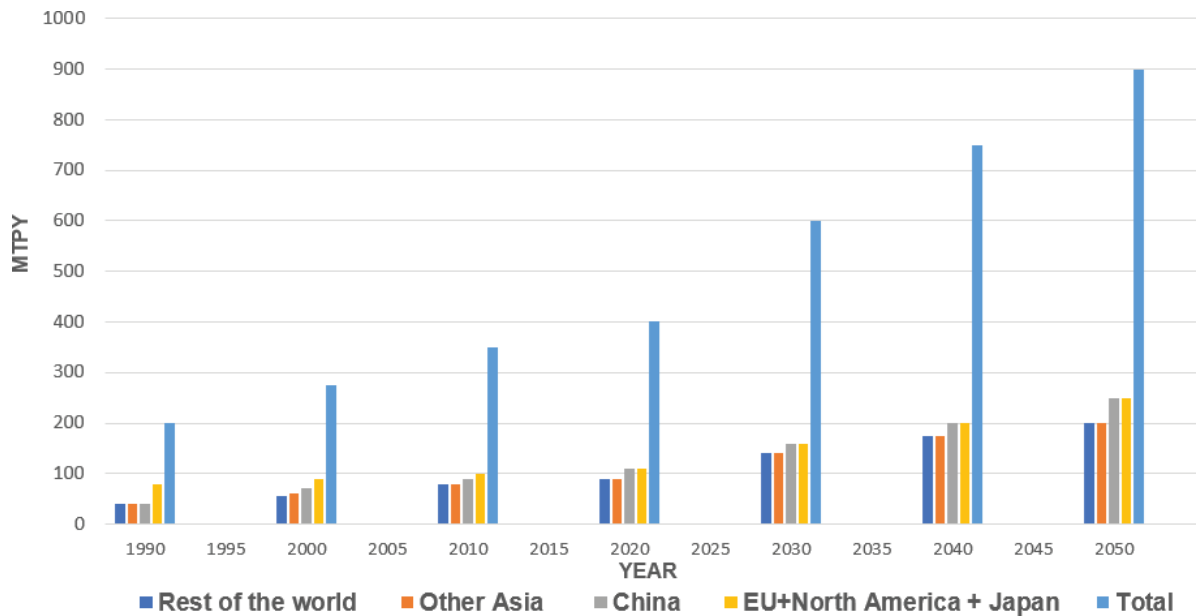


FIGURE 11-15 IMPACT OF CIRCULARITY ON STEEL DEMAND AND PROCESS SHARE (%)

