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Net Zero Emissions Steel R&D: System Integration and optimization

Background

As a major emitter of greenhouse gases, the steel industry needs to undergo major technology changes to drastically reduce its emissions. Innovation and technology breakthrough will be crucial for the transitioning from current status to carbon neutral ironmaking.

In responds to the CSPA call for climate action (Canada's Steel Industry: A Sustainable Choice), CCRA has developed a research program to address the technical challenges in achieving net-zero emission steel production by 2050 (New Era for CCRA). In the CCRA research program, activities are categorized into 5 pillars for promoting collaboration between research groups and with industrial partners. System Integration and optimization is one of the R&D pillars. Sustainable system integration and optimization involves incorporating decarbonization technologies into steel production processes and developing a validated modeling tool to assist in business case assessment. However, the availability of low-carbon energy sources, at the scale required for industrial decarbonization, is limited, Therefore, a system-level/holistic approach to pathway arbitrage (i.e., order-of-merit) is needed to prioritize and optimally allocate scarce resources in the industrial sector. Our plan is to delve deeper into the drivers and barriers of implementing selected decarbonization strategies, with a meticulous examination of the risks and opportunities in the supply chain of specific regions. This approach aims to maximize the economic and environmental benefits of these pathways by exploring regional energy arbitrage and the risks and opportunities within the entire iron and steel value chain. By assessing factors such as the availability of green electricity in Ontario and Quebec, competition with other industries for limited resources like biomass and hydrogen, and the implementation of CCUS strategies, we aim to gain a better understanding of the risk factors and opportunities associated with net-zero CO_2 technologies in both regional and global market to avoid stranded assets in high regret. pathways.

Goal Statement

To reduce the greenhouse gas emissions within the iron and steel sector by leveraging waste heat recovery techniques and integrating energy systems.

Specific Objectives

- To reduce energy consumption in the iron and steel sector and consequently reduce GHG emissions not only within each I&S plant, but also in a regional concept.
- To optimize the CO_2 capturing unit from energy point of view by integrating it with the existing I&S plants.
- To optimize the H_2/biocarbon production unit from energy point of view by integrating it with the existing I&S plants.
- To develop the road map to achieve net-zero targets in 2050 for the I&S sector.

Projects Overview

Integration of waste heat recovery within steel production

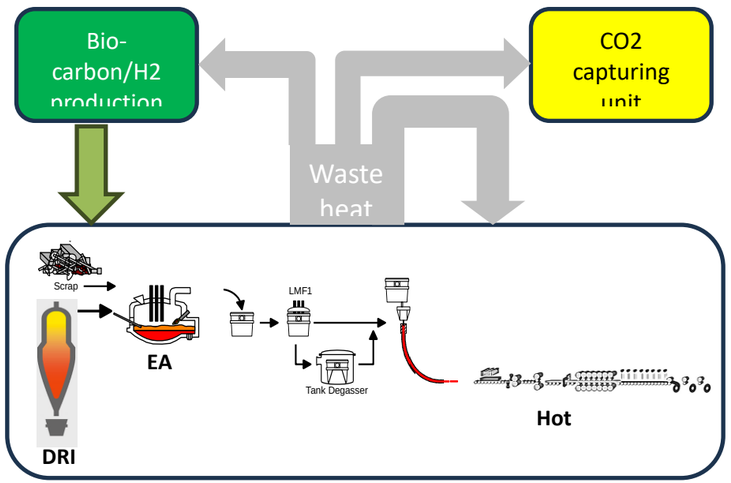
- Assess the current energy consumption levels across various stages of iron and steel production.
- Conduct a comprehensive analysis to identify the primary areas within the iron and steel sector where energy consumption is high or there is a high potential of energy recovery.
- Develop models to maximize energy efficiency, carbon recirculation, and heat recovery for the existing steel refining and casting processes.
- Identify most efficient design of DRI/EAF process considering criteria such as low energy demand, compatibility with renewable resources such as H_2 and biomass and compatibility with BECCS.

Integration of biogenic reductants and fuels production into steel production

- Model the H_2 and bioenergy production pathways integrated with an I&S mill required resource quantities and their respective compatibility with CCS.
- Model the effect of low carbon reductants such as H_2 and biocarbon on the overall integrity of the process.

Integration of CO_2 capture into various sub-processes

- Integration of CO_2 capture into BF-BOF process
- Integration of CO_2 capture into DRI/EAF process

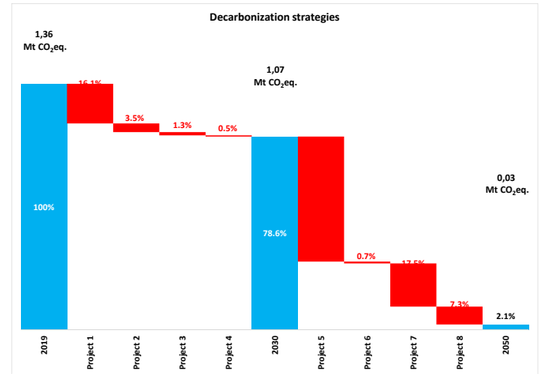


An integrated steel production through the DRI/EAF route

Projects Overview

Carbon neutral/negative I&S plants

- Identify the most viable decarbonization strategies and roadmaps toward a net-zero I&S mill.
  These roadmaps will illustrate the competing decarbonization pathways that are achievable for each sub-sector and regions in Canada, with a view to rapid and cost-effective decarbonization on a national scale, while avoiding stranded assets due to competition for scarce renewable resources.
- Analyse the drivers and barriers for implementing the selected decarbonization strategies.
- Perform regional energy arbitrage, risks analysis, and opportunities for the Canadian steel value chain to better understand competition versus other industries to access limited resources like biomass, renewable electricity and hydrogen and the implementation of CCUS strategies.



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