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Article

SDGs in the EU Steel Sector: A Critical Review of Sustainability Initiatives and Approaches

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Abstract: SDGs are playing an increasing role in defining sustainability paths for energy-intensive sectors. In particular, the steel sector is promoting several parallel initiatives as a key player sector in the European process industry. This work describes the major focal trends related to the sustainability of steel and presents the principal EU approaches and initiatives linked with the ESTEP action area. The core sustainability issues related to SDGs in the EU steel sector are presented with a particular focus on the quantification approaches. Then, the paper presents different areas for SDG implementation by single organizations in the EU context. Such areas provide an operational path for managing and implementing SDGs. In particular, the key areas include: (1) roadmapping initiatives with a focus on specific sustainability targets; (2) eco-labelling trends with reference to usage per label typology; (3) reporting initiatives by single organizations with a focus on specific SDGs; and (4) representative EU steel R&D projects related to selected sustainability targets. The discussion part focuses on a critical review of all presented areas to summarise the main paths in adopting SDGs targeted at the EU steel sector level. As the final outcome, prime emerging barriers are suggested as well as critical issues in implementing SDG-based sustainability targets.

Keywords: sustainability; SDGs; steel; LCA; decarbonisation; eco-labelling

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1. Introduction

Sustainable Development Goals (SDGs) and sustainability find direct and indirect focus action in the process industry since these are key targets for business in the next years: as an example, the iron and steel industry is among the most energy-intensive sectors. It is connected to real-life applications (e.g., building and infrastructure construction [1]), and it is characterised by a process that requires several raw materials with associated environmental, economic and social impacts.

Sustainability in steel has become a dominant topic in recent years as demonstrated by several initiatives and projects aimed at increasing awareness and enforcing the use of quantification methods to products, processes and company-related aspects (e.g., the workforce, surrounding environment and social responsibility) [2]. The actual meaning of sustainability started in the 1980s after its appearance in the 'Limits to Growth' publication of The Club of Rome in terms of ensuring world development in a sustainable way [3].

After a steady state of interest, a new boost appeared after the UN's adoption of the Sustainable Development Goals in 2015 and the awareness that practical implications of these definitions were required to ensure a fair future for humanity and the planet. However, the risk that the word sustainability, due to its presence in the policies and the high attention placed by regulators, becomes only a buzzword is high, especially when other overarching topics become predominant (e.g., the COVID crisis, wars and chip shortages), and the focus is shifted to one of them.

Moreover, most of the natural events (in terms of extreme events) that happen are strongly interconnected, and ensuring a balance within them in evaluation and management is crucial to attempt to understand some of the possible causes and prevent new escalations. Within the Circular Economy Focus Group of the European Steel Technology Platform (ESTEP), several initiatives are in place, and, among them, the production of this paper aims to:

- Evaluate the status of activities related to the sustainability of the steel sector.
- Identify points of strength and weakness.
- Attempt to identify future directions for improvements.

ESTEP

ESTEP was formed in 2003 as one of the first European technology platforms and includes the major stakeholders in the European steel industry. The members comprise major steel manufacturers, steel-related companies, universities and research institutions (including research and technology organisations, i.e., RTOs) that work in the steel sector, major steel users (such as car manufacturers), public bodies and national governments. Since 2018, ESTEP has been a non-profit organization according to Belgian law (an international non-profit-making organization).

The mission of ESTEP is to engage in collaborative European Union (EU) actions and projects on technologies that tackle EU challenges (notably on renewable energy, climate change, circular economy, etc.) to create and promote a sustainable EU steel industry. This is done by disseminating the results of projects, facilitating a supportive environment for collaborative projects and an active network of the ESTEP community sharing best practices.

There are three focus groups (FGs) that cover steel applications: (1) steel solutions for transport and mobility, (2) steel solutions for construction and (3) infrastructure and steel solutions for energy markets, including engineering. FGs deal with activities for attracting people to the steel industry, skill development, education and training programs and occupational safety. FGs for smart factories cover issues for intelligent and integrated manufacturing, applying developments in information and communication techniques.

2. The EU Steel-Making Context for SDGs and Sustainability

2.1. Main Sustainability Issues in the Steel Sector

Among the sectors in which a crucial effort is required to tackle the goals of sustainability and decarbonisation within 2050, steel is one of the most affected. The global production of crude steel is about 1909 Mton, and about 72% of crude steel production comes from Asia, with outstanding performance from China, which alone produces about 54.1% of the global production. Regarding Europe, the EU accounts for 8.0% (152.6 Mton), and CIS (Commonwealth of Independent States) countries account for about 5.5%. Germany is the country with the highest production, followed by Italy and Spain [4]. In the EU, the steel sector's annual turnover is 125 billion EUR.

This industry directly employs around 310,000 people with an average production of 153 million tons of steel per year in more than 500 production sites [4]. The iron and steel sector consumed 33.57 EJ of energy in 2018 [5], and energy costs represent one of the central portions of the manufacturing costs. The concept of sustainability applied to steel appeared several years ago, although it was first related to the economic area.

Energy- and material-intensive sectors have always paid attention to finding new ways to produce more efficiently, reducing the costs while benefiting from cheap energy. In recent decades, the environment, due to enhanced awareness, also became of primary interest for the steel players. However, the steel sector is considered one of the most challenging sectors to decarbonise due to internal constraints (e.g., high heat requirements, the critical role of carbon, trade challenges and extended asset life) [6].

Moreover, steel-making processes have already been optimised over the years to close their thermodynamic limits, and further improvements seem challenging [7]. The energy input requirements significantly decreased from 50 to 75 GJ/ton of liquid steel in 1970 to 20–30 GJ/ton in 2010 [8]. However, the total energy use has increased over the years (from 18.3 EJ in 2000 to 33.4 EJ in 2017) due to the increase in steel production [9].

According to the International Energy Agency (IEA), the projected global steel demand will rise by more than a third by 2050, mainly due to the increased requests of emerging economies for steel [5]. Therefore, although, over the years, the ratio of CO_2 emissions per ton of steel has constantly decreased, in a scenario where steel production will grow, the greenhouse gas (GHG) emissions are projected to become higher than today if adequate measures and innovations to reduce GHG emissions are not enacted.

Steel production takes place at either an integrated facility directly from iron ore or at a secondary facility, in which recycled steel scraps are the main input. In integrated facilities, different parts of the process usually find places, such as coke production, blast furnaces, basic oxygen steel-making furnaces (BOFs) and, also in same case, open hearth furnaces (OHFs), a technology that has become rare [6,10,11].

In these plants, the blast furnace produces pig iron that is utilized by the basic oxygen furnace to produce crude steel. In contrast, electric arc furnaces (EAF), which heat materials by means of an electric arc, are mostly used to produce secondary steel but can also melt solidified iron or sponge iron (direct reduced iron (DRI)). In the EU, the shares of production between these two methods are 56.4% BOF/other and 43.6% EAF, respectively, 86,087 and 66,548 Mton [4].