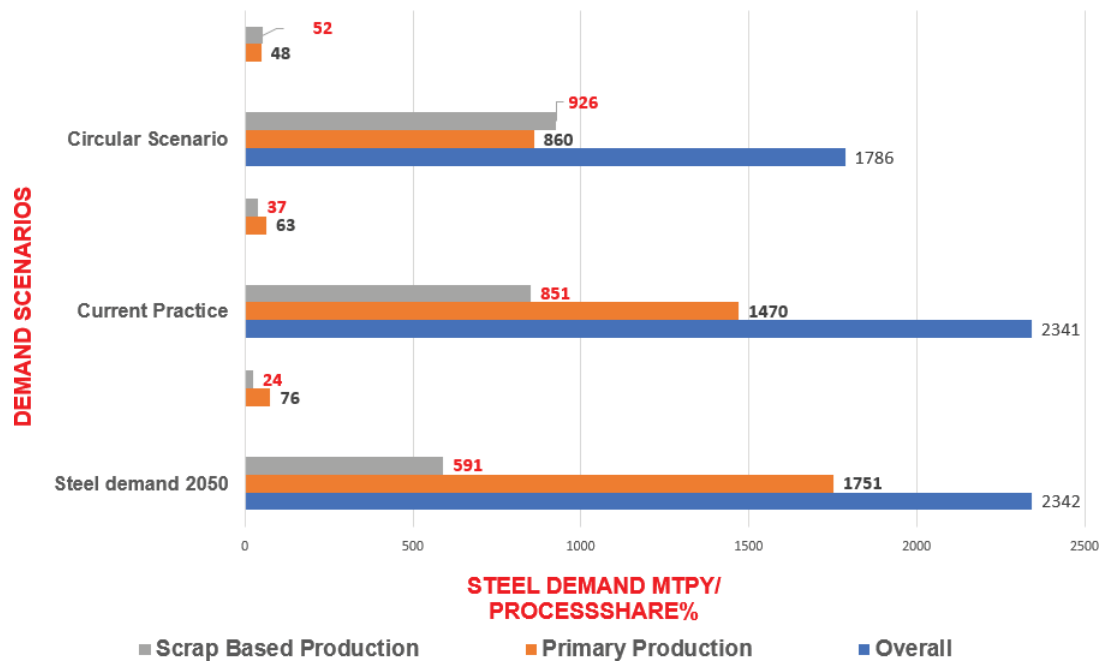


FIGURE 11-16 CONCURRENT PATHWAYS FOR CARBON REDUCTION INDIAN CONTEXT

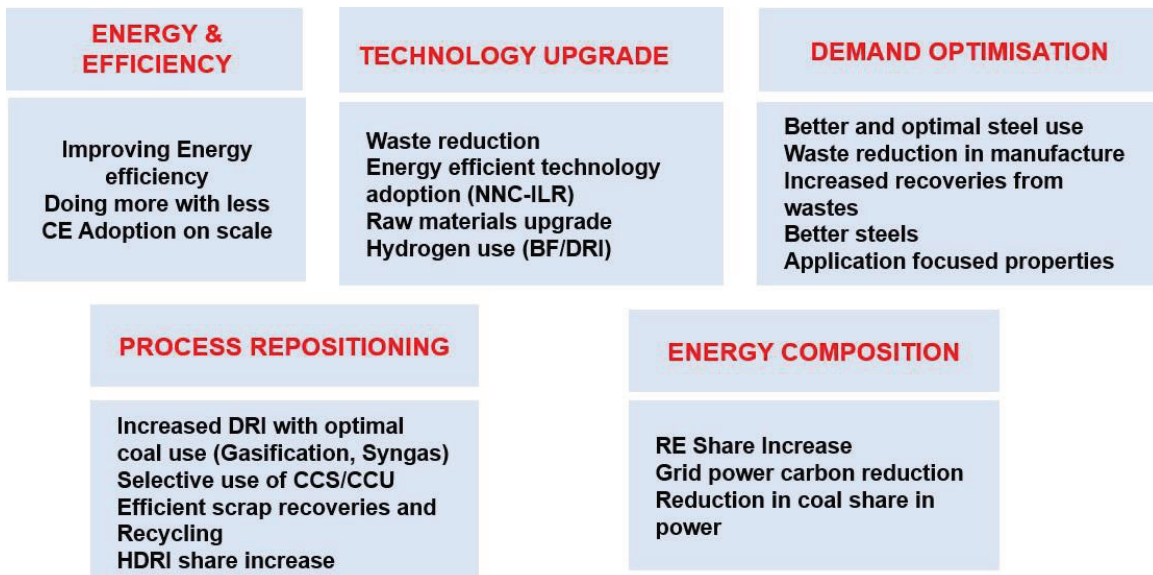


FIGURE 11- 17 GLOBAL STEEL PROCESS SHARES AS PER IEA SDS

