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Towards Green Steel: Challenges, Opportunities, and Strategies for Decarbonization

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The steel industry, responsible for 7% of global CO₂ emissions, significantly contributes to environmental pollution and intensive water consumption. Decarbonizing the sector requires adopting innovative technologies such as hydrogen-based direct reduction, recycling in electric arc furnaces (EAF), and iron ore electrolysis. However, this transition presents major challenges, including the high cost of new technologies, the need for an efficient renewable energy and smart grid infrastructure, scalability issues of emerging solutions, and dependence on raw material purity, which affects both efficiency and production costs.

At the same time, standardization and regulation of the industry are crucial to prevent greenwashing risks and ensure market transparency. Instruments such as the EU's Carbon Border Adjustment Mechanism (CBAM) and carbon pricing policies can incentivize sustainable practices, while international collaboration and targeted investments will accelerate the shift.

The objective of this paper is to provide a critical analysis of the steel industry's transition toward low-emission processes, highlighting key technological, economic, and regulatory challenges. Through a comparative approach, the barriers to adopting new technologies and possible strategies to overcome them will be examined, focusing on practical solutions that balance sustainability and competitiveness.

The path to truly green steel is long and requires strong commitment from both businesses and governments. If implemented correctly, these steps could not only decarbonize the steel industry but also position steel as a fundamental pillar of the global green transition. A crucial aspect of this journey will be the continuous monitoring and improvement of adopted solutions to ensure sustainability goals are effectively met and maintained over time.

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