Scene setting presentation for the panel on raw materials requirements

Dr Barış Çiftçi | Director, Industry Analysis

World Steel Association

Open Forum 2023 - 12 September 2023

Antwerp

worldsteel ASSOCIATION

Disclaimer

Antitrust

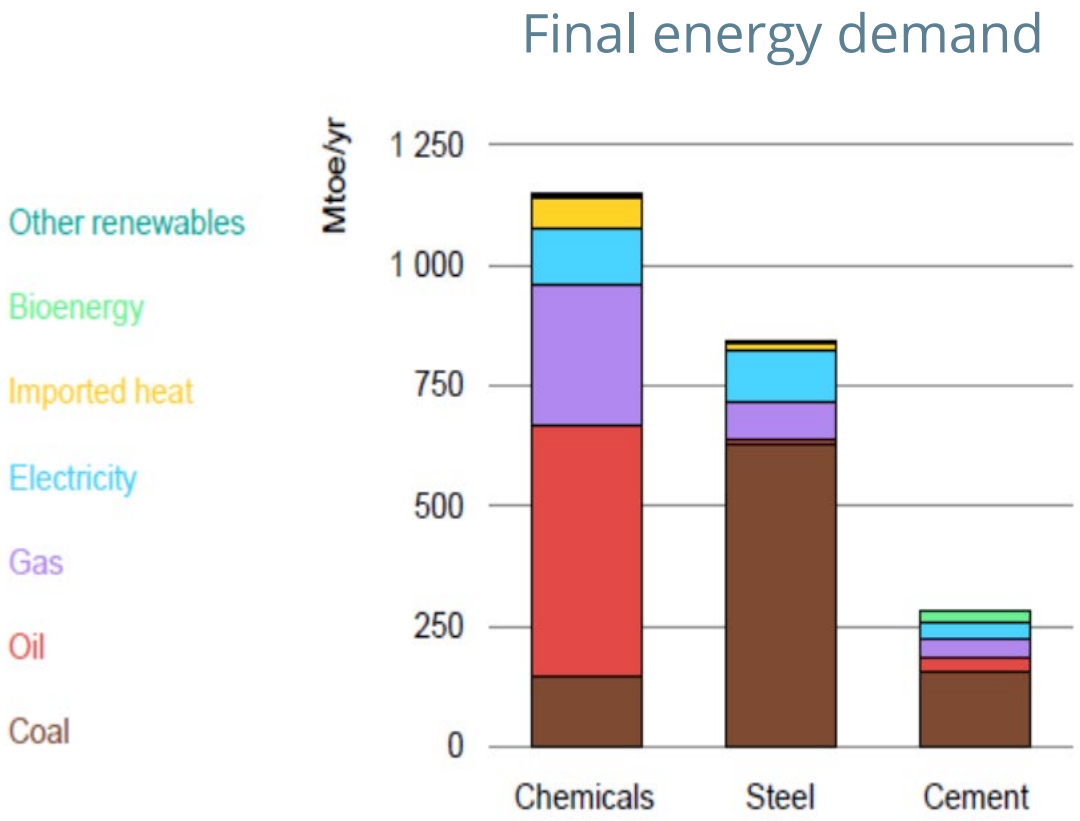
As worldsteel meetings are also meetings of competitors, antitrust and competition law concerns are paramount and certain areas of discussions must be totally avoided:

- No discussions on current or future pricing, pricing terms or any component of price
- No discussions on current or future production output or current or future capacity or capacity utilisation involving non-public information, or desired capacity or production output or capacity utilisation levels, or coordinated capacity, capacity utilisation or production output increases or decreases
- No discussions on allocating geographical or product markets or customers or classes of customers
- No discussions on concerted actions involving costs (including concerted actions against suppliers)
- No discussions on future raw material prices, price terms or negotiating strategies
- No discussions regarding how to respond to price increases or other charges from suppliers or whether or how to pass on any costs to customers
- No discussion on contemplated trade actions or complaints about trade flows
- No discussion on non-public company-specific forward looking commercial strategies or plans

Visit worldsteel.org\About us for detailed antitrust guidelines.