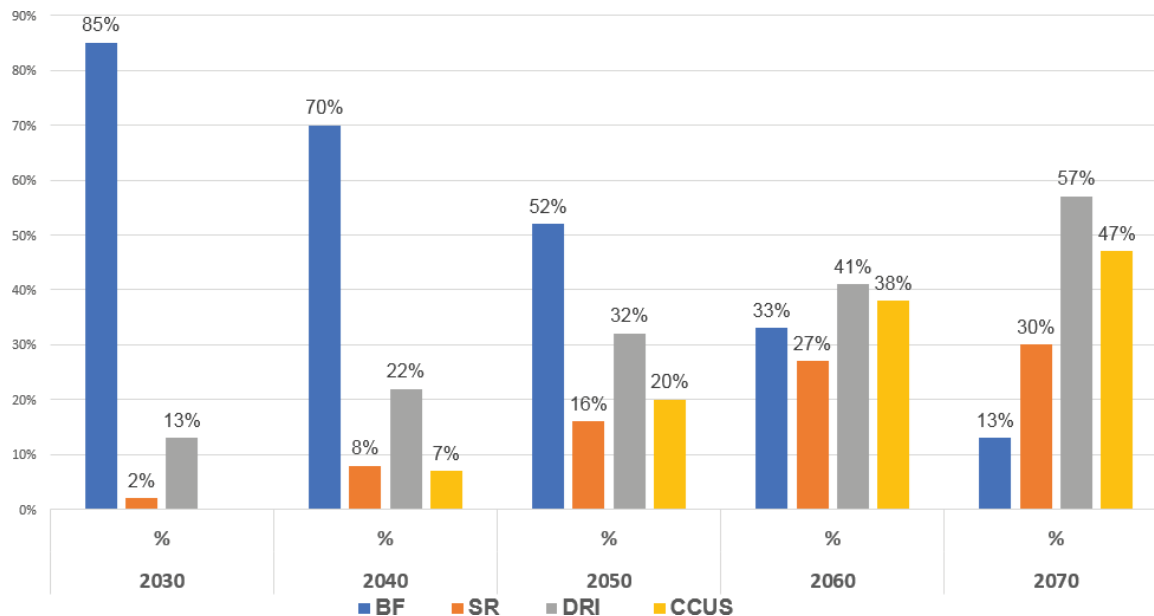


FIGURE 11- 18 SUSTAINABLE CARBON TARGETS AS PER IEA SDS

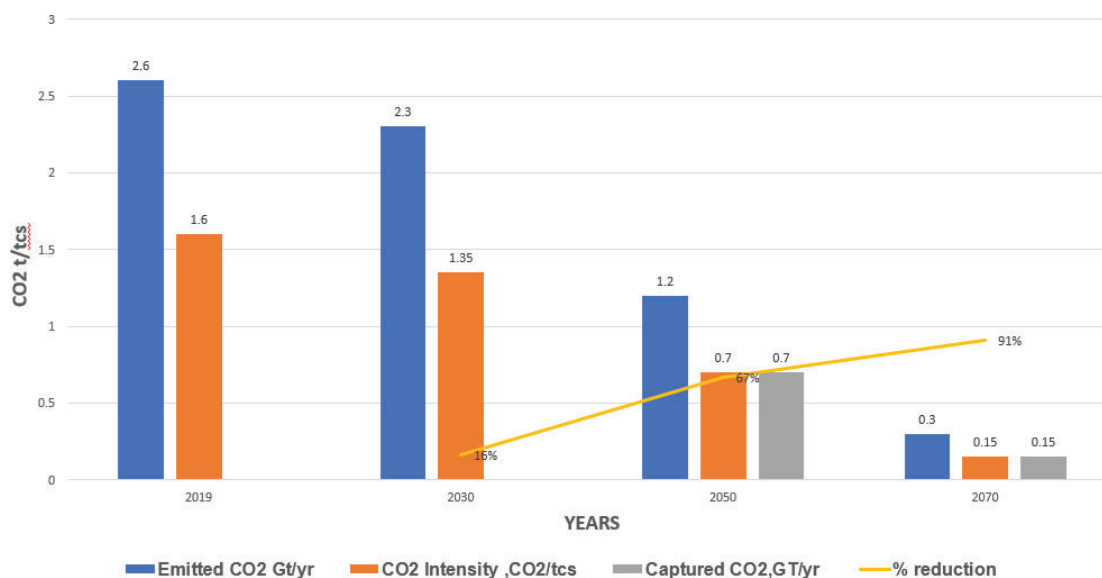


FIGURE 11-19 INDIAN STEEL PROCESS ROUTE TRANSITION (MTPY)