In 2020, the total direct CO_2 emissions of the steel sector were about 2.6 billion tons, representing between 7% and 9% of global CO_2 emissions [12]. According to the report of material economics, globally, it is estimated that, for every ton of steel produced through integrated steel-making, on average, 2.3 tons of CO_2 are generated with the better performance of the European producers, which, on average, produce 1.9 ton of CO_2 per tons of steel [13] (according to Worldsteel , 1.85 ton of CO_2 [12]).

The two methodologies presented differ substantially in the diversity of inputs and energy intensity: in BF/BOF (the primary route), carbon is crucial since it is utilized as a reducing agent (including other materials), as the energy source required to reach the temperatures by which is possible melt iron ore, and it is an essential element of steel. On the other hand, the CO_2 emissions from secondary steel are significantly lower due to the different inputs required and the possibility of acting on the energy mix, which generates electricity. The approximated value is 0.4 tons of CO_2/ton of steel for EAF [14].

A relevant driver for the sustainability of steel is related to the use of scraps as input for secondary steel (and in part also for primary steel), with an average recycled content estimated at 82% in EAF and 23% for primary steel in the United States (US) [15]. If steel can be recognized as one of the most recycled materials on the planet, this is highly related to the chance offered by the scraps depending on their availability [15,16]. Scraps are usually divided into three groups [14,15]:

- Home scraps: scraps that are internally generated in the steel production process and are consumed within the factory gate.
- New scraps: scraps generated by manufacturers of steel-containing products are transported from scrap dealers and, therefore, are likely to contain residuals.
- Old scraps: this is the highest share of scraps and comes from end-of-life of products that entered service (e.g., vehicles, buildings and infrastructure). This kind of scrap has an embodied product life.

Other critical environmental impacts are associated with steel production, such as water consumption: according to Gao et al., in China, a ton of steel consumes on average 7–8 m^3, while, in other developed countries, this is 3–4 m^3 due to outdated technology and plant age [17]. Several chemical compounds, such as ammonia, cyanide, benzene, naphthalene and chlorides, can be found as pollutants generated by steel processes [9]. Other criticalities are related to air pollution [18–20], water pollution [21,22] and the evaluation of the consequences of steel activities on human health [24? –26].

2.2. The SDGs and Sustainability Approaches in the Steel Industry

In 2015, the members of the United Nations developed the 2030 Agenda for Sustainable Development, in which 17 Sustainable Development Goals (SDGs) and 169 related targets are the central pillars upon which to build future strategies. Through this instrument, the UN focused on the main drivers to ensure a sustainable future for the entire world. In addition to the well-known definition of sustainable development, over the years, it has become increasingly clear that there is a need to focus not only on the economy but also on other features that contribute to sustainable development, including the environment and social impacts.

The so-called "triple bottom line" is one of the most widely adopted sustainability concepts developed by Elkington [27]. Through this, a new point of view was developed, proposing a balanced approach between the three components [28]. However, in practical terms, it is challenging to comprehensively assess the topic even when utilizing different sustainability assessment methods (see Section 2.3).

One possible approach in the steel sector aimed to pursue the sustainability targets can be industrial symbiosis where, with the adoption of circular economy principles, it is possible to maximise the exchanges of physical material and by-products within the different value chain actors [29–31]. An interesting point of view is the possibility of including SDGs within the influence of the nexus concept [32–36]. Apparently, the most prominent target on which international policies about sustainability focus is the reduction of CO_2 emissions without considering the other environmental components.

The key message of the nexus concept is to emphasize the critical interlinkages across different resources with a dedicated focus on synergies and trade-offs in a more integrated manner and not aseptically. Bleischwitz et al. proposed a five-node nexus, defined as a resource nexus, composed of land and materials, in addition to the most prominent ones, i.e., water, energy and food, as a context-specific methodology to trace and link two or more natural resources [33]. This approach follows the one developed by Liu et al. about the comprehension of the realities and complexity of the interconnections between human and environmental systems as a crucial factor to be integrated into SDGs [37].

Another instrument that is strictly linked to companies and SDGs is the production of the sustainability report, which includes sustainability strategies as part of corporate social responsibility [38]. Through these tools, it is possible to actively assess the positive and negative impacts of policies and business choices with the possible linking of activities to specific SDGs. In this regard, some scholars introduced the new term "SDG-washing" with an apparent reference to green-washing in which companies are not transparent in presenting the results or their activities [39,40].

A possible contextualization of SDGs in the steel sector is depicted in Hatayama's review of fifty steel companies [41], in which only thirteen of them presented an association between the activities in place and SDGs. According to the authors, the reason for this is that half of the steel companies under analysis were based in China, and these actors tend not to link activities with SDGs. Companies focused mainly on SDGs related to developing production processes, improving the working environment and community services. However, it is remarkable that metal industry associations (concerning steel, Worldsteel and Eurofer) suggest that companies include SDGs evaluation in their reports.

2.3. Quantification Approaches for Sustainability

As support for companies and stakeholders, different tools have been developed to quantify sustainability practices in a structured manner. Johnsson et al. presented a comparison of five SDG assessment tools developed by different companies analysing the aim, scope, boundaries, focus and use of the results [39]. Long et al. indicated the importance of a sustainable assessment indicator system to support development toward a more environmental-aware development of the Chinese steel industry and outlined how this is missing [42]. Overviews of sustainability assessment tools can be found in the industrial sector and also in policy making. Review and examples are widespread, focusing on different methodologies or strategies depending on the scholars [43–47].

Most of the tools mentioned above rely on the framework of the life cycle assessment (LCA) and the related life cycle cost (LCC) and social life cycle assessment (S-LCA). These three methods, respectively, focus their analysis on the environment, economy and society: the concept of life cycle sustainability assessment (LCSA) was created to incorporate these three aspects and to provide a comprehensive analysis considering the pillars on which sustainability relies. LCA is a methodology that quantifies the potential environmental burdens of products or services along all the life cycle stages according to different categories [48].

Through this assessment, it is possible to evaluate and manage environmental impacts by providing support to industries and setting specific targets that can be used to optimize them [49]. ISO 14040 and ISO 14044 [50,51] provide the framework and rules to generate an LCA. The European Commission and, in recent years, national trade associations (e.g., Confindustria in Italy, for instance, in the ceramic and electric and electrotechnical sectors as well as Worldsteel and Eurofer at the international level) recognized the importance and the robustness of LCA to assess the potential environmental impacts as a support for designing low environmental impact products and support claims. The broad scope of LCA allows different applications (services, products, processes or parts of these). However, some aspects are still in progress, such as the translation of LCA results in SDG-ready data to support sustainability reports [41].

The importance of the steel sector concerning environmental impacts led a large number of LCA (and also LCC/S-LCA) studies to evaluate different aspects, comparisons and production methodologies [52–65]. Worldsteel recognized the importance of this method in 1995 with the first life cycle inventory data collection, which has been continuously updated for 17 products [66]. EUROFER supports LCA and life cycle thinking (LCT) as a fundamental methodology related to product policy making as the EU's 2020 Circular Economy Action Plan stresses. The association provides essential input to the environmental impact indicators of the product environmental footprint (PEF) [67]. One of the strengths of LCA is the ability to consider the impacts of the whole value chain from raw materials through the production and use phase until the end of life management based on the system boundaries selected for each study.

