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Decarbonization In the Steel Industry, Resource Management and Environmental Impact Assessment

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ABSTRACT

The steel industry, as one of the basic global industries, plays a very important role in the production of carbon dioxide and greenhouse gases. Considering the necessity of the global decarbonisation process and the big challenges facing the steel sector in Iran, the stakeholders must discover ways to achieve the decarbonisation of the Iranian steel sector. In this context, we present an initial exploration of this perspective, where the general focus is towards using suitable substitute materials, using more scrap steel and changing existing recycling methods to remove more impurities (e.g., vehicle disassembly). instead of crushing them, which challenges material separation). better design and material substitution; increasing energy efficiency; Changing carbon-intensive technologies to net zero; etc., which have the potential to accelerate the transition towards decarbonization of steel and thus strengthen and promote the vital process of decarbonization in the steel sector. New technologies are being developed that will significantly reduce carbon emissions in the iron and steel sector. Ways in which the uptake of more sustainable technology can be stimulated, including their orientation.

Introduction

Green steel: green steel, uses recycled materials and metal waste as raw materials and uses advanced technologies and optimal methods, to reduce greenhouse gas emissions, save natural resources, and reduce the environmental effects of production. This type of steel is produced through the electric induction melting (EAF) process and using renewable energy. Green steel is considered a more sustainable alternative to traditional steel, as its production results in lower greenhouse gas emissions and air pollutants. Also, using recycled materials in the production of green steel means reducing the use of natural minerals and preserving natural resources.

Green steel is used in various industries such as construction, automotive, marine industry, energy industry and machinery industries. The development and use of green steel can help preserve the environment, reduce greenhouse gas emissions, and preserve natural resources.

Decarbonization of Iranian steel:

Iran's steel sector is economically significant. Pressure to reduce carbon emissions is intensifying as other countries strive to achieve net zero carbon emissions by implementing green trade policies, such as carbon taxes and laws to limit carbon leakage. In Iran, the steel sector is mainly supplied by coal-fired power plants, which emit significant amounts of CO2. The primary methods used in Iran to reduce iron ore to iron include BF and EAF processes. Decarbonization of Iran's steel sector may include the use of alternative energy sources, such as renewable energy or the development of carbon capture and storage technologies. However, these alternatives are still in the early stages of preparation. According to research, Iran's goal of decarbonization and transition to net zero requires significant structural and legal reforms on a national scale.

Iran's commitment to the goal of the Paris Agreement to achieve net zero emissions by early 2050, along with the challenges of the steel sector, emphasizes the importance of socio-technical reforms for decarbonization. These reforms include significant adjustments in technology, materials, organizations, institutions, politics, economy and socio-cultural aspects.

Unfortunately, studies show that Iran still relies heavily on fossil fuels as its primary energy source, and this dependence creates challenges in accelerating energy transfer to support the low-carbon development path, and the use of alternative sources is inevitable.

Research method:

The research method of the green steel production process may be different depending on the methods and technologies used, in this research the following steps were investigated:

- Collection of recycled materials: first, recycled materials such as steel waste, recycled iron, industrial waste and biological indicators are collected.

- Classification and cleaning of materials: The collected materials are examined and classified and any contamination, contaminants or other foreign objects are removed from them. Then the recycled materials are washed and cleaned.

- Melting and purification: Recycled materials that are classified are placed in a melting furnace. In this step, iron is cleaned from other materials and a uniform mixture of iron and green steel is obtained.

- Production of green steel: green steel is obtained by melting recycled materials and iron as the output of the melting furnace. This green steel can be used to produce various steel products.

- Post-manufacturing processes: After green steel is produced, other processes such as forging, casting, shrinking, cold shrinking, plating, and chipping may be performed to produce final products.

Green steel production is done using advanced technologies and improved methods. Below, I mention some of the important technologies used in the production of green steel:

- Electric induction melting (Electric Arc Furnace - EAF): In this process, electric induction furnaces are used to melt materials. These furnaces use induced electricity to generate heat to melt materials

and produce green steel.

- Use of recycled materials: Green Steel uses recycled materials such as steel scrap, recycled iron and industrial waste as raw materials. These recycled materials reduce the supply of mineral resources and help reduce the environmental impacts associated with mineral extraction.

- Optimization of production processes: improved techniques and technologies such as precise control of melting temperature and time, optimization of material flows and reduction of pollutants are used in the green steel production process. These improvements can lead to energy savings and improved quality characteristics of green steel.

- Use of renewable energy: In the production of green steel, the use of renewable energy such as solar and wind energy is considered. These methods reduce greenhouse gas emissions and lower dependence on fossil energy sources.

- Pollution control technology: To reduce air and water pollution related to green steel production, advanced filtration, separation and purification technologies are used. These technologies ensure the improvement of air quality and minimize the emission of pollutants.