worldsteel ASSOCIATION

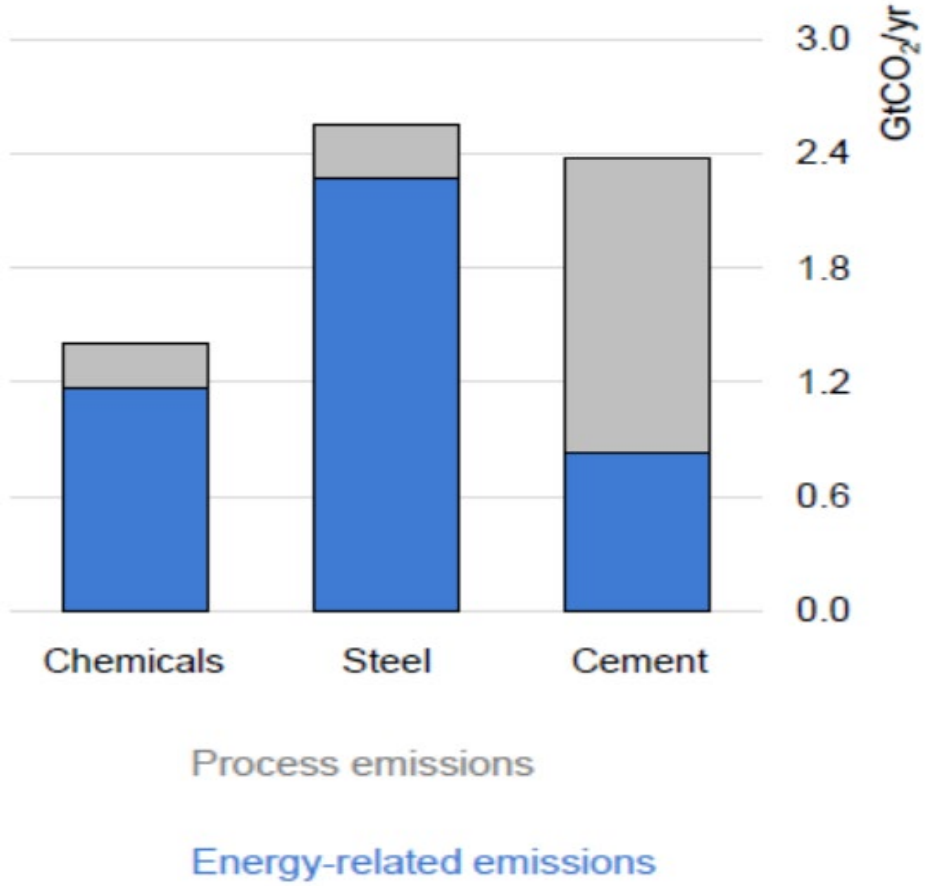
Global iron & steel industry - an energy & emissions intensive sector



- 20% industry & 8% of total final energy demand
- Coal represents about 75% of the sector's energy demand
- 2.5% of global gas demand with 90 billion cubic metres
- 5.5% of global electricity demand with 1,230 TWh