Despite all the presented potentialities of LCA, it is important to also stress the weakness related in particular to the complexity of the data retrieval, the time-consuming activities requested, the need for an iterative process and the difficulty in the comprehension of the results. Therefore, another methodology that has gained popularity within companies is the carbon footprint (CF), which can be considered an LCA on a single impact category [68–71]. Based on ISO 14067 [72], the CF is characterized by some differences in assumptions and calculation compared with the LCA, so it is not easy to compare LCA and CF results [62]. One of the critical aspects is the division of the results in scope: in fact, the GHG Protocol [73,74] includes the concepts of value and supply chain, dividing the GHG emissions from business into three categories:

- Scope 1: Direct GHG emissions occur from sources that are owned or controlled by the company.
- Scope 2: This accounts for GHG emissions from the generation of purchased electricity consumed by the company.
- Scope 3: This is an optional reporting category that allows for the treatment of all other indirect emissions, such as the consequences of the activities of the company but occur from sources not owned or controlled by the company.

Scope 1 and 2 are the ones that can be easily calculated and found in most of the environmental communication of companies (e.g., sustainability reports, environmental claims on "zero emissions"). However, it seems challenging to calculate Scope 3 emissions, although most of the time, they account for a significant share of a business's carbon footprint.

In the steel sector, the CO_2 emissions of downstream processes are usually much lower than from ore-based upstream (core) processes. Therefore, the focus lies on upstream applications as well as Scope 1 (direct emissions) and Scope 2 (indirect emissions from the production of required energy) emissions. This trend of focusing mainly on Scope 1 and 2 has spread to different sectors. Table 1 shows, for different sectors, the different values of scopes according to sustainability reports or other information available for some relevant companies.

Table 1. GHG emissions divided by GHG protocol scopes for different sectors based on publicly available documentation.

Sector	Company	Scope 1	Scope 2	Scope 3
Steel	Ori Martin [75]	20%	26%	55%
Steel	voestalpine [76]	53%	2%	45%
Steel	Outokumpu [77]	22%	34%	44%
Steel	Tata Steel Group [78]	69%	6%	25%
Information Technology	Apple [79]	<1%	0%	>99%
Information Technology	Huawei [80]	1%	36%	64%
Energy	Enel [81]	41%	4%	55%
Energy	Equinor [80]	5%		95%
Confectionery	Ferrero [82]	7%	1%	92%
Consumer Goods	Unilever [83]	1%	0%	99%

Although the carbon footprint is indeed considered as the most used and widespread technique to calculate impacts and monitoring emissions, including in the steel sector, other methodologies are currently in place, such as the water footprint that tracks the water consumption dividing it into the three categories: green, gray and blue [65,84,85]. For example, Mattila et al. showed that, for CO_2 mineralisation using steel-making (BOF) slag, the single impact global warming potential (GWP) resulted in a flawed LCA, making it necessary to include other impact categories, such as water use [86]. A proper definition of the system boundaries and the so-called functional unit (for example, kg CO_2/kg steel produced) will help to determine if simplified concepts, such as CF, can replace a proper LCA that can cover up to twenty impact categories in addition to GWP.

2.4. Main EU Policy Schemes and Initiatives

EU objectives toward increased attention and awareness of sustainability implications are becoming stricter and more demanding year by year. With regard to the steel sector, the European Commission, for instance, enforced anti-dumping and anti-subsidy duties on imports from foreign countries, such as China, Korea, Turkey and Russia, to support and protect EU steel [87]. In June 2021, the EC extended the EU steel safeguard measures for three years to stabilise imports due to the current market fluctuations.

The steel sector in Europe is following a daring path toward reducing the environmental impacts associated with steel production to meet the requirements of the EU Green Deal and other leading EU initiatives, such as Fit for 55. The EU aims to reduce GHG emissions by at least 55% by 2030 and become the first climate-neutral content by 2050 [88]. In this regard, the ambition of reaching effective results before the 2030/2050 targets clashes with the economic dynamics and consequences of both the pandemic and war.

Reducing CO_2 emissions is not the only target on which the steel industry is currently focusing. In the EU context, the steel sector (represented by industry associations, such as eurofer) is covered by several EU Directives and regulations as a relevant stakeholder [67] (here below are some of them):

- Waste Framework Directive: Steel promotes measures to reuse products, reduce waste generation and increase preparation for reuse.
- Waste Shipment Regulation: it tackles illegal shipments of wastes to countries with more forgiving waste policies supported by well-defined procedures and audits to avoid these shortcuts.
- End-of-Life Vehicles (ELV): it represents a crucial, partially untapped scrap source for secondary steel-making, expanding the quantity of material that can be utilised.
- Regulation of Ecodesign requirements for sustainable and green products: the complexity of the definition about what *sustainable* and *green* mean and related terms allow space for several implications; therefore, proposals for more stringent definitions must be found.
- Industrial Emissions Directive (IED): leaning on the EU green deal framework, it tackles the theme of emissions. Further revisions of the Directive must integrate together multiple SDGs to achieve a comprehensive view of the topic.

Another critical policy mechanism is the EU Emissions Trading System (ETS), which profoundly affects the iron and steel sector due to the intrinsic nature of the energy-intensive sector. According to Stede et al., companies in the steel sector have been shielded from the total carbon pricing via the free allocation of emission allowances but, in this manner, on the one hand, they have been protected by the carbon leakage risks, on the other hand, this has delayed the adoption of technologies and initiatives for a transition [89]. Another measure implemented by the European Commission is the Carbon Border Adjustment Mechanism (CBAM) on the carbon content of imports.

Through this instrument, the EU aims to ensure that the steel incoming in the EU faces the same carbon prices as the EU steel industry, which is subject to ETS regulation [88]. An important field for the European Union is developing innovative projects through specific platforms and calls. In this respect, the Research Fund for Coal and Steel (RFCS), managed by the European Commission, is one of the most consolidated. Throughout its 20 years, it supported several projects to innovate the sector with applications in steel processes and digitalisation. In 2021, a new legislative package was created within the EU Green Deal.

Another important instrument is the Clean Steel Partnership (CSP), a public financing programme linked both to RFCS and to Horizon Europe (HEU), which, each year, converges about 100 M€ that are integrated by funding from the private sector. This program is in line with the climate ambitions and commitments set by the European Green Deal, the UN's 2030 Sustainable Development Goals and the Paris Agreement [90]. CSP nurtures the long-term vision that is aimed to reduce CO_2 emissions compared to the 1990 levels in two ways [90]:

- Develop technologies reducing CO_2 emissions from steel production by 50% by 2030.
- Develop deployable technologies that can reduce CO_2 by 80–95% by 2050, ultimately achieving climate neutrality and Technology Readiness Level (TRL) 8.