- Energy efficiency: In the green steel production process, techniques and technologies are used to improve energy efficiency. Among these technologies, we can mention heat recovery, optimization of heat transfer systems and optimal use of secondary energies.

- Waste management: In the production of green steel, improved methods of waste and waste management and recycling are used. This includes the collection and recycling of usable materials, the proper management of hazardous waste, and the reduction of waste generation.

These technologies and methods help to reduce environmental impacts, improve the efficiency and performance of green steel, and save resources. Also, by improving the production processes and using advanced technologies, the amount of pollution and emission of greenhouse gases will be minimized.

Results and discussion:

The world's steel industry is making a serious turn towards the production of steel in electric arc furnaces, analysis shows, due to the phenomenon of global warming and the need to reduce the production of greenhouse gases (GHG) in the world, which has a tremendous impact on climate change and has had a climate, the production of steel in electric arc furnaces is quickly traditionally replacing the production of steel with the consumption of coal (for the production of metallurgical coke) required for use in blast furnaces that produce carbon dioxide and greenhouse gases. Therefore, the trend of iron and steel production in the world using electric arc furnaces is increasing.

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The global steel industry is embracing electric arc furnaces at a favourable rate, a clean alternative to the blast furnaces typically used to produce steel.

The share of iron and steel production in carbon emissions (global GHG) is 7%. In the process of converting iron to steel, producers use coal and heavy fossil fuel pollutants in blast furnaces. Therefore, the trend of iron and steel production in the world using electric arc furnaces is increasing. A new analysis by San Francisco-based Global Energy Watch also found that shortly, 43 per cent of planned global steelmaking capacity will be based on electric arc furnaces, down from 35 per cent last year. 2023 has also increased. The report states: "The steel industry has moved from inactivity to progress in the direction of green steel production and reduction of carbon gases, which is an important factor in global warming".

However, the transformation process is not happening fast enough to transition to green steel production. Electric arc furnaces should account for 53% of the total global steel production capacity by 2050 to be guided in the direction that aims to limit the time trend of heat up to 1.5 degrees

Celsius. If the current trend of global steel production continues with the use of blast furnaces and the use of fossil fuels, until 2050, the share of steel production from electric arc furnaces will remain around 35%.

- The use of green steel compared to traditional steel has significant environmental and economic benefits. Below are some of the benefits of using green steel over traditional steel:

- Reduction of greenhouse gases: traditional steel releases a lot of greenhouse gases such as carbon dioxide into the air. On the other hand, green steel leads to a significant reduction in greenhouse gas emissions by using recycled materials and optimizing production processes.

- Conservation of natural resources: Traditional steel production requires a large amount of minerals, such as iron ore. But green steel, by using recycled materials, depends on less consumption of natural resources and leads to the preservation of mineral resources.

- Reduction of water and soil pollution: Traditional steel may indirectly cause water and soil pollution in its production process. However, in the production of green steel, using advanced technologies and methods, water and soil pollution is minimized.

- Energy saving: Traditional steel production requires high energy consumption because it requires melting iron ore in large furnaces. Instead, green steel requires less energy consumption and provides energy savings by using recycled materials and optimizing production processes.

- Longer lifespan: green steel has more resistance and strength due to the use of recycled materials and optimization processes. This makes green steel products have a longer useful life and require fewer repairs and replacements.

- Economic added value: The use of green steel can help produce products with high added value. Due to the growing need for sustainable and environmental products, green steel can act as a factor of market trends and competitive advantage of companies.

- Supply of recycled resources: The production of green steel using recycled materials leads to more demand for collecting and recycling metal scraps. This leads to the creation of a market for recycled materials, gradually reducing the landfilling of metal waste and the use of new resources.

By using green steel, it is possible to design and build structures and products that take into account high energy efficiency, reduction of greenhouse gas emissions, and preservation of natural resources. This change towards the optimal use of resources and environmental protection can also be beneficial for society in general.

Conclusion:

Green steel is produced by hydrogen fuel and electrolysis of water and electricity. This steel is not structurally different from normal steel and the only difference is in the production method. Apart from the high costs of this method, green steel reduces environmental pollutants and greenhouse gases and significantly contributes to the preservation of the environment. The need to decarbonize the steel industry is critical to curbing climate change. Hydrogen-based direct reduction is one promising low-carbon technology under investigation. While there are challenges associated with its implementation, the potential benefits of hydrogen-based steelmaking are significant. With continued research and investment, the steel industry can become a more sustainable and low-carbon future. To curb climate change, the process of reducing iron ore to a product equivalent to crude iron is essential. After decades of research, several technologies are beginning to approach commercial readiness. In addition to carbon capture and storage, two promising low-carbon technologies are molten oxide electrolysis and direct hydrogen reduction.

Green steel is a very good solution to reduce carbon emissions and uses hydrogen and electric fuel instead of fossil fuels to produce steel. To achieve mass production of green steel, we need strict rules by international organizations and governments. Of course, such a process is currently very expensive and requires advanced equipment, and it cannot be expected to achieve such a product overnight.

