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WSD's steel experience, steel database and availability of steel statistics are the principles for performing steel forecasts, studies and analysis for international clients. WSD seeks to understand how the "pricing power" of steel companies the world over will be impacted by changes in the steel industry's structure. The views and opinions expressed in this article are solely those of World Steel Dynamics and not necessarily those of AIST.

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Steel mills' CO_2 reduction challenge: Achievable, at least based on the steel mill announcements

The steel mills' CO_2 reduction challenge is a game changer.

The good news for non-Chinese steel mills is that Chinese policymakers, given the massive CO_2 emissions of its steel industry, will be implementing steel production controls for years to come. Hence, Chinese steel mills are no longer a major exporting threat to their offshore competitors.

Outside of China, the financial requirements and increased operating cost to limit CO_2 emissions, along with the many older "legacy" plants that are not a candidate for sizable CO_2 reduction investments, will be a restraint on steel output for years to come.

Hence, the global steel industry is now in an "era of steel production constraint" that has put steel buyers on the defensive.

Challenges for steelmakers include:

- Capital investments to minimize CO_2 emissions are monumental. WSD estimates that the aggregated capital requirement by 2050 — when using International Energy Agency (IEA) forecasts by steel production process and WSD's estimates of the capital outlay requirement by process — is about US$780 billion (see Table 1).
- Many integrated steel plants need to be reconfigured to depend less on their coke ovens, sinter plants, pelletizing plants and blast furnaces. This process, whether it depends on

Table 1

Steel Industry Capital Spending Requirement by 2050 to Eliminate CO_2 Emissions

Process	Preliminary capital outlay/ metric ton* (million US$)	2019 (metric tons)	2050 (metric tons)	Change vs. 2019 (metric tons)	Capital outlay (billion US$)
Commercial BF-BOF	350	1,310	615	(695)	237
Innovative BF-BOF with CCUS	500	0	62	62	31
Commercial SR-BOF	450	19	0	(19)	0
Innovative SR-BOF with CCUS	600	0	205	205	98
Commercial DRI-EAF	250	131	185	54	46
Commercial DRI-EAF with CCUS	350	0	41	41	22
100% H_2 DRI-EAF	1,000	0	164	164	164
Scrap-based EAF	250	412	779	367	185
TOTAL	381	1,872	2,051	179	783

*Production = IEA. Capital spending needs = WSD Estimates.
SR is smelting reduction. CCUS includes carbon capture, some processing of the carbon to produce non-CO_2 containing products and the sequestering of some of the CO_2 in empty underground caverns. Production of hydrogen requires either a hydrolyzer and/or the existing steam reforming approach that uses natural gas (in which case, the CO_2 captured partly processes with the remainder sequestered).

sharply increased hydrogen usage and/or carbon capture and processing, may lead to a 30–80% surge in operating costs based on ArcelorMittal's position papers.

- New technologies permitting the production of low-cost hydrogen from renewable energy sources need to be further developed. If hydrolyzers that make use of electrolysis are employed, these units need access to purchased electricity at bargain prices. One of the many investigations by steelmakers to access low-cost hydrogen is the extraction of hydrogen from ammonia, after the ammonia has been transported to the plant site.
- Given that the capital investment to reconfigure a steel plant is massive, the project will need access to huge government-guaranteed longer-term "green loans" that carry ultralow interest rates.
- Governments the world over will be embarking on huge investments to build renewable wind turbine and solar power electricity–generating facilities. Additional investments will then be required for the transporting and distribution of the renewable electricity, along with sufficient storage battery capacity, to users.
- There's probably a need for sizable nuclear power plant capacity to be built outside of China; that is, if nuclear power can be considered a renewable source. Nuclear power is already considered to be renewable power in China. It is needed because wind turbines and solar farms have only about a 25–30% efficiency rating, when generating power, versus 97%+ for nuclear.
- Governments just committed to a "level playing field" when it comes to their CO_2 emission reduction policies, including the placement of sizable taxes on imported steel products that emitted excessive CO_2.
- There will be a massive rise in purchased electricity by the steel industry by 2050, even assuming no rise in global steel output. For example, if a 2-million-metric-ton-per-year steel plant (a) makes use of electrolyzers to create the hydrogen via electrolysis; (b) employs a direct reduced iron plant using hydrogen to produce carbon-free high-Fe pellets; and (c) employs electric arc steelmaking furnaces, this plant might require 60% of the electricity output of a new 1,000 MW nuclear plant — that might cost US$5 billion to build. And, to make the challenge even greater, the nuclear power needs to be provided at a subsidized price of perhaps only 2 cents per kWh.
- Many governments are apparently using the European Union's Emission Trading Scheme as a model. The EU's greenhouse gas emissions approach has established a price for CO_2 per metric ton by listing on a futures exchange. Also, "carbon credits" are issued to steel plants that are large CO_2 emitters. Recently, the price of a metric ton of carbon dioxide on the European Climate Exchange rose to a record high of about US$56/metric ton. Hence, if an EU steel company emits 2 metric tons of CO_2 per metric ton of steel produced and seeks to boost steel output by 1 million metric tons, unless it has available carbon credits, it would need to purchase US$108 million of new carbon credits. (Note: Trading of carbon credits takes place on the European Climate Exchange, NASDAQ OMX Commodities Europe, Powernext, Commodity Exchange Bratislava and the European Energy Exchange.)