Optimizing US Steel Production For Climate Goals

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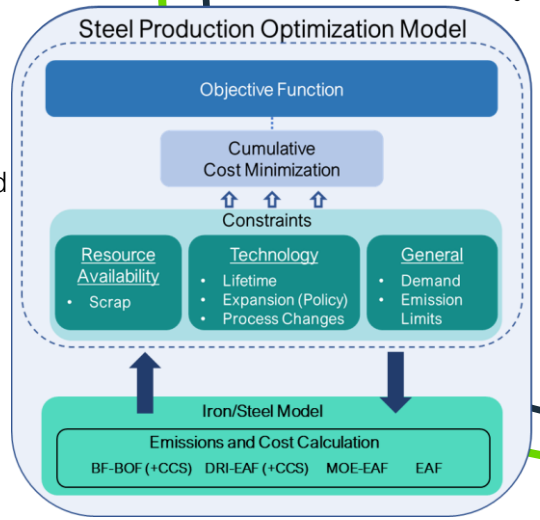
Introduction

- The United States has goals of cutting 50% of emissions by 2030 and reaching net zero emissions by 2050[1].
- Steel industry-related emissions were responsible for about 11% of greenhouse gases from US industrial processes and product use[2].
- There's a gap in evaluating the **cost optimization scenarios for the US steel industry's transition** to cleaner steel production while considering new IRA credits[3-4].

Materials And Methods

- We conduct greenhouse gas (CO_2 equivalent) emission analysis from key raw material extraction to the crude steel production. Our analysis also includes the costs within the steel plant boundary.
- Selected steel production pathways: coal-based **blast furnace-basic oxygen furnace (BF-BOF)**, natural gas and hydrogen-based **direct reduction and electric arc furnace (NG-DRI and H_2-DRI)**, carbon capture and storage **(CCS), molten oxide electrolysis (MOE)** and **EAF** using scrap metal.
- We use plant and sector-level information (ex: emission goals, lifetime, demand) to optimize cumulative cost in Python via our linear program model.
- The years of interest are from 2022 to 2050.

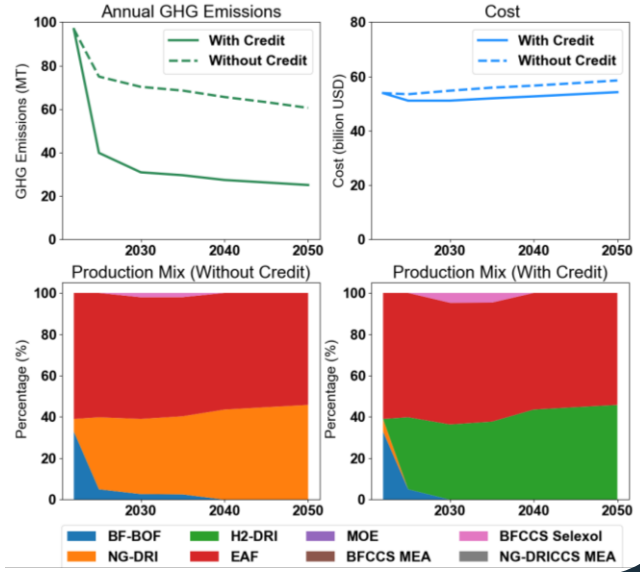


Research Highlights and Impact

- We optimize US steel production on a cost basis with and without relevant IRA credits.
- **Without the credits, natural gas-based production is favored for primary (non-recycled) steel and less carbon capture is utilized.**
- Over five times as much natural gas is consumed without the credits.
- Adopting the 45V credit ($3/kg H_2) and 45Q credit ($85/t$CO_2$ captured permanently) benefits the US steel industry:
  - **1 Gigatonne of cumulative CO_2e emissions are avoided** from 2022-2050.
  - Over **$3 billion in cost savings in 2030 and over $ 4 billion in 2050.**

Cost Optimization with and without hydrogen and carbon capture (45V and 45Q) credits

Results (Graphs/Diagrams)



Discussion/Conclusion

- The optimized system adopts new technologies like H_2DRI and carbon capture, but **almost 25 million tonnes of greenhouse gas emissions** remain.
- Future work will look at replacing fossil fuels from raw material preparation, ironmaking and steelmaking with biomass, and as well as other potential decarbonization incentives for the industry.

References

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