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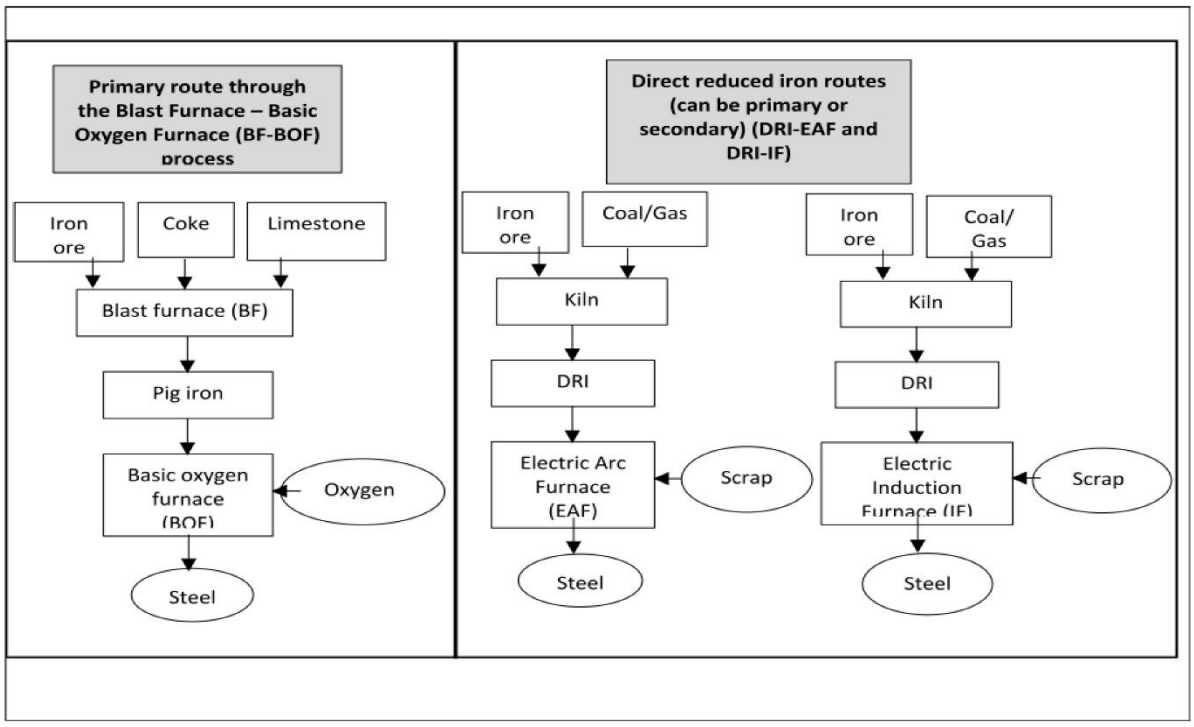

Figure 1: Steel production process in Iran

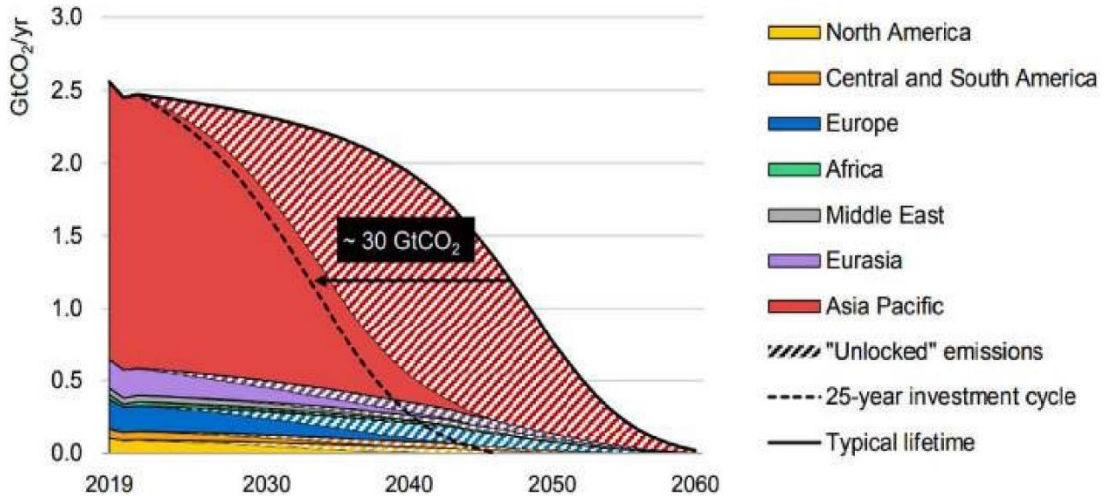

Figure No. 2: Lifetime prediction chart of CO2 emissions resulting from the production infrastructure of Daran steel