3. Initiatives in the Steel Sector

3.1. Roadmapping

Most steel companies are establishing different strategies to couple internal targets and specific objectives settled by national and international bodies. The main goal is to decarbonise as much as possible the whole sector through optimisation, new processes or the usage of specific parts/objects as well as optimising the use in other sectors of by-products. Before the COVID crisis in 2020 and the Ukrainian war-related issues in 2022, the roadmap appeared to be well defined with key dates set at 2025, 2030, 2040 and 2050 to meet specific increasing targets driven by international and company policies.

The foreseen strategies have been deeply modified, first, to react to the crisis and return to the previous levels and, in 2022, as a reaction to the sharp increase in the cost of energy and raw materials that are reflecting a drop-down reaching the supply and value chain and, in the end, the customers. According to Worldsteel [12], three different steps are required:

1. Step up: An important strategic programme to improve the efficiency of mill operations through the following:
    1.1. Optimal raw material selection and use.
    1.2. Increasing energy efficiency and minimising waste.
    1.3. Improving yield.
    1.4. Improving process reliability.
2. Maximisation of scrap usage: In this way, the BF/BOF path will slowly leave space for a wider diffusion of the EAF path.
3. Use of breakthrough technology:
    3.1. Use of carbon as a reducing agent and preventing CO_2 fossil emissions using carbon capture and utilization (CCU)/carbon capture and storage (CCS) and/or sustainable biomass (e.g., biocharcoal) [91].
    3.2. Substitute hydrogen for carbon as a reducing agent, producing, in this way, H_2O instead of CO_2.
    3.3. Use of electricity through an electrolysis-based process.

It is essential to indicate that these methodologies will require substantial funding and appropriate policies since the TRL of these technologies is still not high, and several efforts are still required. According to IEA [5], the additional cost of steel produced with technologies that are less CO_2 intensive would be around 10–50% higher than today. However, an interesting analogy that can be useful as a reference toward an optimistic future can be represented by the variation in the renewable electricity price over the years. In addition, IEA [5] stresses how the Chinese blast furnace plants, which account for over 50% of the global steel share, are relatively young (12 years on average), and their replacement with newer infrastructure is not economically feasible.

According to some scenarios, the steel demand in some sectors will be deeply influenced by material efficiency and circularity improvements as well as substitution with other materials, such as aluminium, plastics and carbon fibre [92]. However, from a life cycle point of view, these replacements may not be net-positive regarding CO_2 emissions. If, in some sectors, steel usage might be reduced, in others, it will be crucial. In the energy transition scenario, steel is the critical material for wind turbines (representing about 70–80% of the mass of a single turbine) and also for photo-voltaic (PV) panels.

Studies infer that, on the one hand, between 107 and 132 tons of steel per MW installed are required for wind energy and, on the other, for PV energy, around 68 tons per MW. Moreover, according to the foreseen plan concerning climate action, the demand for steel from wind and solar energy would be around 3.7 Mt/year (wind) and 1.8 Mt/year (solar) by 2030 and, by 2050, would reach 7.0 Mt/year (wind) and 3.7 Mt/year (solar) [93]. Digitalisation can significantly support better management of steel demand and utilisation (including end-of-life handling).

Several activities are currently in place from both an ecodesign point of view (the optimisation of quantity of steel used and reduction of scraps) and for scrap quality sorting as an input material in EAF. Moreover, the possibility to provide information concerning the type of scraps utilised in input or the methods used to produce the steel (e.g., electricity source utilised) will be an essential topic in the broader framework of the Digital Product Passport proposal starting its expansion in several sectors. Another important issue is the usage of scraps as an essential material—in particular, for secondary steel [94–104]. Although steel produced through EAF is significantly less carbon-intensive, some constraints and limits may further limit the diffusion of this steel-making path. The quality and quantity of scrap currently limit the share of secondary steel.

Steel is used in infrastructure and buildings for its durability, among other key characteristics; therefore, a relevant quantity of potential scraps are "blocked". Although these quantities could become available, there is a high risk that the steel quality is inadequate for several sectors (e.g., automotive). Due to these quality constraints, most of the time, steel made from recycled scrap is utilised for applications that do not require a high-quality grade.

However, another aspect that seems to drive the market is funding availability. This consideration is required for investments; new projects; new products; better health, safety and environment (HSE) conditions; and salaries, and consumers are now aware of where the money comes from. However, the first aspect to consider is that there is no standard definition of green or sustainable finance [105–107]. Sustainable financing imposes that the investments focus on environmental, social and governance (ESG) aspects to provide a holistic assessment of these factors. In this way, it is possible to invest in sustainable economic activities and projects with a longer-term perspective [105,106].

According to the European Commission, this method has to "support economic growth while reducing pressures on the environment, addressing greenhouse gas emissions and tackling pollution, minimising waste and improving efficiency in the use of natural resources" [108]. Among all these definitions, the critical aspect is to consider sustainable finance (and even investments), as defined by Cunha et al., as an umbrella term representing all concepts related to the implementation of financial and investment activities based on sustainability-oriented strategies [109].

The Corporate Sustainability Reporting Directive (CSRD) entry into force for companies implies that economic and non-economic information included in the reports comply with the taxonomy to present the information transparently and provide a standardised way to share information. The banking sector is intended to follow a similar modality through the Sustainable Finance Disclosure Regulation (SFDR). According to Claringbould et al., around 180 billion € of additional investments will be required each year until 2030 in the EU to reach the energy and CO_2 emission reduction targets [108].

3.2. Labelling and Claiming

The opportunity to incorporate the footprints of the environmental (and even economic and/or social) impacts is an important leverage factor that can ensure that players place themselves in a dominant position and be ahead of several aspects that will very likely require attention in the future. Several standards are in place regarding the environment under the ISO 14000, and companies are adopting an increasing number yearly. Ways to communicate sustainability for products and companies can include the labels, which are certified by external companies (third parties), and the claims, i.e., declarations made by the company, which do not require any verification.

In particular, these standards can be essential for both the internal organization (e.g., ISO 14001 related to the Environmental Management System) and for market purposes. The opportunity to sell products with associated standards or labels is an asset for the market, especially with the increasing requests for this information in public procurement. In the construction sector, in particular, this aspect is becoming crucial, and the availability of an eco-label associated with a product can be a game-changer. Environmental labels can provide information about the overall environmental benefits of a product or service. This kind of information can significantly influence consumer choices while risking producing greenwashing practices. Environmental labels can be divided into three types:

1. Type I—environmental labels: applied for ecolabelling schemes in which the product criteria are clearly defined (e.g., Nordic Swan, EU Ecolabel and Blue Angel) and regulated by ISO 14024. An ecolabel identifies products or services proven to be environmentally preferable within a specific category.
2. Type II—Self-declared environmental claims: labels made by the manufacturers themselves where there are neither criteria or labelling schemes (compostability and recyclability). Regulated by ISO 14021.
3. Type III—Environmental declarations: labels produced using a life cycle approach through specific programs managed by dedicated organizations (Environmental Product Declaration (EPD)) and regulated by ISO 14025.

