# Glass half full or half empty?

# Steel industry decarbonization to 2040

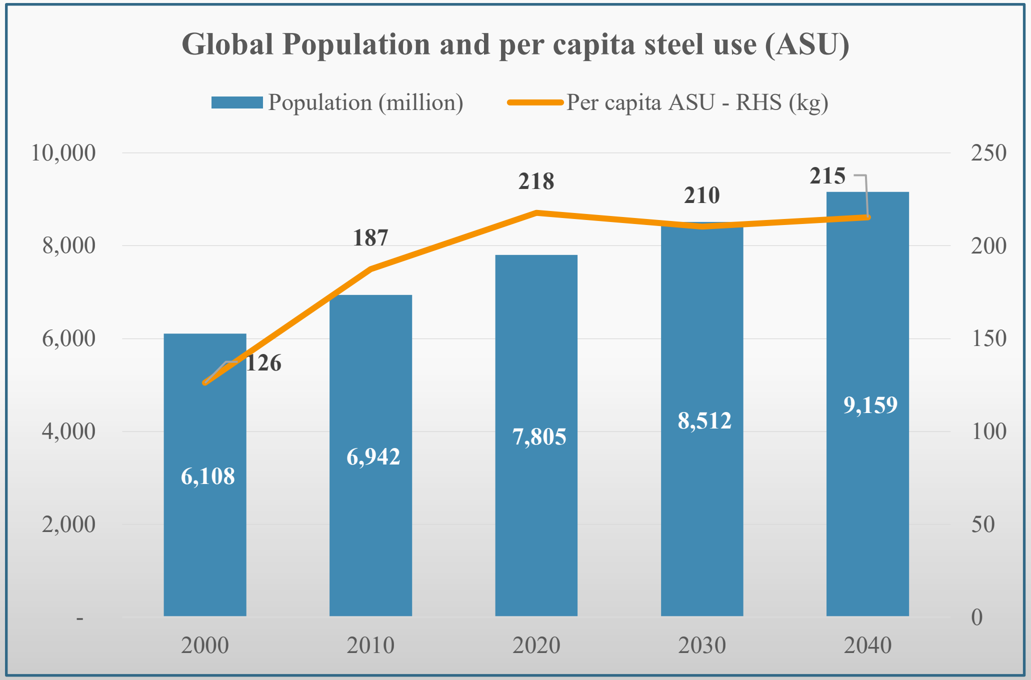
## Presentation to the worldsteel Climate Action Open Forum

## Brussels, 11 June 2024

WSD WORLD STEEL DYNAMICS®

# Global steel production forecast

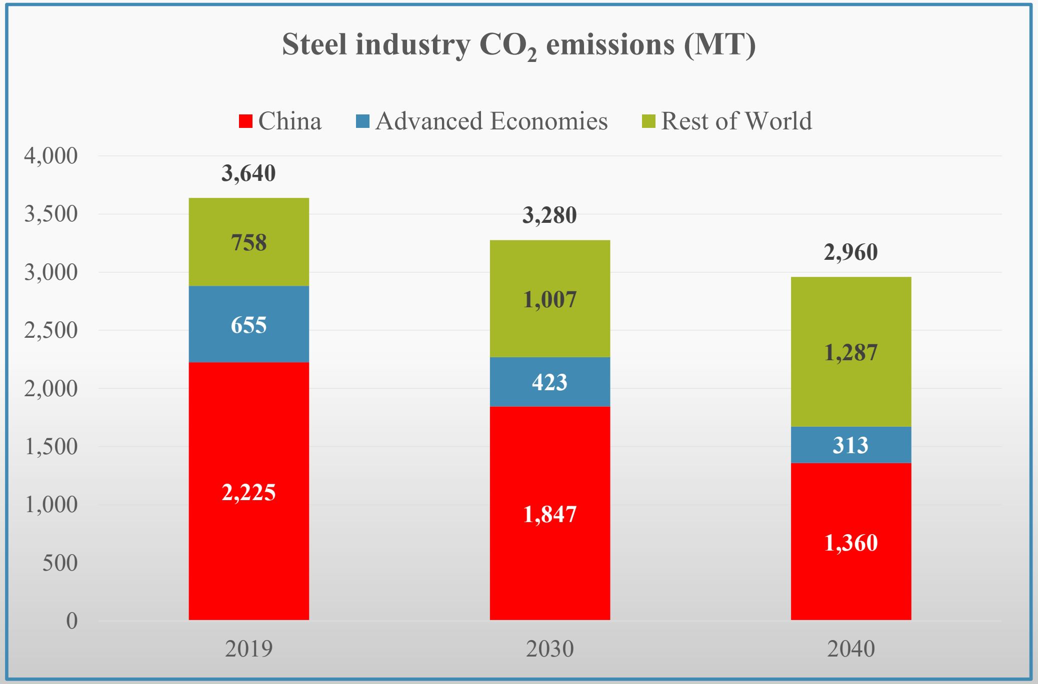
WSD expects global steel production to increase to 1,940 MT this decade as China's decrease partially offsets strong growth in India and ASEAN. Output further increases to 2,135 MT by 2040 as growth in those regions accelerates.

