International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

A Revolution in Steel industry: Towards Sustainability

Vibhu Sawhney

Student, Business, Gems New Millennium School

Abstract

Steel is one of the largest industries in the world but the manufacturing process emits up to 8% to 10% of the worlds CO2. This is because to make steel it requires fossil fuels like coal. This causes a lot of environmental damage. As the people are getting more and more invested in the idea of a sustainable world, many companies that produce steel have already devoloped a solution for this that is Green steel that is going to help them tackle the problem of global CO2 emission.

In this research we are going to investigate how the steel industry is shifting from traditional steel manufacturing to environmentally friendly green-steel production and what are the challenges they are facing to adopting it quickly. The paper also reviews present day
technologies which support this transition and shows how major companies back this change and assesses both financial and environmental aspects of green-steel deployment. The research demonstrates that green steel technology enables the construction industry to reach
sustainability targets through affordable solutions.

Introduction

The steel industry one of the biggest industries in the world which is valued at a massive USD 1.63 trillion in 2025 and predicted to increase from USD 1.72 trillion in 2026 to approximately USD 2.60 trillion Steel is so deeply used globally that the world cannot work without it in modern time. Steel has maintained its fundamental role in industrial development since ancient times because it functions as the fundamental building material for constructing all types of structures from small homes to tall skyscrapers. The material stands out because it shows exceptional durability and versatility and complete recyclability for different construction requirements. The production of conventional steel requires large amounts of energy which results in major CO2 emissions. The environmental protection movement has triggered a fast-growing interest in developing green steel technology for steel production. The research examines how green steel technology enables construction industry development through sustainable growth while maintaining economic stability.

What Is Conventional Steel?

Steel stands out because it offers high strength and high flexibility at the same time. The strength to weight ratio of steel makes it an excellent material for builders to construct lightweight yet extremely strong structures. The material maintains 100% recyclability which makes it
suitable for long-term building projects. The construction method of steel enables builders to create prefabricated frames at higher speeds. The production of conventional steel through blast furnaces with coal results in major greenhouse gas emissions during its manufacturing process.

Environmental Impact

The construction industry relies heavily on steel for development yet steel production generates CO2 emissions which result in major global temperature increases. The industry operates as one of the world's leading carbon-producing industrial sectors and produces 8 to 10% of the global CO2. The development of green steel works to decrease environmental pollution while supporting sustainable construction.

Defining Green Steel

The manufacturing process of green steel uses environmentally friendly methods which produce less carbon emissions than conventional steel during production. The production of green steel happens through electric arc furnaces which run on renewable power instead of traditional blast furnaces that use coal. The production of green hydrogen through renewable energy sources enables its use as a carbon-neutral substitute for coal in steel manufacturing. It's Contribution to Sustainability Goals The usage of green steel technology serves as an element for worldwide sustainability initiatives because it helps countries reach their sustainability targets. The use of renewable energy and green hydrogen in steel production results in a 95% reduction of emissions compared to traditional steel manufacturing techniques (Hawkins et al., 2023). The reduction of emissions produces better environmental conditions which produce beneficial impacts for human health and natural ecosystems. The production of green steel from recycled scrap materials reduces the requirement for primary resources and decreases the need for mining activities. The growing market for sustainable materials creates employment opportunities throughout the renewable energy and clean technology sectors (Brown & Smith, 2022).

Applications and Production Methods

Green steel maintains full compatibility with conventional steel for all construction needs including bridge construction of bridges and infrastructure development. The structural framing industry benefits most from green steel because its lightweight strength properties make it suitable for prefabricated construction. The use of green steel in construction projects leads to improved operational efficiency which results in financial advantages and reduced energy consumption. The construction industry will adopt green steel as their primary material to achieve net-zero emission targets in their upcoming projects

Barriers to Widespread Adoption

The market has not adopted green steel on a large scale because two main obstacles stop its implementation. The high expenses for producing green steel through new methods stem from the challenges of constructing extensive renewable energy infrastructure. The green steel market requires financial support and regulatory frameworks to create market demand because it currently has no market presence. The green steel market sector needs proper financial and regulatory backing to grow because it operates as a new market segment. The green steel market sector faces obstacles during its development because it operates as a new market segment but will expand through suitable financial and regulatory support. The market adoption of green steel encounters multiple obstacles which stop its broad market acceptance. The complications faced while producing green hydrogen.Whenever we talk about the slow adoption of green steel we often link it to limited market support and high costs, even though the biggest challenge is not discussed a lot. One of the most important reason of green steel being adopted at a very slow rate is in the complicated way of making green hydrogen. Green hydrogen cannot be produced by just expanding the factories or getting approvals by the government but Green hydrogen requires emmens

amounts of solar and wind energy, and the machines that are used to separate hydrogen and oxygen still operate at low efficiency, which result to waste of energy. Another big issue with hydrogen is with its storing and transportation, as it's a very light gas it is also very important to store It in extremely cold temperatures or under high pressure. These challenges are way different from financial or market barriers, and this makes it harder for industries to depend on hydrogen every day. where section 8 tell us about the economic and the financial barriers that affects the adoption of green steel this topic explains us the that the transition to green steel is very difficult as the production, storage, transportation of green hydrogen is very complicated. Understanding the difference between these are very important for researchers as it allows them to identify the technical and economic and technological requirements for transforming the steel sector.