Source: IEA Iron and Steel Technology Roadmap 2020

Global iron & steel industry - an energy & emissions intensive sector

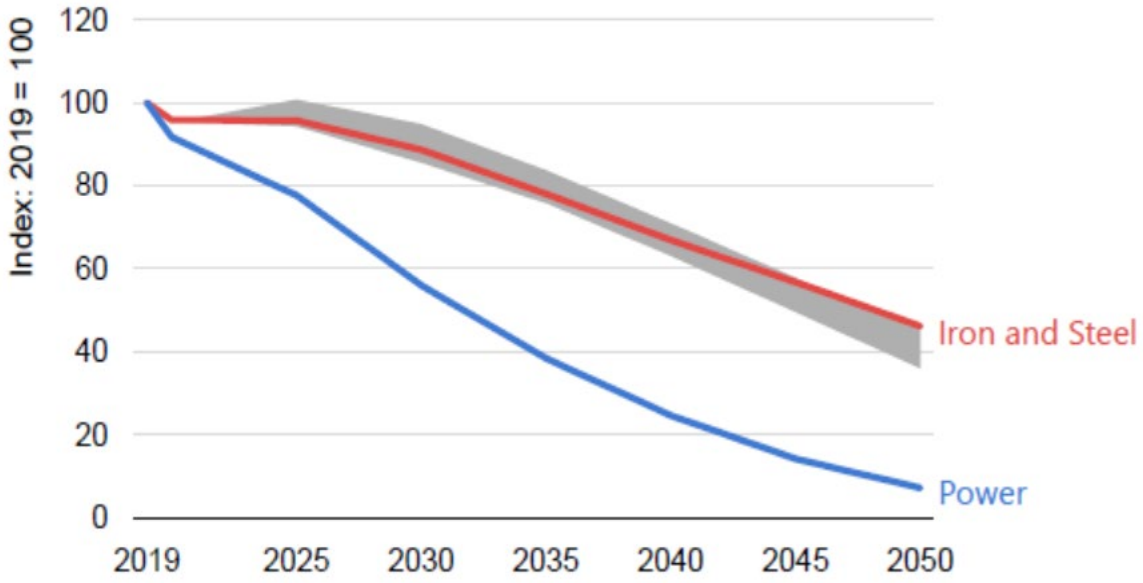


- Direct emissions of the sector account for about 7% of the global total and more than the emissions from all road freight
- Including indirect emissions from the power sector and the combustion of steel off-gasses, the share of energy system CO2 emissions attributable to the iron and steel sector rises to about 10%

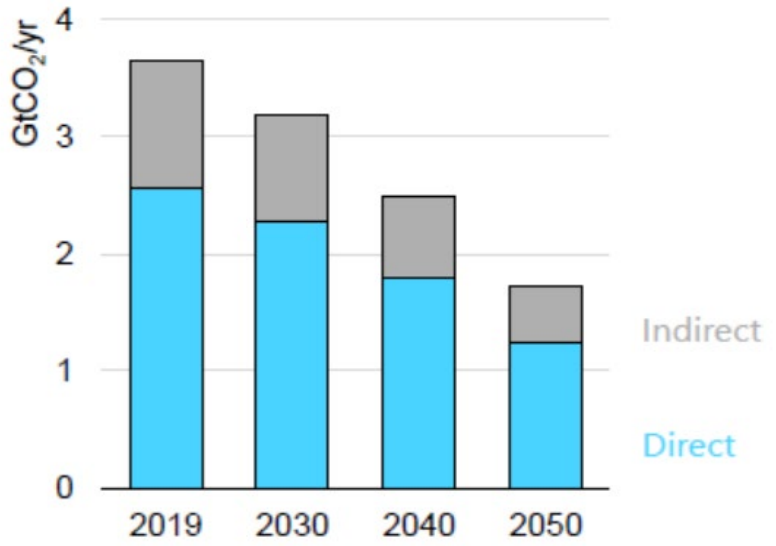
Source: IEA Iron and Steel Technology Roadmap 2020

IEA's CO2 emissions projection for the iron and steel sector

CO_2 emission trajectories in the Sustainable Development Scenario



Iron and steel sector direct and indirect CO_2 emissions in the Sustainable Development Scenario