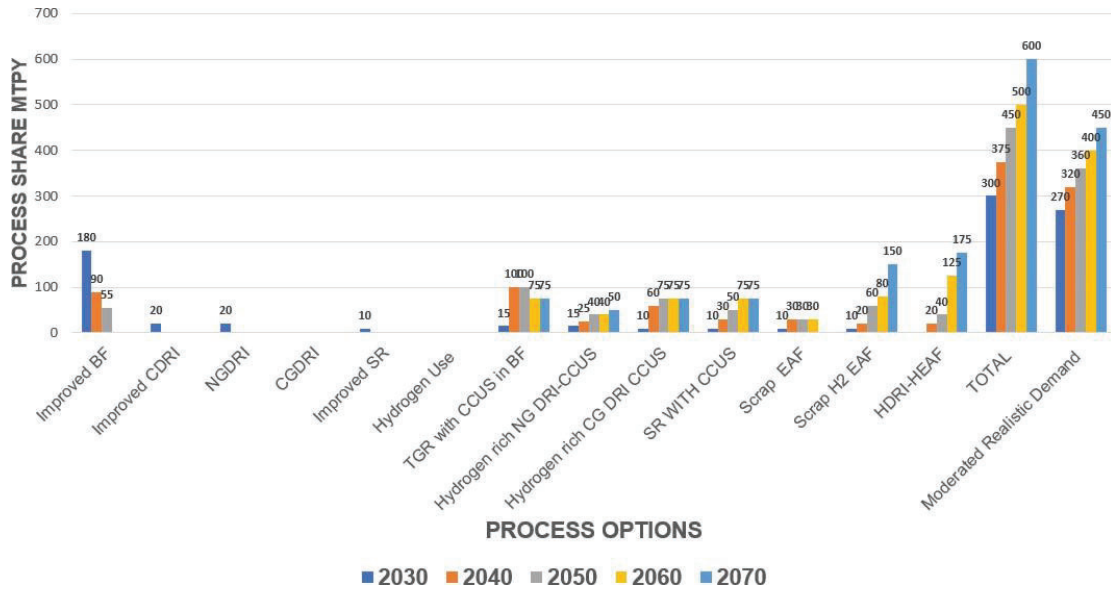


FIGURE 11-20 PROCESS ROUTE TRANSITION & GROSS CO₂ (MTPY) INDIA SCENE

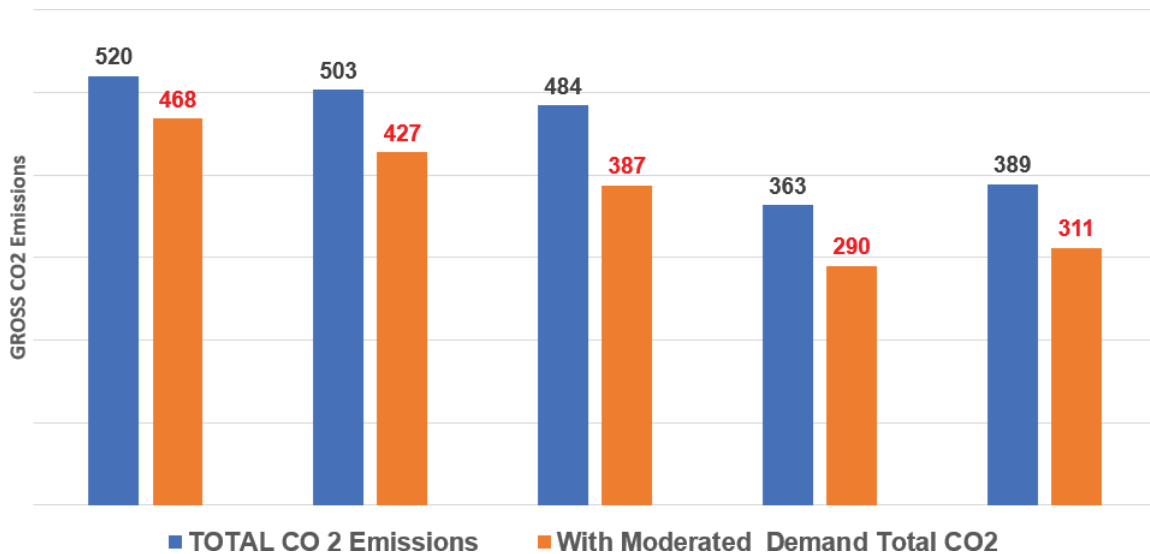


FIGURE 11-21 INDIA PROCESS ROUTE TRANSITION & CO2 INTENSITY (tCO2/tcs)