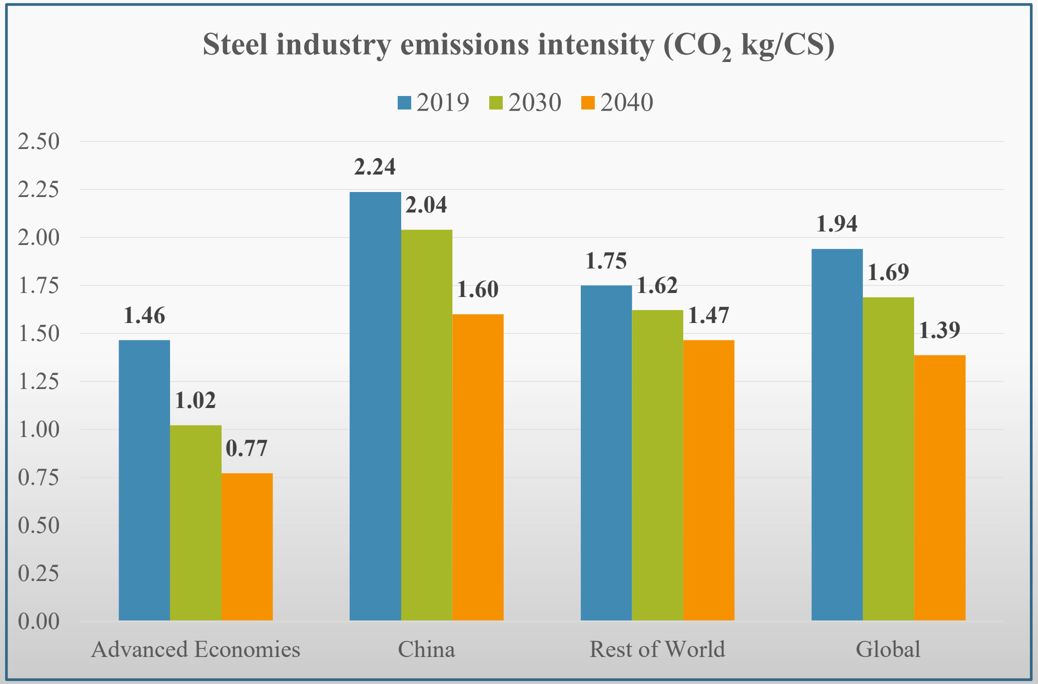




Source: WSA, WSD analysis

# Global steel industry $CO_2$ decarbonization progress

WSD expects total steel industry $CO_2$ emissions to decrease nearly 20% to 2,940 MT by 2040. Global average intensity decreases to 1.39 $CO_2$ kg/tCS with all regions showing intensity declines.*