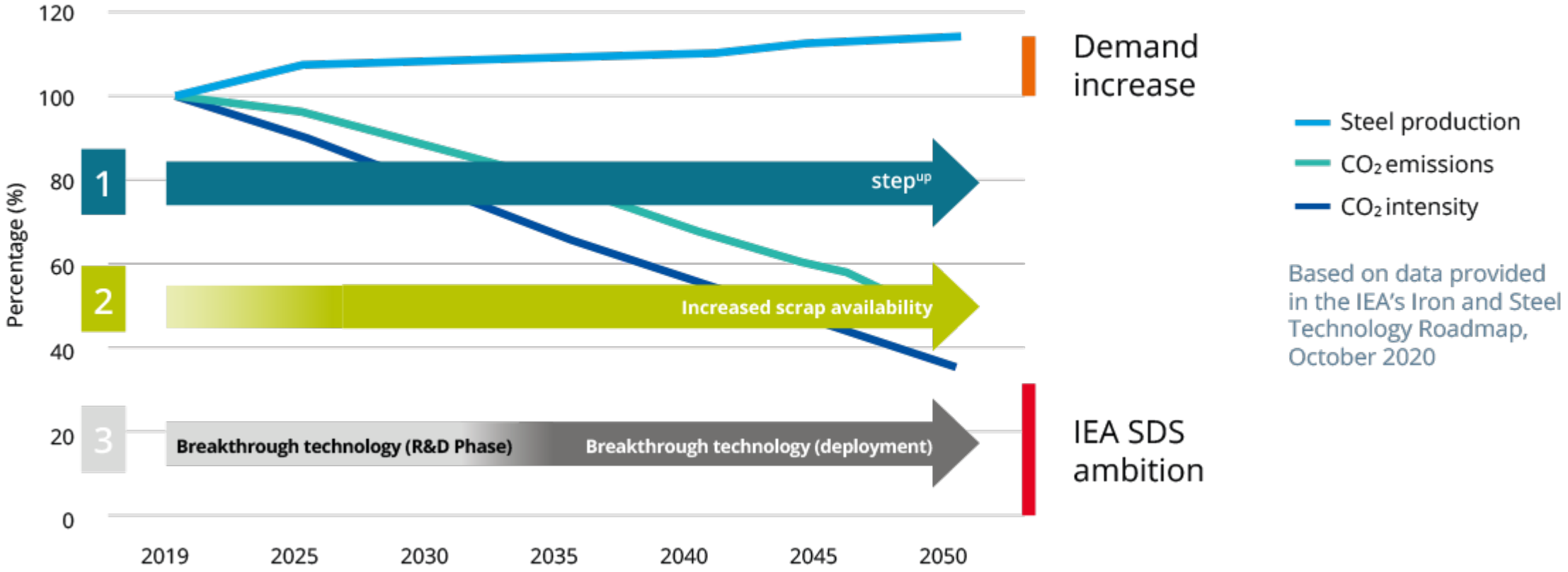


Source: IEA Iron and Steel Technology Roadmap 2020

IEA's SDS projection suggests a 55% in iron and steel industry's emissions in 2050. CO2 intensity of the sector should drop by about 60% from 1.4 tCO2/t of crude steel to 0.6 tCO2/t (direct emissions)