An example of a type I ecolabel applied to steel is the ABNT (Associação Brasileira de Normas Técnicas) Environmental Label [110], an Ecolabel, obtained by ArcelorMittal Brasil for some of its plants as certification of the initiatives undertaken by companies in terms of reducing the environmental impacts [111]. Another is GreenPro, an Indian ecolabel that focuses on a holistic lifecycle approach in the building and manufacturing industries [112]. In the steel sector, an increasing number of companies are creating specific departments dedicated to sustainability with a specific focus on obtaining Type III eco-labels.

In order to produce this certification, a deep knowledge of industrial processes, materials and energetic aspects is required since all these are under analysis in a life cycle study. Some of Europe's leading EPD programme operators are Environdec, Product Environmental Profile (PEP) Ecopassport, Institut Bauen und Umwelt (IBU), Aenor, EPD Italy and epdNorge. Through the generation of an EPD, companies can share with stakeholders the environmental impacts associated with a specific product or service transparently due to the external verification required by the programme operator to release the label. A remarkable point is the fact that type III labels are voluntary; therefore, companies are not required to produce them and, notably, they are not free; therefore, such an activity is a plus with economic implications for companies.

Additionally, the wide range of steel applications and related products do not always make it possible to produce an EPD immediately. However, additional effort is required to generate specific product category rules (PCR) that can be considered as the practical application of general programme instructions for a specific group of products: this operation makes possible the setting of the best framework for the development of the study case by case. Table 2 presents an overview of the number of EPDs produced by ESTEP platform members.

Table 2. Number of environmental product declarations (Type 3 environmental labels) produced by members of the ESTEP platform.

Company	Number of EPDs	Programme Operator
ArcelorMittal	30	Institut Bauen und Umwelt e.V. (IBU)
Salzgitter	2	Institut Bauen und Umwelt e.V. (IBU)
Tata Steel Europe	11	Tata Steel UK
Thyssenkrupp Steel Europe AG	2	Institut Bauen und Umwelt e.V. (IBU)
voestalpine	8	Institut Bauen und Umwelt e.V. (IBU)
Bauforumstahl	4	Institut Bauen und Umwelt e.V. (IBU)
Outokumpu	4	Institut Bauen und Umwelt e.V. (IBU)
Sidenor	3	Environdec
Vallourec	2	Environdec
Duferco	2	Environdec
Tenova	1	Environdec
Acciaierie di Sicilia	1	EPDItaly
AFV Accaierie Beltrame	1	EPDItaly
Alfa Acciai	1	EPDItaly
Alfa Acciai	2	EPDItaly
Feralpi Siderurgica	2	EPDItaly
Ferriere Nord	4	EPDItaly
Tenaris	6	Environdec
Ori Martin	4	Environdec
Celsa	9	Environdec
Aperam	4	UL
Liberty Steel Group	4	CENIA—Czech Environmental Information Agency

The EPDs are simply a part of the green labels that are proliferating in the market and are widespread in different sectors. These labels are private and public with the possibility to be voluntary based on companies' willingness to invest in them due to the related cost.

However, one of the main criticalities is that different claims are hardly comparable because each label relies on different methodologies and assumptions.

Therefore, there is a high risk that a considerable number of green labels do not effectively support the path toward more sustainable products or processes but enhance the confusion reducing the trust in this kind of solution. A similar case can be found in the finance sector, where massive investment growth in sustainable financing may hide greenwashing practices since no standard assessment and follow-up methodologies are available. Therefore, one central EU aim is to harmonise this complex network by adopting standard methodologies that can ensure consistency and comparability, such as the Green Claims and Sustainable Product Initiative.

The German steel trade association (Wirtschaftsvereinigung Stahl) proposed a classification system for green steel as a subsequent step after the definition of the essential elements of a green steel definition [113]. Although this is only a preliminary work, this activity may pave the way for the identification and agreement on what the term green should imply for the steel sector first, in Germany and then in the whole of Europe.

Society regulates the demand for products, and, since green consumerism is becoming crucial especially for new generations, the market must fulfil these requests through long-term strategies that ensure consistency. From this, the rationale of the policies undertaken by the EU can be summarized as shown in Figure 1 [114].

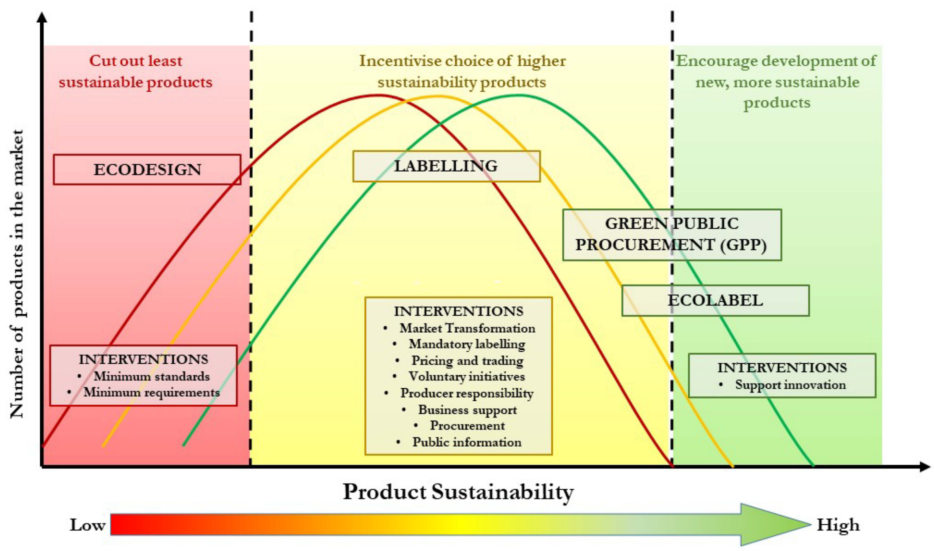

Figure 1. EU actions on product labelling.

From a company perspective, the possibility to share its strategy and objectives transparently with stakeholders is important, mainly due to the enhanced awareness concerning sustainability and the resulting competitive advantage. In this context, claims are widespread in different contexts of the market aiming to show each product as one of the best options available for a specific aspect (e.g., CO_2 emissions or water consumption). Due to the confusion generated by growing availability of environmental labels, the EU Green Deal took action to force companies to base their green claims on standard methodologies to reliably assess the impacts on the environment and society.

3.3. Reporting and Initiatives

Using green labels is not the only way to embrace sustainability utilized by companies. The instruments developed by public authorities, such as the SDGs and the EU Green Deal, with their multiple objectives and approaches can support the industrial sector first toward an increased awareness about sustainability implications and later to a shift of behaviour. Especially for large companies, the communication of activities related to sustainability and their commitment can be crucial since the consumers' attention is progressively increasing.

Therefore, there is a high risk of adverse impacts (e.g., reputational risk) on the market if policies are not transparent or are misleading.