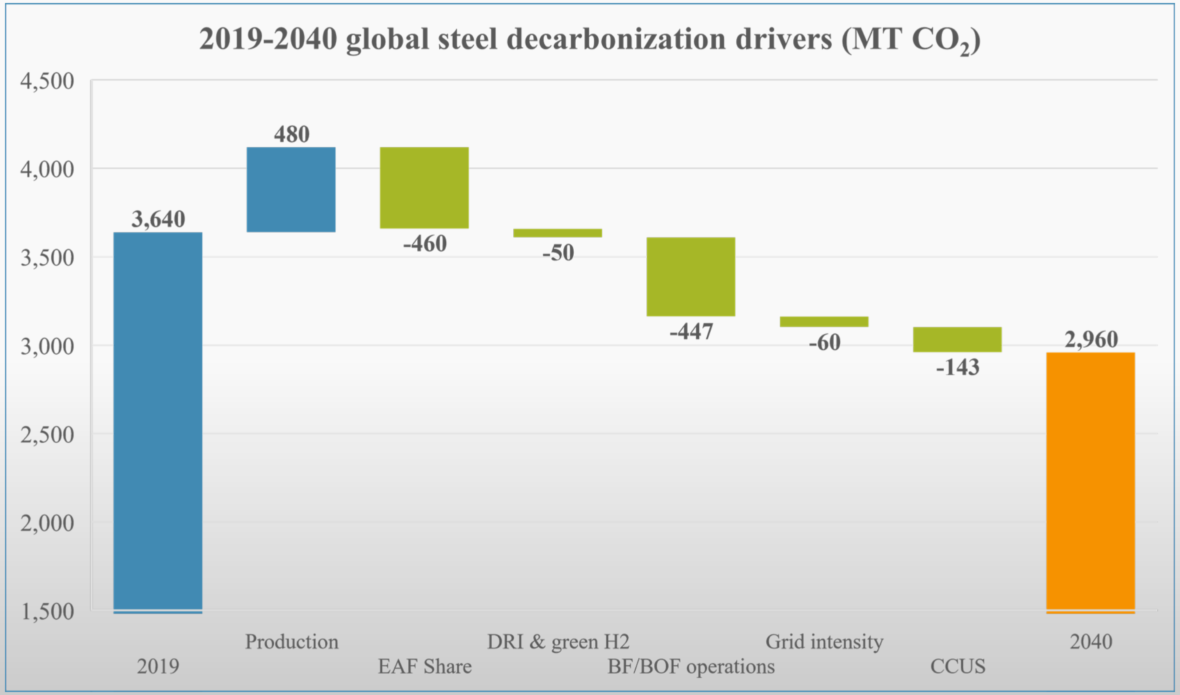

* Scope 1, 2, and inside the gates Scope 3

Source: WSD analysis

WORLD STEEL DYNAMICS

# Global steel decarbonization drivers

WSD's steel decarbonization and cost model focusses on six primary decarbonization drivers.