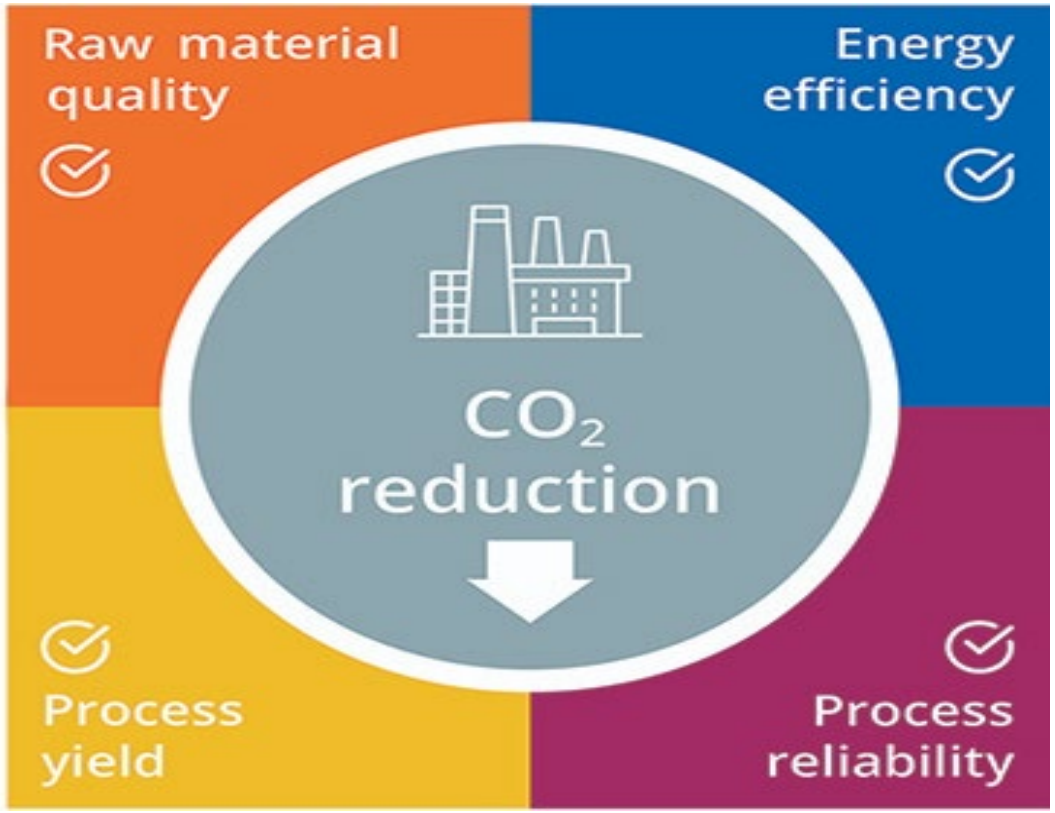
Reducing our impact: three components

Steel production, total CO_2 emissions and CO_2 intensity, 2019 – 2050 under the International Energy Agency (IEA) Sustainable Development Scenario (SDS)