The integration of SDGs in steel-making must be a priority, and some results are already available. However, expanding the attention to SDGs not directly linked to steel and steel-making should be defined as a mid-term target to ensure the balance mentioned above and avoid polarised initiatives toward a specific goal. As part of sustainability, an even greater integration of steel in the context of the Circular Economy may be essential to building other activities. The re-use of slag, dust, water and other by-products in different sectors is a strong asset that may be verified the feasibility of further implementations or applications.

The possibility to insert these products on a broader framework must be ensured and supported by legislation, and the companies that perform specific treatments must meet the minimum standards for their application in other sectors. The goal should be that everything that is produced (the products, by-products and, if feasible, even wastes) might be utilised as input or ancillary materials for another production path to avoid the loss of materials that can be utilised. A possible method to be developed jointly for new infrastructures or improved efficiency is the concept of industrial symbiosis, searching for new applications and enhanced optimization.

In addition, a social symbiosis might be foreseen in terms of utilising by-products (e.g., district heating from waste heat in steel-making, carbon capture and utilisation, producing synthetic calcium carbonate from steel-making slags) and infrastructure, such as the construction of renewable energy areas or projects related to society. Companies and businesses can then transfer a higher awareness of sustainability to other stakeholders and customers. Instruments foreseen by international policies, such as the Digital Product Passport, can include sustainability-related information, such as:

- Life cycle data, including the results of LCA analysis for different impact categories or single ones.
- Data about the best practices or internal policies of companies in terms of specific projects (e.g., European frontiers projects or internal projects).
- Environmental and social claims supported by real data and compared with specific targets, such as SDGs.

As for SDGs, steel companies increasingly include information on their website and in their sustainability report, i.e., the public disclosure and communication of a company about ESG goals and the progress and expected strategies toward them. Worldsteel developed new sustainability principles with associated objectives and criteria to tackle nine topics related to ESG (see Table 3) [66].

Table 3. Sustainability principles according to wordsteel. Key SDGs for steel are indicated in bold.

Worldsteel Key Topic	SDG	Objective
Climate Action	7–13	Proactively address climate change and take effective actions to minimise the industry's GHG emissions
Circular Economy	12	Maximise the efficient use of resources throughout the life cycle of steel products and support society to achieve a circular economy
Environmental Care	3–6–11–12–14–15	Conduct operations in an environmentally responsible manner
Health and Safety	3–8	Maintain a safe and healthy workplace and act on health and safety incidents, risks and opportunities
People	4–8	Enable our people to realise their potential while providing them with an inclusive and fair working environment
Local Communities	6–11	Build trust and create constructive relationships with local communities
Responsible Value Chain	12	Lead responsible business practices through the value chain
Ethical and Transparent Operations	8–12–16-17	Conduct operations with high standards and transparent processes
Innovation and Prosperity	1–8–9	Pursue innovations for technologies and products to achieve sustainable economic development

The Clean Steel Partnership within its objectives aims to contribute to SDGs, in particular, focusing on the following goals [90]:

- Goal 3—Good Health and Well-Being: through the decarbonization of the steel industry, CSP aims to contribute to the reducing the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
- Goal 8—Decent Work and Economic Growth: additional circularity of materials and improved productivity and efficiency in steel-making contribute to sustainable growth and better working conditions.
- Goal 9—Industry, Innovation and Infrastructure: technical developments in the steel sector bring huge potentials for less resource-intensive infrastructure solutions and contribute to the transformative innovation in other industrial sectors, leading to growth, high-value technology, innovation and resource efficiency.
- Goal 12—Responsible Consumption and Production: the enhancement of circularity in the steel industry contributes to the promotion of responsible consumption and production patterns.
- Goal 13—Climate Action: CSP will facilitate research, development and demonstration of technologies that eliminate CO_2 emissions in the steel sector.

To practically evaluate how and how well steel companies are considering SDGs in their policies, the authors of this paper performed research on the United Nations Global Compact website. In this portal, companies of different sectors can provide evidence of their strategies and operations regarding universal principles, such as human rights, labour, the environment and anti-corruption. We filtered the participants to the initiative based on the type (selection of 'Company' field) and sector (selection of 'Industrial Metals & Mining') without filtering on specific countries. In addition, we also included a brief review of the companies involved in ESTEP that are not included in the United Global Compact website for a final number of forty-seven companies under analysis.

The analysis aims to show how companies behave and their commitment to the SDGs. It is possible to see that most of the efforts focus on economic goals (following the division proposed by Rockstrom and Sukhdev [115]). In contrast, applying to societal and environmental goals showed only some hot spots (Figure 2), particularly about climate action (SDG 13). It is essential to mention that several companies, although participating in the United Nation Global Compact (UNGC), showed no indications of SDGs covered by their internal policies and strategies.

To tackle aspects related to sustainability and SDGs, several parallel initiatives (and related standards) are currently ongoing, and the following ones are the main ones applied to the steel sector:

- Science-Based Target initiative (SBTi) [116]: This is a partnership between Carbon Disclosure Project (CDP), the United Nations Global Compact, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF). Its main scope is related to climate through the definition of a path to reduce emissions in line with the Paris Agreement goals. The steel sector has a dedicated path that is currently under development due to different stakeholders' support. The focus of SBTi is on the operation phase.
- Energy Transitions Commission (ETC): This is "a global coalition of leaders from across the energy landscape committed to achieving net-zero emissions by mid-century", in line with the Paris climate objectives. The aim is to develop potential roadmaps for operational activities to support different sectors. Within these roadmaps, ETC aims to merge different methodologies, initiatives and corporate targets.
- Responsible Steel: this initiative focuses on steel aiming to define and promote responsible practices in different phases (i.e., sourcing, operations and products). In addition to the standards, they also produce a certification verifying compliance with the program.
- Centre for Climate-Aligned Finance: The focus is on the financial sector to help high-emitting sectors to overcome decarbonisation barriers. The development of the IMPACT+ Principles for Climate-Aligned Finance aims to support the private financial institutions in the identification of strategies aligned with sustainability targets.