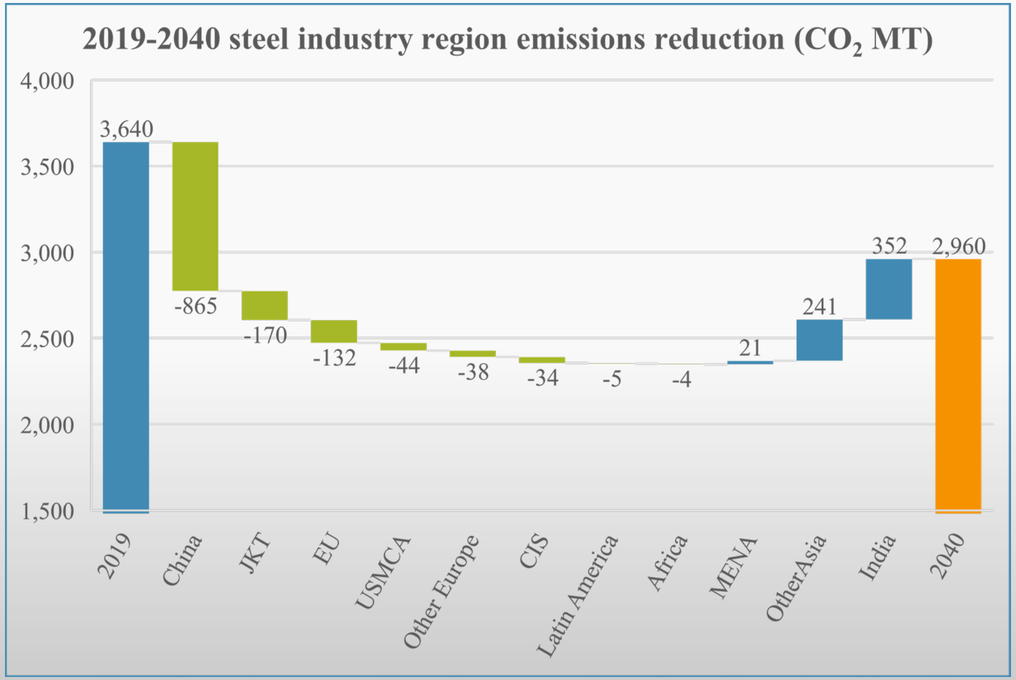


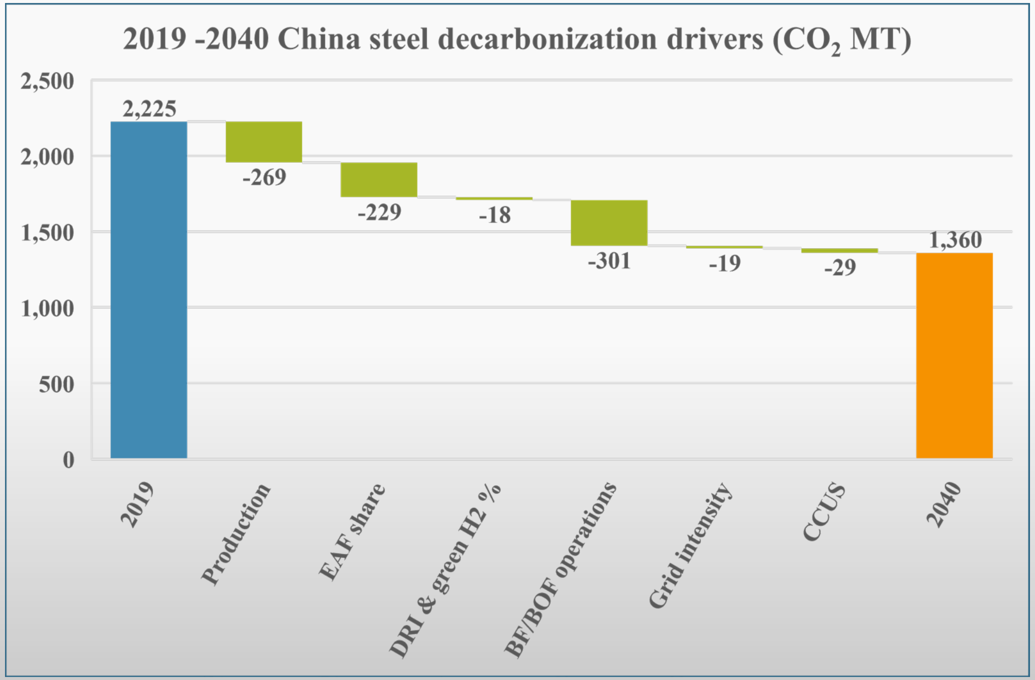

- **Production:** 260 MT increase in steel output adds 480 MT in global $CO_2$ emissions.
- **EAF share:** 380 MT increase in EAF production and share increase from 28% to 42% decreases emissions by 460 MT.
- **DRI & green $H_2$**: increase in DRI production to 235 MT, the EAF charge rate from 19% to 23% and he green $H_2$ share of reductant mix from nil to 25% reduces global emissions by 50 MT.
- **BF/BOF operations**: increased BF efficiency, hydrogen injection and other fuel mix changes, decreased BOF hot metal ratios, improved yields and other factors reduce global emissions by nearly 450 MT.
- **Grid intensity**: reduction in the weighted global average grid intensity from 480 to 36 $CO_2$ kg/kwh decreases emissions by 60 MT.
- **CCUS**: 30% carbon capture for DR operations and 5% for BF eliminated nearly 15 MT of $CO_2$.

Source: WSD analysis

# Steel industry region $CO_2$ emissions

Steel industry emissions in India, SE Asia and MENA increase ~615 MT by 2040 but are overshadowed by the nearly 1,300 MT decrease in emissions in China and other regions.