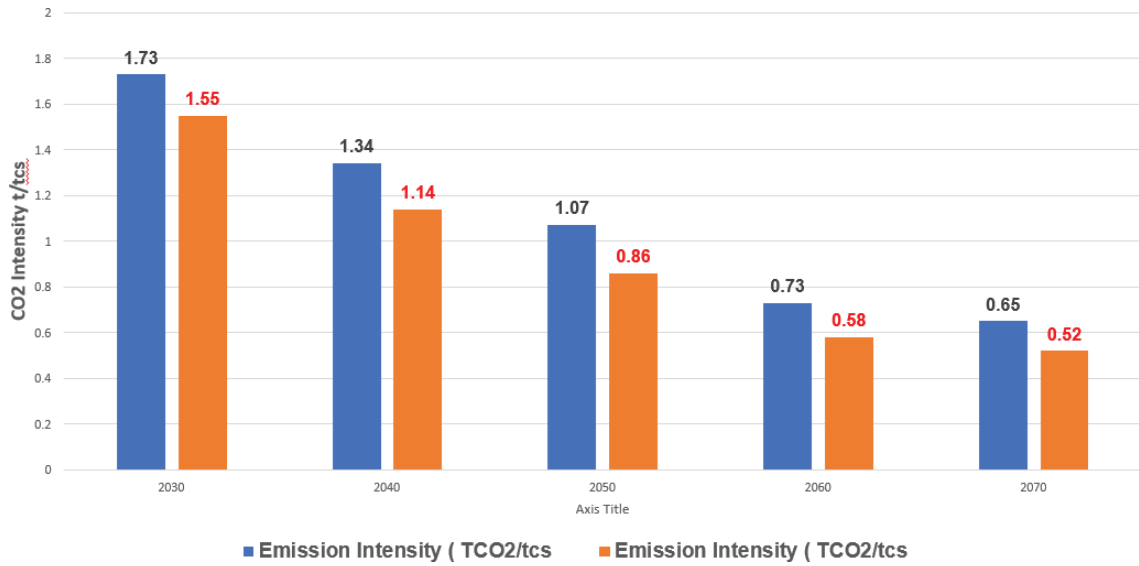


FIGURE 11-22 INDIA PROCESS SHARES(%) AS PER PROPOSED TRANSITION

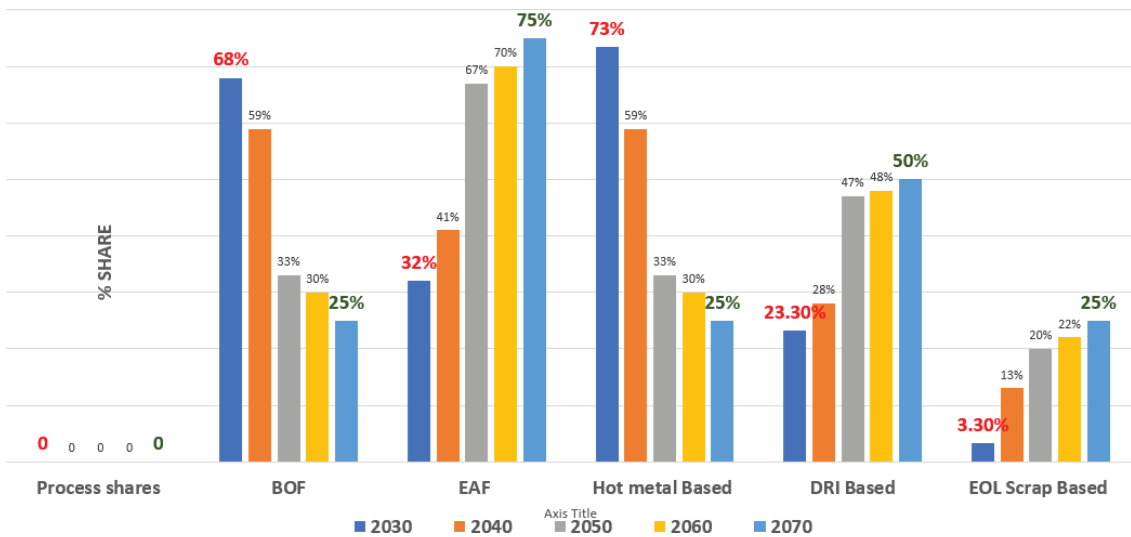
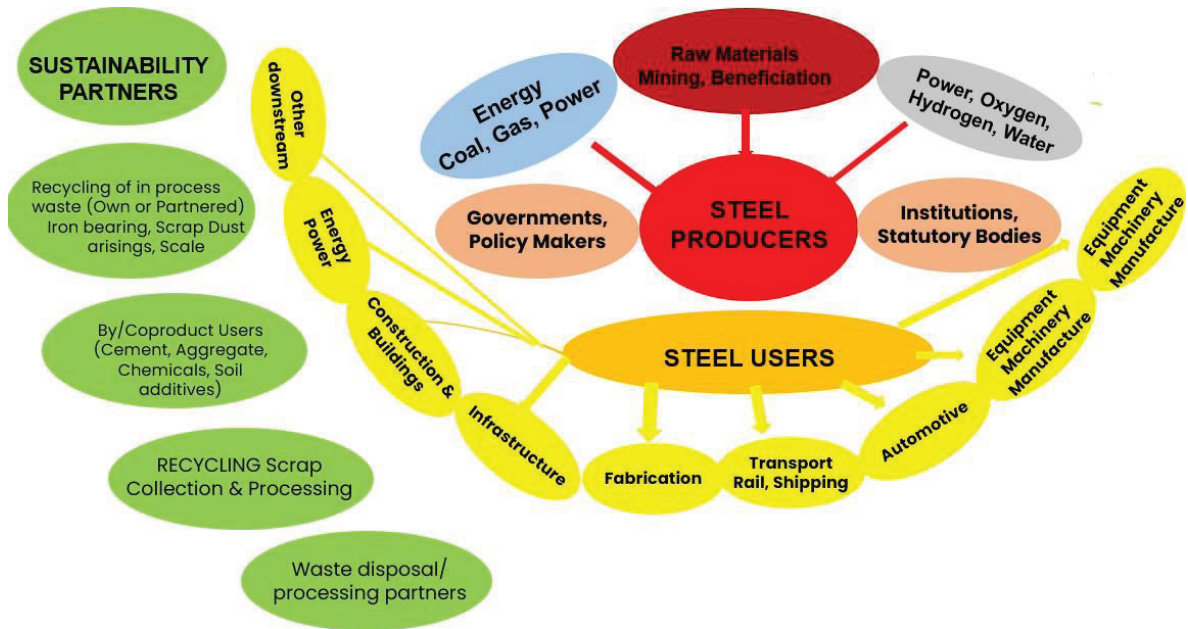