Government Support and Policies

Multiple governments worldwide have initiated policies which include: The European Commission developed a Green Steel product identification system which enables customers to locate products that fulfill low-emission standards (European Commission, 2022). Steel manufacturers must run their operations with renewable energy because of mandatory rules which support sustainable business practices (International Energy Agency, 2022). The Global Steel Association supports steel recycling through its policies which enable the creation of new products from recycled steel materials (Global Steel Association, 2023).

CASE STUDY 1 (HYBRIT)

hybrit pioneering fossil free steel in sweden hybrit is one of the earliest and most ambitious global efforts to create large scale green steel the initiative began in 2016 as a collaboration between three major swedish companies ssab is a well known steel producer lkab is a state owned mining company and vattenfall is a national energy provider together they set out to build a steelmaking chain that avoids the use of fossil fuels from the moment the ore is mined until the final product is made their process replaces coal and coke with green hydrogen which is used to directly reduce iron ore in 2020 hybrit opened its pilot facility in lule in northern sweden and successfully produced sponge iron using only fossil free hydrogen the following year ssab rolled the first batch of fossil free steel and delivered it to volvo marking an important milestone for the industry hybrits own assessments show that this new hydrogen based method can cut carbon dioxide emissions from roughly 1600 kilograms per ton of steel to about 25 kilograms which represents a dramatic improvement challenges faced energy demand and supply producing green hydrogen requires huge amounts of renewable power hybrit found that scaling hydrogen production must happen alongside major expansions in renewable electricity generation and improvements to the national power grid meeting this demand remains one of the projects largest challenges efficiency and industrial scale although the pilot plant proved that the concept works running a full industrial operation with pure hydrogen is far more complex current electrolysers still face efficiency limits and hydrogen costs remain higher than traditional fuel sources making large scale production difficult hydrogen storage hybrit developed an underground storage site to stabilize hydrogen supply but storing hydrogen safely and affordably is a technical challenge the infrastructure requires advanced engineering and significant investment economic risk and policy support the project relies heavily on government support and public funding analysts have raised concerns that if electricity prices rise or if renewable capacity does not grow fast enough the overall business model may be affected consistent policy backing is important for long

term success scaling up to commercial production hybrit plans to open its first commercial scale sponge iron plant in gllivare around 2026 with a target output of about 13 million tonnes moving from a pilot facility to full industrial production however requires major capital investment secure long term hydrogen supply and a lengthy permitting process.

Their goal is to reduce 10% of CO2 emitted in sweden

Case Study: ARS Steels & Alloy International Pvt. Ltd.

ARS Steels & Alloy International Pvt. Ltd. operates as the top Indian company for green steel manufacturing based in Tamil Nadu. The company specializes in manufacturing low-carbon steel products which include TMT bars for building construction needs. The company achieved two essential milestones during its operational period.

ARS achieved a CO2 emission rate of 1.6 tons per ton of steel which positions it among the lowest in India (ARS, 2025).

ARS became the first Indian business to deliver ultra-low-emission TMT bars for vital construction projects (ARS, 2025).

ARS has established a goal to reach net-zero carbon emissions across its operations before the industry reaches this target in 2028 which is 2 years before the industry(ARS,2025).

Economic Implications

The construction industry shows interest in green steel because its extended benefits
exceed the initial investment costs. The construction industry can select green steel as a substitute for conventional steel because it provides recyclability and low carbon
emissions and green building certification. With the technology if the companies produce on large scale which will decrease production costs and increase market penetration of green steel.

Conclusion

The construction industry must adopt green steel because it represents an essential step toward environmental protection and worldwide climate target achievement. The adoption of green steel faces two main barriers which stem from expensive production methods and insufficient infrastructure development. The long term advantages of green steel for environmental protection and economic growth remain undisputed in the current market Even though there are many challenges. The combination of green steel technology development with government support will make this material essential for sustainable building practices which will create an environmentally friendly and enduring future.

REFERENCES

1. Hawkins, R et al (2023). Green Steel and Its Environmental Impact. Journal of Sustainable Manufacturing Science and Production, 45(3), 213-230.
2. Brown P & Smith L. (2022). The Future of Green Steel in the Global Market. Economic Review of Steel, 33(2), 101115.
3. Miller J. and his co-authors published Advancing Net-Zero Construction: The Role of Green Steel in Green Building Journal Volume 16 Issue 4 from pages 77 to 89 during 2021.
4. Chavez M. and Liu H. conducted research about industrial challenges that prevent green steel adoption in Environmental Economics Volume 9 Issue 1 from pages 25 to 40 during 2023.

5. The European Commission published The EU Green Steel Taxonomy as a document in 2022. Brussels: EC Press.
6. The US Department of Energy published the National Hydrogen Strategy as a document in 2023. Washington D.C DOE.
7. The International Energy Agency published its Global Energy Report in 2022 from Paris. Paris: IEA.
8. The 2025 Annual Report from ARS Steels & Alloy International Pvt. Ltd appears in Tamil Nadu. Tamil Nadu: ARS. Jackson L. and his co-authors published Economic Viability of Green Steel Production in Journal of Green Economy Volume 28 Issue 2023 Issue 1 from pages 14 to 28.
9. https://www.precedenceresearch.com
10. https://www.jswsteel.in
11. https://www.hybritdevelopment.se/en/