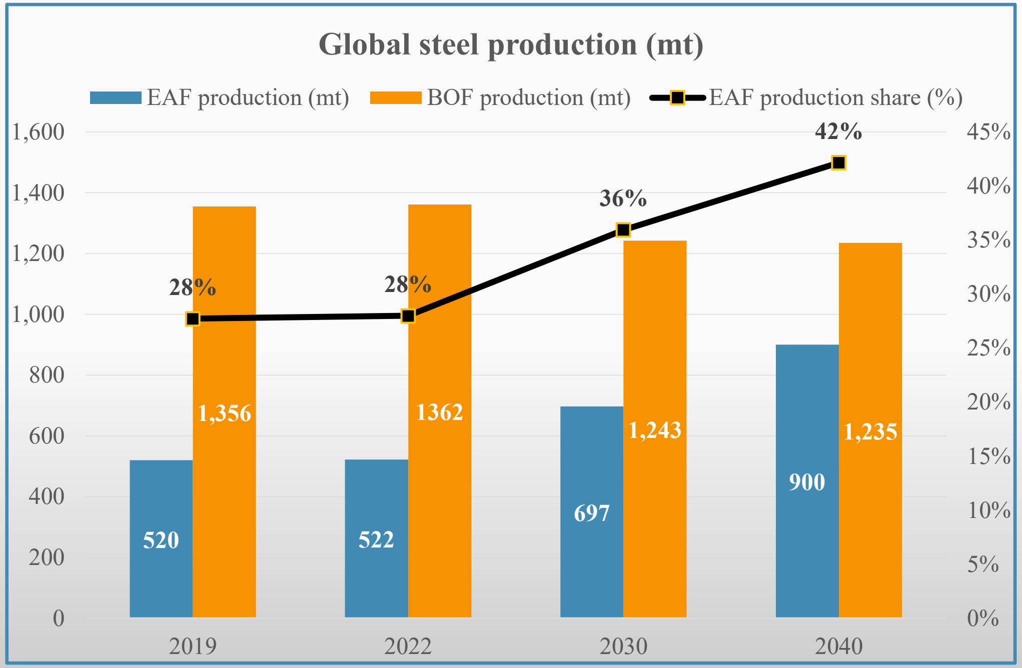

Source: WSD analysis

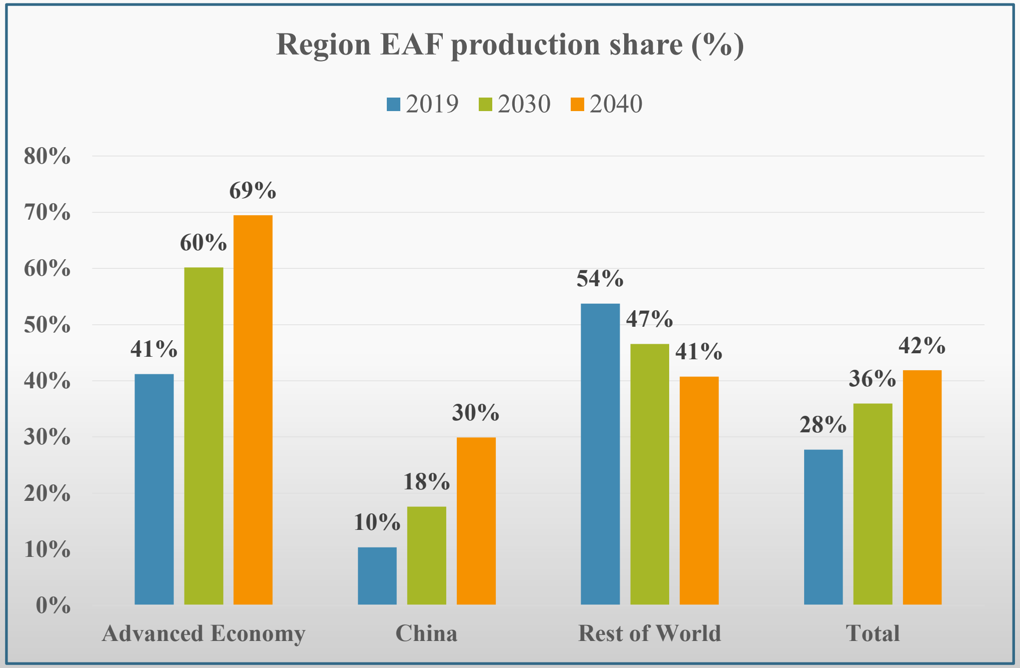


WSD WORLD STEEL DYNAMICS

# EAF production and production shares

WSD expects the global EAF share to increase to 42% based on the availability of scrap which is also used to reduce BOF hot metal ratios. The EAF share declines in the Rest of the World due to primarily BF/BOF capacity additions.




Source: WSA, WSD analysis

# 2040 base case conditions

In WSD's base case scenario, reducing global average emissions intensity to 1.39 $CO_2$ kg/tCS by 2040 requires significant advances in all decarbonization drivers.

| Dimension | 2019 | 2030 base case | 2040 base case |
|---|---|---|---|
| EAF Production | 520 MT (28%) | 700 MT (36%) | 900 MT (42%) |
| Scrap consumption | 625 MT | 765 MT | 965 MT |
| DRI production | 108 MT* | 175 MT | 235 MT |
| Iron ore consumption | 2,215 MT | 2,120 MT | 2,130 MT |
| Coal consumption | 905 MT | 780 MT | 680 MT |
| Avg grid $CO_2$ intensity | .483 kg/kwh | .404 kg/kwh | .360 kg/kwh |
| Blast furnace fuel rate | 528 kg/tHM | 508 kg/tHM | 477 kg/tHM |
| $CO_2$ captured** | <.05 MT | < 1.0 MT | 95 MT |
| Total green hydrogen | 0 | 1.6 MT | 13.0 MT |
| | | | |
| Total emissions | 3,640 MT | 3,280 MT | 2,950 MT |
| Intensity ($CO_2$ kg/tCS) | 1.94 | 1.69 | 1.39 |

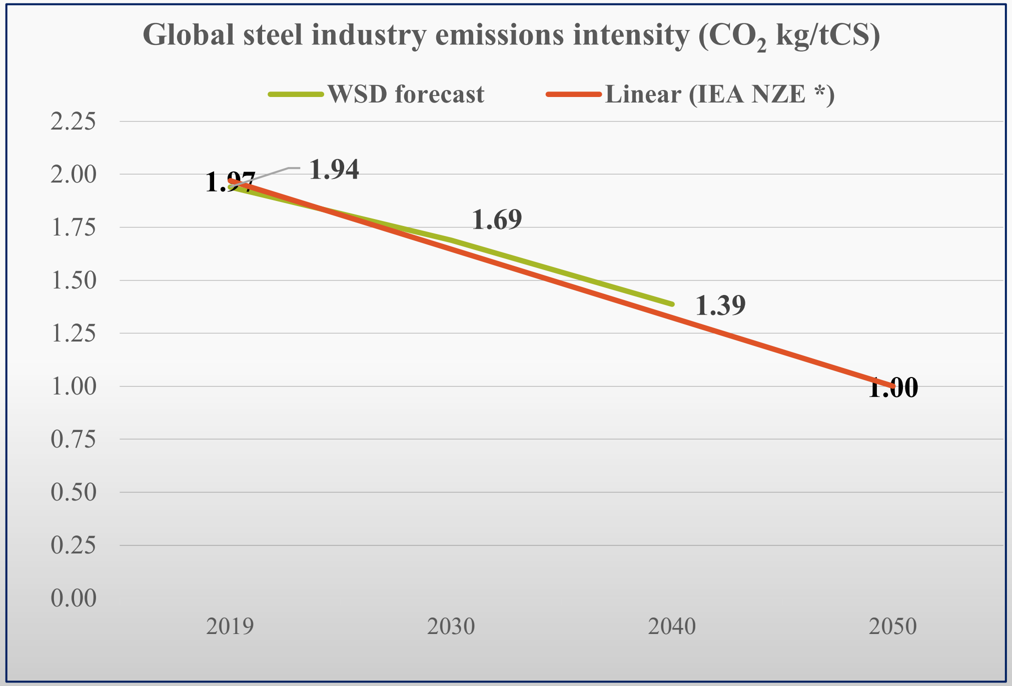
- 135 MT in 2023 (worldsteel)