FIGURE 11- 23 STEEL INDUSTRY STAKE HOLDERS



Chapter 12

SUSTAINABLE STEELPLANTS- INDIA CONTEXT

FIGURE 12-1 ASPIRATIONAL INDIAN PROCESS SHARES WITH DEMAND MODERATION

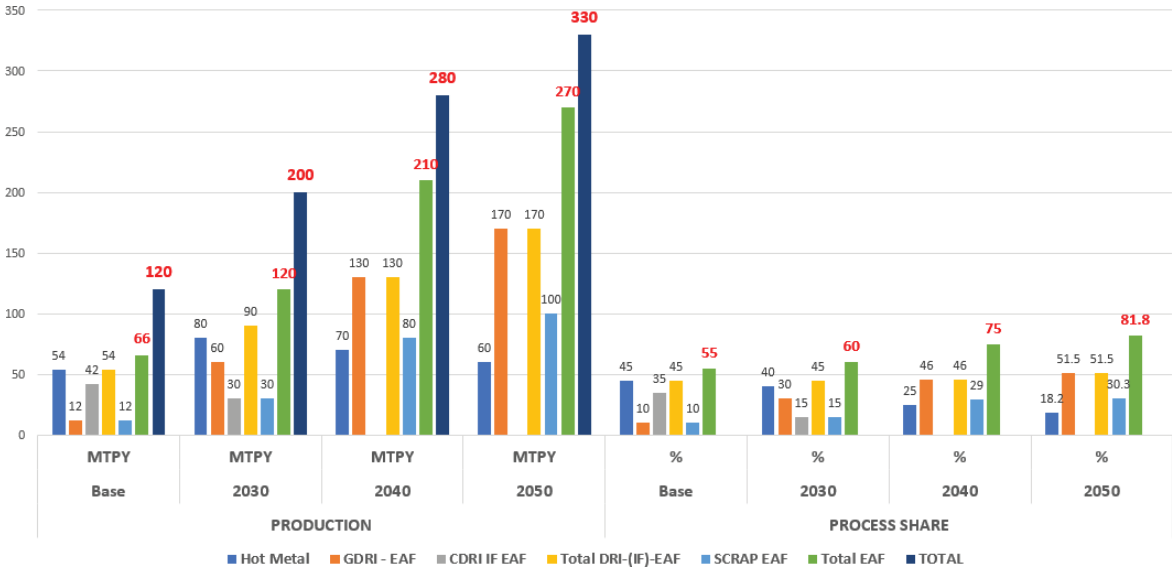