Source: IEA Iron and Steel Technology Roadmap 2020

Efficiency improvements in steelmaking

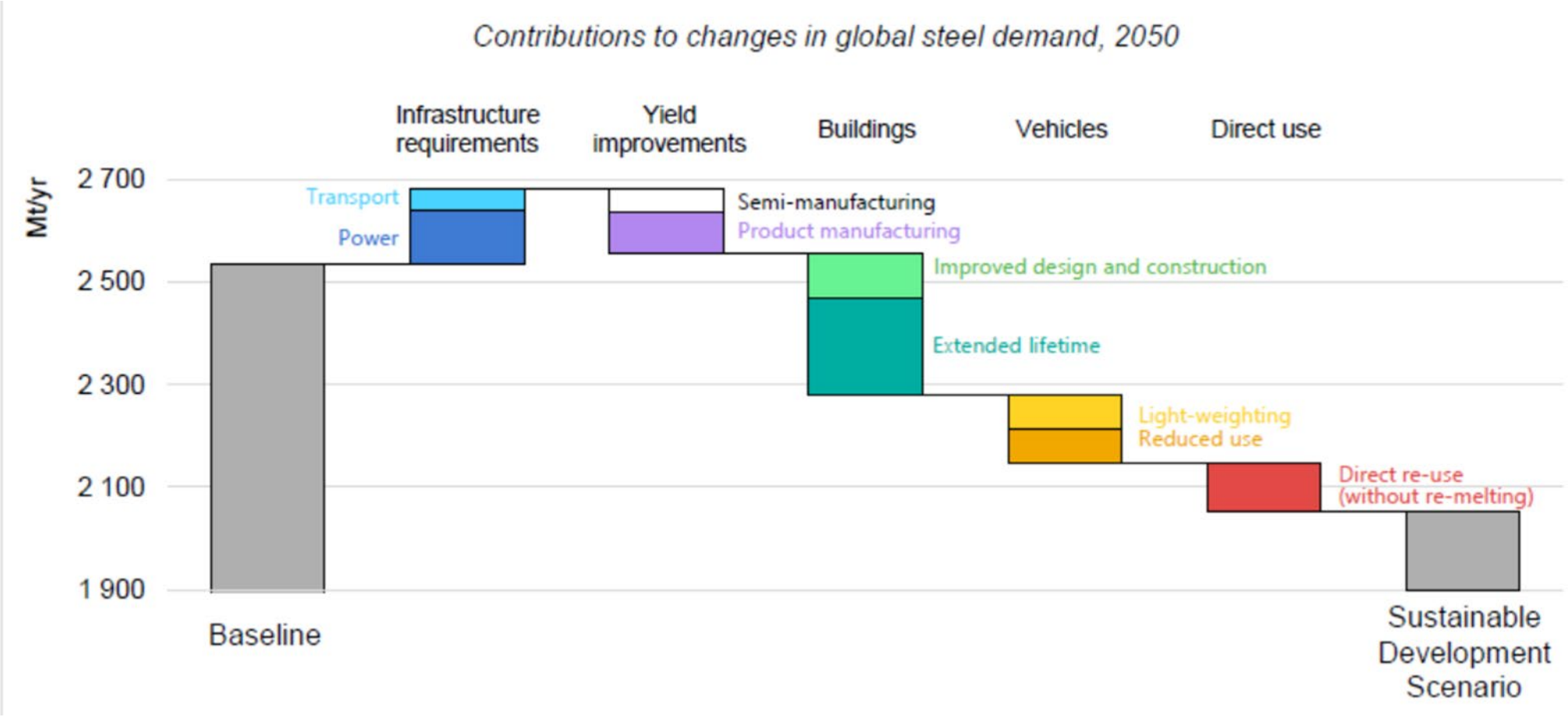


- worldsteel's Step-up programme shows there is about 15% improvement potential in energy use and CO2 emissions for many facilities around the world
- This potential can be achieved by using the existing technology in place on most sites, if the industry applies best practices from the better performing sites across the industry

Source: worldsteel Step-up programme link

About 15% improvement potential in energy use and CO2 emissions, which can be achieved by using the existing technology in place

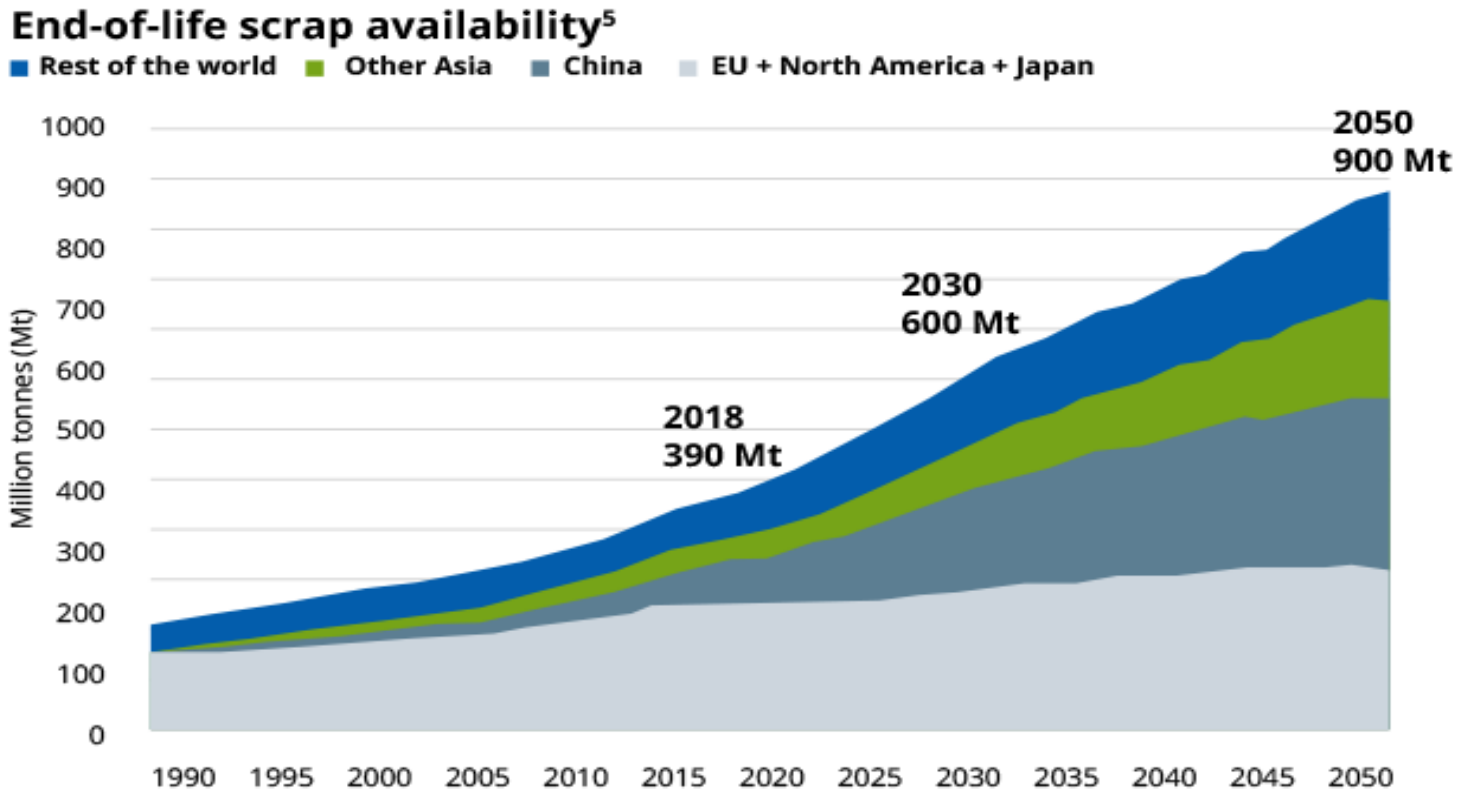
Circularity and efficiency gains in steel use