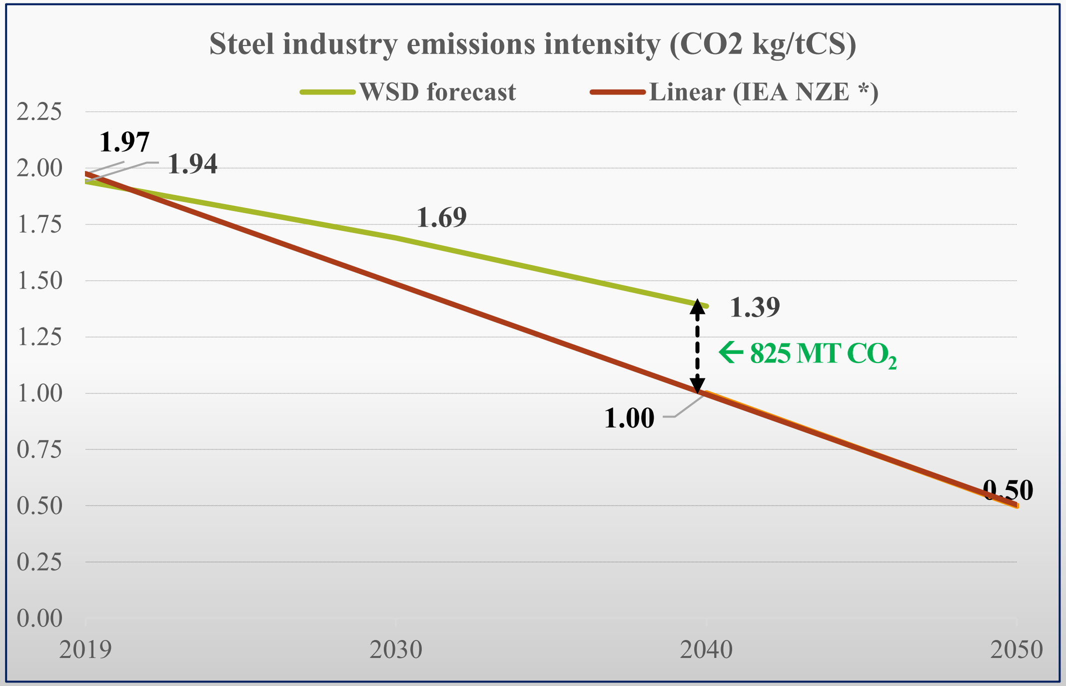
** DRI + BF

Source: WSD analysis

# Glass half full.........or half empty?

WSD's 2040 forecasts positions the global industry on course to reach the IEA's SDS target of ~ 1.0 $CO_2$ kg/tCS, but not the NZE target of < 0.50 CO2 kg/tCS.






WSD WORLD STEEL DYNAMICS

# Can we do better?

If the 2040 base case scenario is a stretch, the ”2040 1.00” case requires truly heroic action on all fronts.

| | 2019 | 2030 base case | 2040 base case | 2040 1.00 case | Lever |
|---|---|---|---|---|---|
| EAF Production | 520 MT (28%) | 700 MT (36%) | 890 MT (42%) | 1,060 MT (50%) | More DRI |
| Scrap consumption | 625 MT | 765 MT | 965 MT | 965 MT | Max available? |
| DRI production | 108 MT* | 175 MT | 235 MT | 365 MT | To fill scrap shortfall |
| Iron ore consumption | 2,215 MT | 2,120 MT | 2,130 MT | 2,060 MT | More DRI/less BF |
| Coal consumption | 905 MT | 780 MT | 680 MT | 550 MT | Coke rate < 310 kg/tHM |
| Avg. grid $CO_2$ intensity | .483kg/kwh | .404 kg/kwh | .360 kg/kwh | .225 kg/kwh | Renewables |
| BF fuel rate | 528 kg/tHM | 508 kg/tHM | 477 kg/tHM | 460 kg/tHM | Several |
| $CO_2$ captured** | <.05 MT | < 1.0 MT | 95 MT | 480 MT | 50% DRI, 35% BF |
| Total green hydrogen | 0 | 1.6 MT | 13.0 MT | 27.5 MT | 50% DRI 30% BF |
| | | | | | |
| Total emissions | 3,640 MT | 3,280 MT | 2,950 MT | 2,135 MT | All of the above |
| Intensity ($CO_2$ kg/tCS) | 1.94 | 1.69 | 1.39 | 1.00 | |