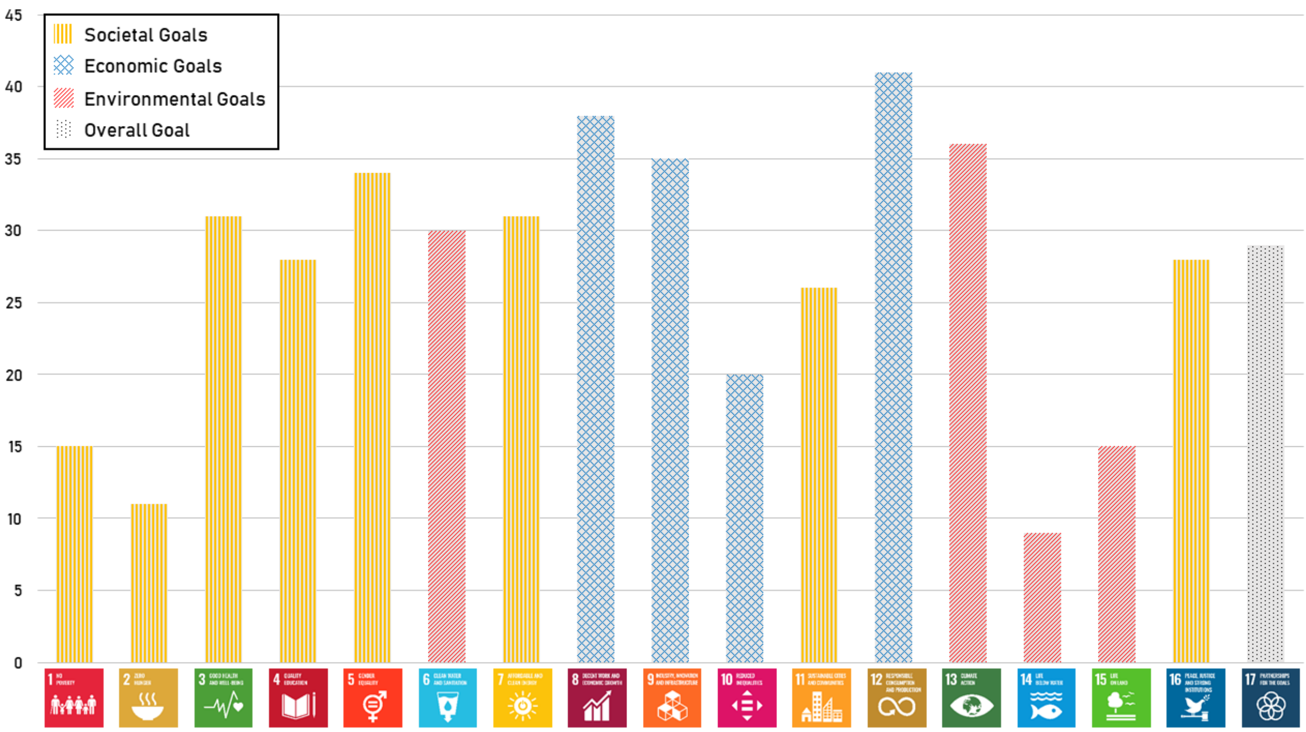

Figure 2. SDGs coverage across steel companies. Outcomes of analysis about SDGs from the United Nations Global Compact (UNGC) website and sustainability reports of participants to the ESTEP initiatives (forty-seven companies related to steel sector). The list of companies can be found in the Supplementary Materials.

However, it is essential to highlight the misalignments between voluntary initiatives and the broader regulatory framework. One key aspect is the different speeds because the firsts follow the market opportunities attempting to maximise any potential aspect. In contrast, the second ones are often slower, and sometimes it happens that, when ready to use, they are already overcome by new methodologies or initiatives. Secondly, since voluntary initiatives are often tailored to specific sectors, the transfer of the methodologies to other ones does not simply reduce their applicability in this way. Despite this, a public initiative may reduce or even solve these issues through supervision that can ensure harmonisation, reduced cost of compliance and enhanced trust. Increasing or imposing higher transparency may be the first solution for different aspects, and some examples are listed below:

- Operations: a review of the requirements for companies to report and disclose emissions through the EU Pollutant Release and Transfer Register (E-PRTR).
- Products: with the support of proper digitalisation tools, it is possible to include environmental performance aspects, tracked in several ways, such as LCA or the carbon footprint in a product in the framework of the Sustainable Products Initiative and Digital Product Passport.

3.4. Innovation

The iron and steel sector is characterised by several R&D activities directed at finding new technologies to improve the quantity and quality of production, reducing both costs and environmental (and social) impacts. During the last couple of years, industry sectors have been deeply affected by energy prices with severe impacts on the cost of production in all its phases. Most of the innovation activities seems to be focused on specific SDGs (12, 13, 8 and 9) in particular with respect to the decarbonisation initiatives, enhancing circular economy practices and founding new ways to reuse materials or take advantage of new techniques.

However, the steel sector started the journey toward overall efficiency several years ago. Both private and public initiatives explored different paths and options in several fields of the steel-making process. Indeed, the European Commission recognised the importance of 'blending', i.e., this combination of EU financial support with public and private finance (e.g., pension funds or insurers) to support projects aimed at improving the sustainability efforts of companies [108]. In particular, in response to global and EU policies to reduce GHG emissions and avoid uncontrolled temperature growth, most activities focus on decarbonisation.

Kim et al. identified five different options and related emerging technologies that can support the steel sector in different phases, such as the raw materials, the proper steel-making process, the origin control of the products, the options for waste and recycling and potential emerging breakthroughs technologies [6].

Another EU report identified two potential pathways [88]. The first is one applicable in the short term by modifying the process and switching from fossil fuels to low-CO_2 energy sources, for instance, replacing the coal and/or coke in the BF with biomass [91] or hydrogen and by reusing the CO_2 through CCU for the production of basic chemicals and synthetic fuels. The second one is more complex and is characterised by the complete replacement with H_2 or electricity as input to reduce iron ore consumption, which will require new steel plants. Moreover, these technologies currently present a low TRL, and they might be deployed only in the most optimistic case in 2030 or even in 2040 or 2050.

The EU project "GREENSTEEL for Europe" aimed at the identification of the technologies needed and their impacts toward more sustainable production of steel, also focusing on the barriers and the key activities to be undertaken (see Figure 3) [98]. The Hybrit project is an example of a joint venture between Swedish companies (SSAB, LKAB and Vattenfall) that aims to find, investigate and evaluate new possible ways to make most of the value chain for energy-iron-steel fossil-free. In addition to this, with some overlap, Worldsteel [12] lists other projects defined as "breakthrough technologies" with a focus on primary steel (see Figure 4).

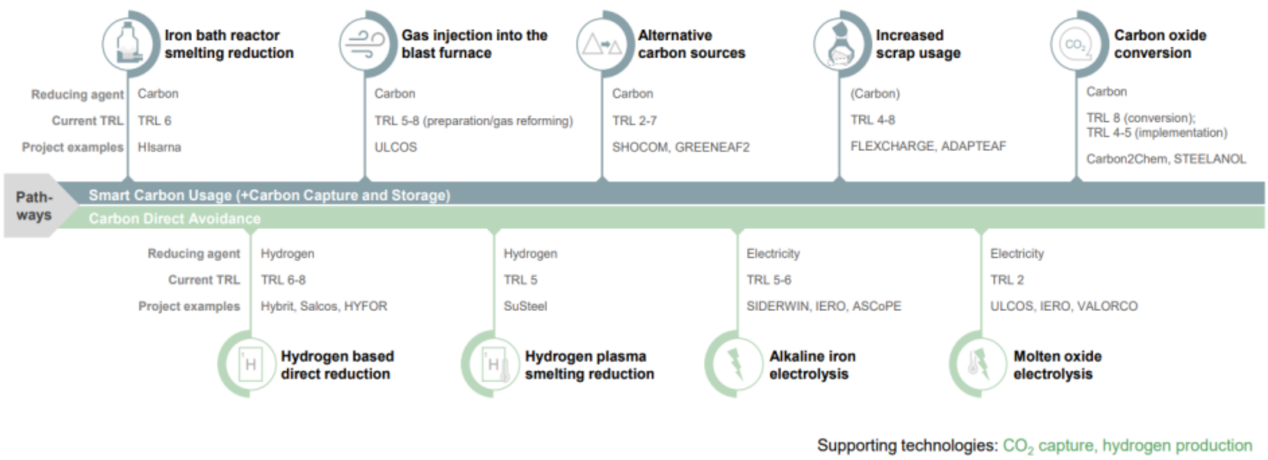

Figure 3. Decarbonisation technologies identified by GREENSTEEL for the Europe project [98].