Source: IEA Iron and Steel Technology Roadmap 2020

IEA expects significant yield improvements and wide adoption of circular economy

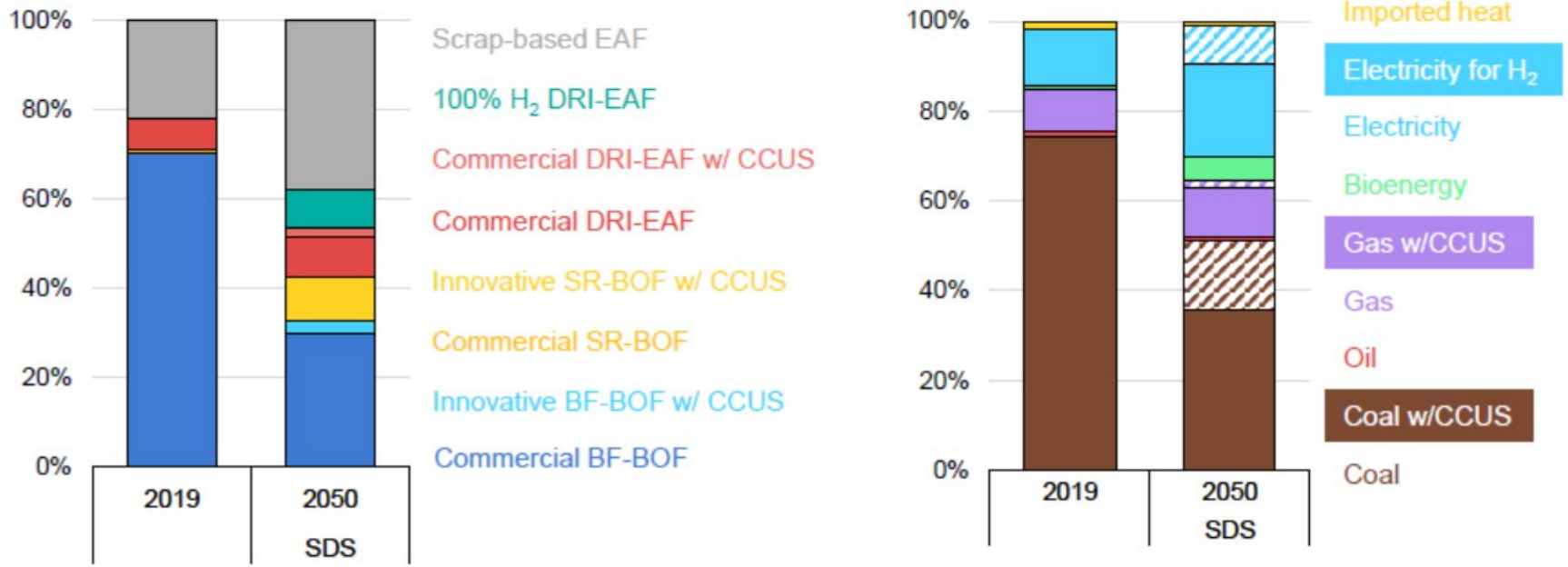
Growing scrap availability will be one of the biggest decarbonization levers for the industry



Source: worldsteel's scrap availability model

Steelmaking structure to undergo a radical transformation

Shares of process technology (left) and final energy carriers (right) in the Sustainable Development Scenario



Source: IEA Iron and Steel Technology Roadmap 2020

Unabated coal use drops about 50%, while share of BF-BOF drops from 70% to 33%. Share of electricity in the sector's total energy use grows to 30% (9% for H2) from 12.5% in 2019