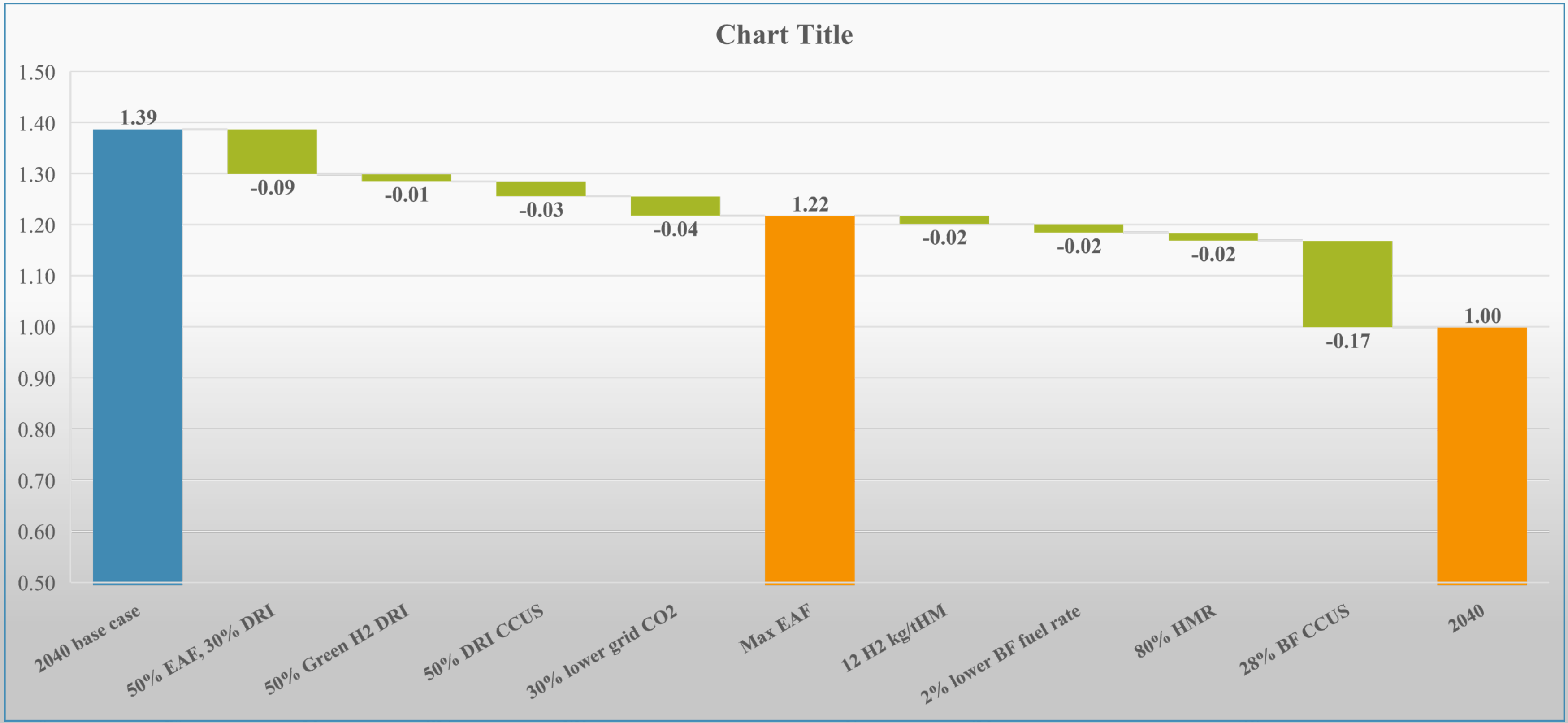
- 135 MT in 2023 (worldsteel)

** DRI + BF

Source: WSD analysis

# Can we do better?

All eyes on the BF/BOF route: can we drive intensity lower with more hydrogen and other fuels? Can we make carbon capture work technically and financially in the absence of a universal carbon tax?