FIGURE 12-2 INDIAN STEEL ASPIRATIONAL CARBON INTENSITY

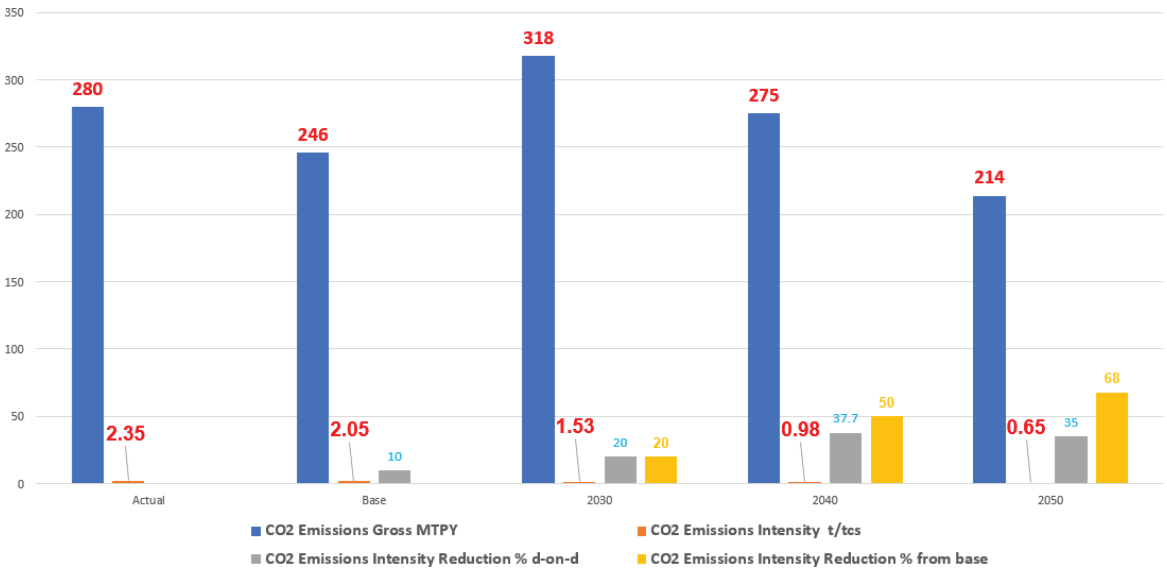


FIGURE 12-3 CO2 IMPACT OF HIGH C DRI USE IN BF

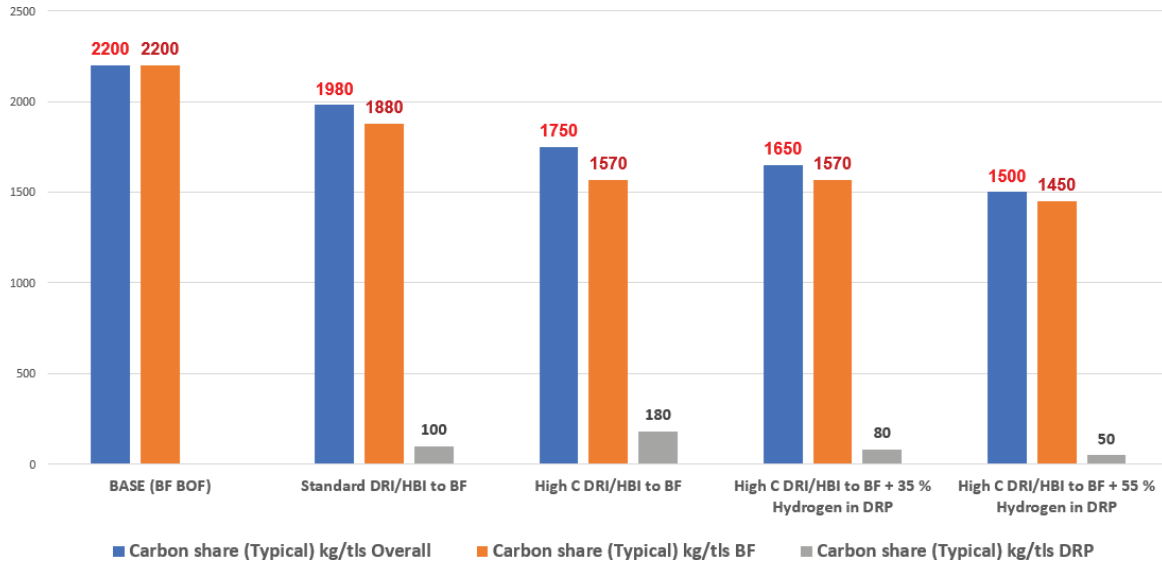


FIGURE 12-4 IMPACT OF HIGH C DRI USE ON CO2 IN EAF