Financial constraints

- 3.5 – 5.5 Tr USD investment required across-value chain
- Renewable energy + grid bears the biggest cost with 2 – 3 Tr USD
- 200-300 B USD in new steelmaking and 120-250 B in CCUS

Source: estimates driven from various studies

The expected cost of the transition to a decarbonized steel industry is 3.5 – 5.5 Tr USD across the value chain

worldsteel ASSOCIATION

Construction constraints

Under IEA's Sustainable Development Scenario,

- 1x 100% H2 DRI steel plant need to be built every month
- 1 CCUS facility (similar to 800,000t facility in Abu Dhabi) need to be built every 2-3 weeks from 2030 until 2050
- Technology provider and contractor capacity
- Labor shortages?
- Geopolitical concerns

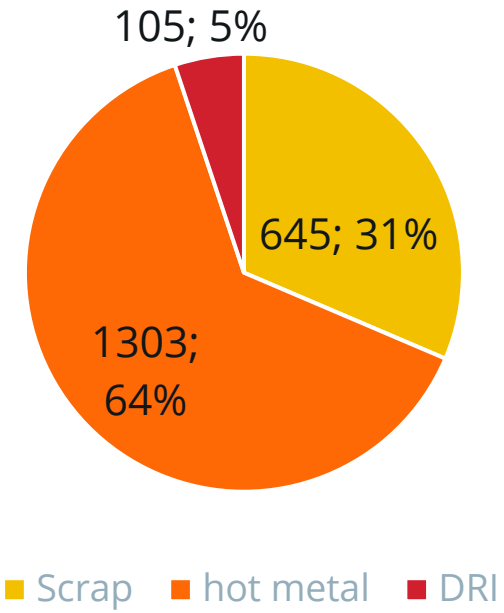
Energy constraints

- Electricity consumption of the industry doubles under IEA's SDS scenario amounting to 2 470 TWh in 2050 (including electricity required for electrolytic hydrogen production)
- Electricity supply decarbonizes by over 95%, from 540 gCO2/kWh on average in 2019 to 18 gCO2/kWh in 2050

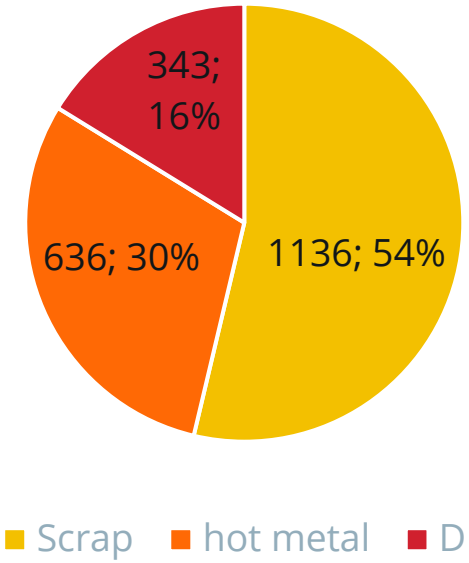
Hydrogen steelmaking and electrification will require vast amounts of green energy and hence targeted and accelerated development of green energy generation capacity

Raw materials constraints

Metallics pool for steelmaking in 2019



Metallics pool for steelmaking in 2050 in the IEA SDS scenario



Source: IEA Iron and Steel Technology Roadmap 2020

DR-grade iron ore availability, natural gas availability & green hydrogen availability are some of the several potential bottlenecks that could slow down the decarbonization of the global steel industry

Development & optimization

- Development and deployment of breakthrough technologies will require development, optimization and streamlining of numerous processes
- Hydrogen steelmaking: development, optimization and streamlining of large-scale transportation, storage & containment of hydrogen, gas recirculation & treatment, melting & refining of C-free DRI with high gangue content, plant design and process balance

Steel value chain should become progressively greener and move in harmony towards the net-zero ambition

- This is a race against time! We need to find & invest in the most efficient ways of decarbonizing our businesses. The most capital efficient, energy efficient and time efficient ways
- Constraints are real and have the potential to slow down / derail the decarbonization process
  - We need to discuss these constraints with all steel value chain stakeholders and establish green partnerships to overcome such challenges
  - Promote dialogue
- A successful decarbonization process requires a concerted transformation of the value chains from raw materials and energy supply to the usage and recycling of steel-containing goods