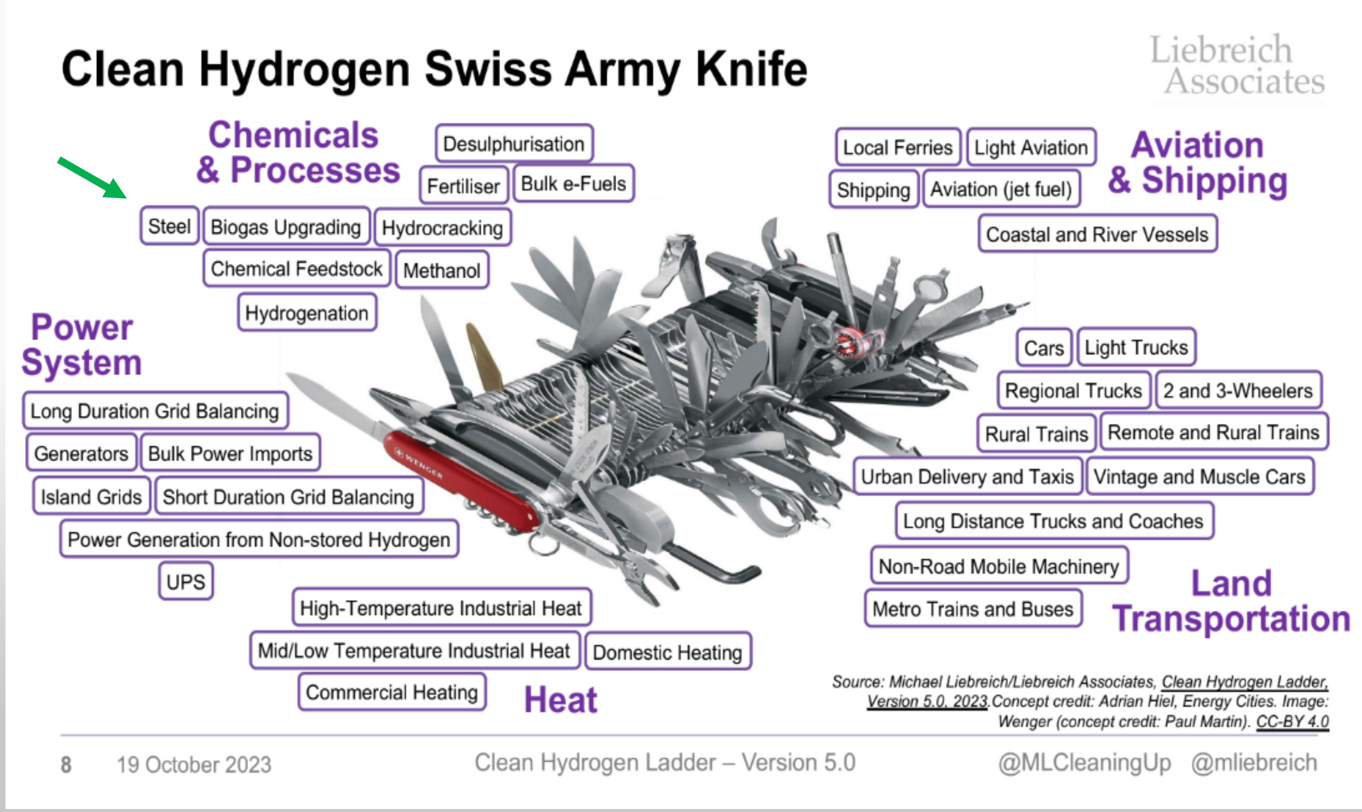


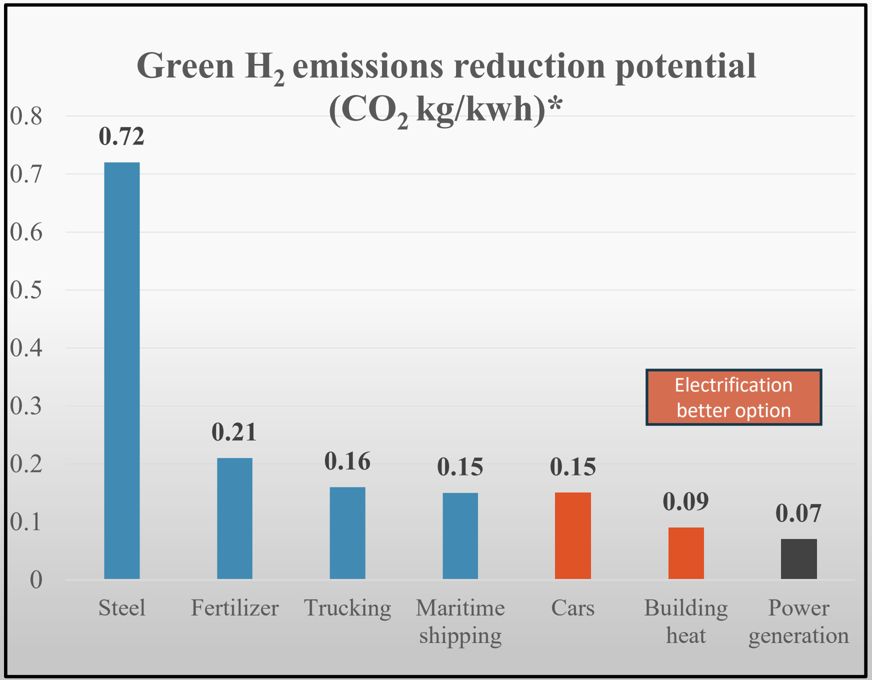



WSD WORLD STEEL DYNAMICS

# Final thought: clean hydrogen is the universal answer to all the world's decarbonization needs

….. but steel has a compelling story to claim priority usage.




* Source: Rocky Mountain Institute (RMI), https://rmi.org/we-need-hydrogen-but-not-for-everything/