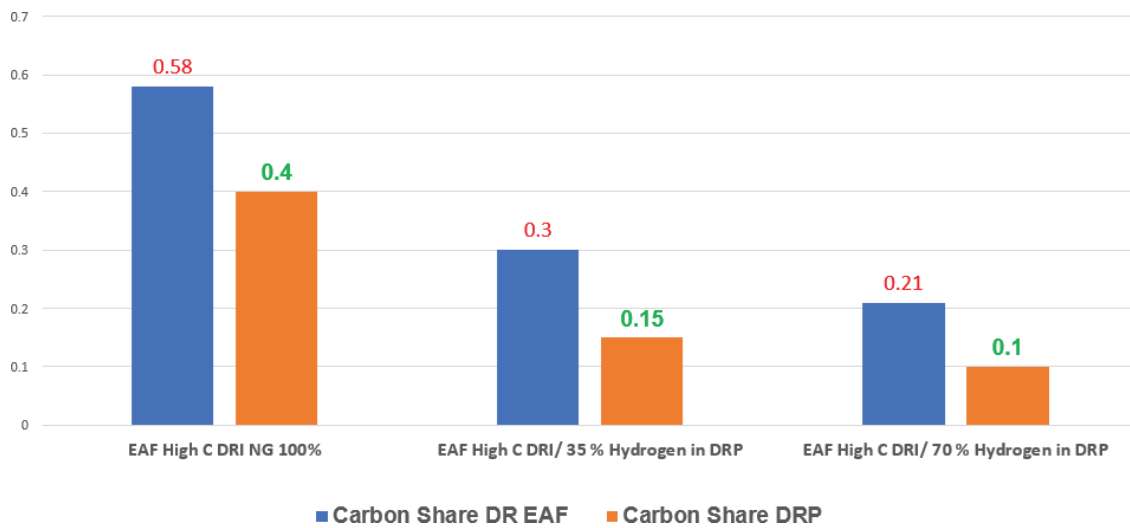
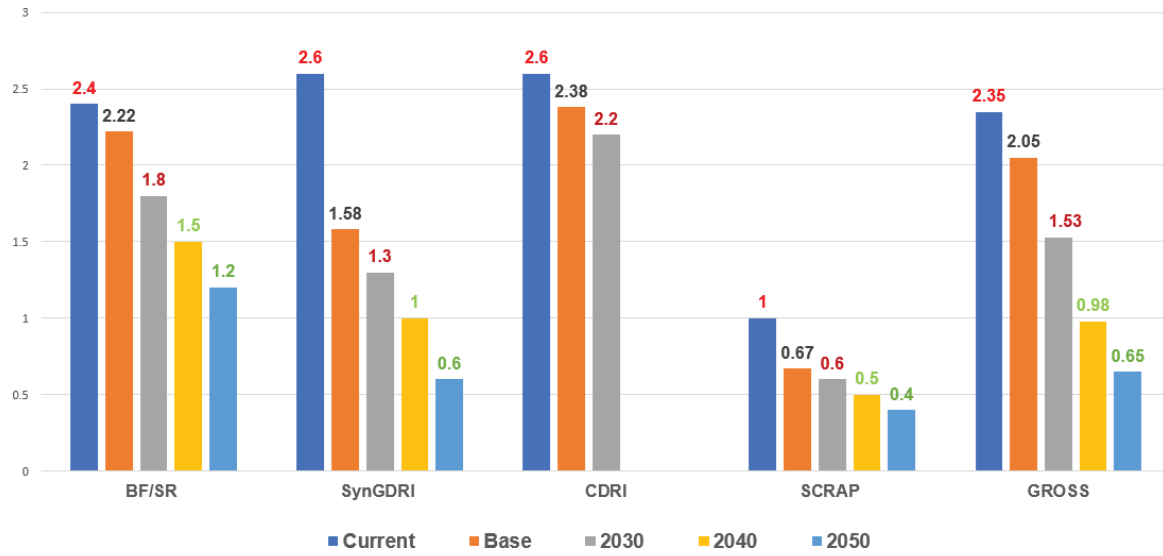


FIGURE 12-5 TARGET CARBON INTENSITIES



Chapter 13

EXTERNAL FACTORS GOVERNING SUSTAINABILITY

FIGURE 13-1 STEEL INDUSTRY STAKEHOLDER ROLES