From the circular economy point of view, the possibility of reusing steel scraps for producing secondary steel is a consolidated topic, and projects are focusing on better evaluating scrap quality through digital tools and reductions of scraps during the secondary process. Another critical trigger for the steel sector and circular economy is the residue valorisation (dust, sludge and slage) as steel co-products or by-products in other sectors instead of considering them as waste [9,86,102,117].

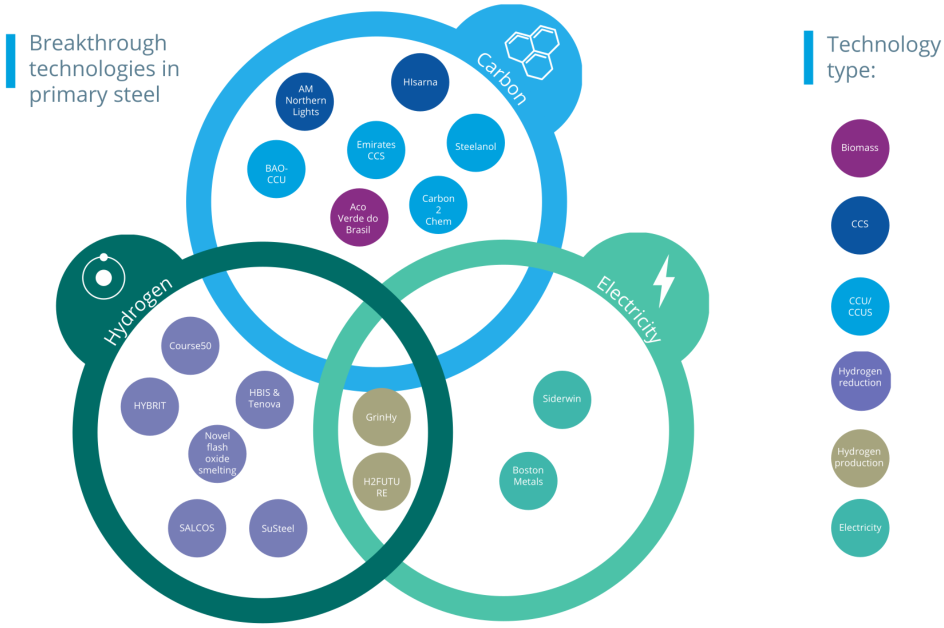

Figure 4. Projects identified by Worldsteel for decarbonisation in primary steel [12].

4. Discussion

4.1. General Outcomes

Several initiatives and strategies are in place or are foreseen to optimise the sustainability of the steel sector in different parts of its process. Since the most significant cause of concern is related to climate change and, therefore, GHG emissions (CO_2eq emissions), most of the practices focuses on this aspect through the substitution of carbon-intensive raw materials (carbon, coke and iron ore) and the source of energy (e.g., natural gas) with potentially CO_2-free materials or vectors to make decarbonisation possible. However, some of these efforts may be futile if the focus of the activities is only the reduction of CO_2 emissions without considering other pillars and aspects of sustainability as social aspects and other issues, such as water consumption, land use, biodiversity safeguards and ozone depletion.

The lack of joint actions related to SDGs in industry is a well-known issue that should be further investigated and, if possible, mitigated. An holistic perception is still missing and the evaluation of the interlinks of different SDG for activities and initiatives is not a key target. An example is the term "carbon tunnel vision" defined by Jan Konietzko to remark upon how, most of the time, the focus in policies and activities is targeted to achieving "net" zero emissions while ignoring other aspects of sustainable development goals [118]. For instance, switching from fossil fuel energy to renewable energy brings with it several benefits (e.g., reduction of CO_2 emissions) but also other considerations such as enhanced requests of rare minerals and land use.

If the steel sector aims to really reduce CO_2 emissions, only two routes are currently feasible: using direct reduction replacing fossil fuels with electricity (as the energy source) and hydrogen (as the reducing agent for iron ore) or attempting to capture as much carbon as possible storage underground (CCS) or devoting it for other purposes (CCU).

4.2. Specific Issues for Sustainability Implementation

According to the examined initiatives and context, it is important to highlight how several barriers and criticalities are scattered along the path.

1. Availability of renewable energy: Several initiatives rely on the foreseen availability of a huge quantity of renewable energy (210–355 TWh according to the report of Material economics [13] and over 350 TWh following for the Joint Research Center (JRC) and the European Commission [88]); however, first, while writing this, there is no such

availability, and, secondly, the associated cost is not competitive compared to fossil-based electricity. One of the key challenges will be ensuring the availability of this clean energy (wind, solar and hydro) and ensuring its stability through accumulators to avoid potential blackout of the lines if adverse conditions or situations occur.

2. Carbon capture usage and storage (CCU, CCS and CCUS): the technology for carbon capture actually can only act on a small share of the emissions that distinguish the steel-making process. Ref. [5] infers that, "in the Sustainable Development Scenario the iron and steel sector is projected to cumulatively capture 3.5 Gt CO_2 of its direct emissions by 2050, i.e., 6% of total direct emissions generated in the sector from 2020 until 2050". One of the main constraints is linked to differences in deploying these technologies at different geographic locations and the high costs associated with the development and utilization [98].
   Another critical aspect is related to the efficiency of such technologies related to carbon capture that perform reasonably well if directly linked to the steel-making process. However, extensive process modifications are required [88] and with lower performance for free air carbon sequestration. The usage in other sectors of the CO_2 captured may reduce emissions related to its production by dedicated producers giving value to a by-product of the steel-making process. However, a significant investment in developing the necessary infrastructure for adopting industrial symbiosis solutions are required to optimize these exchanges further.
3. High-quality steel scrap: one of the conditions to reduce the primary steel production (and, therefore, the associated impacts) relies upon the availability of scraps characterized by their reuse in sectors extremely demanding from the quality point of view. Due to the longevity of steel, its availability from decommissioned infrastructures, buildings and vehicles is limited. It may not satisfy standard requirements when reused due to several aspects, such as corrosion, new types of alloys utilized or impurities. Scraps are usually down-cycled to lower quality steel keeping the demand for primary steel high [88]. According to [95], in 2020, the proportion of steel scrap used in the EU's crude steel production was 55.7% with a significant difference compared to China, the world's largest steel scrap user, whose share was 20.7%.
4. Green market: products that take into consideration sustainability aspects usually also have higher costs and, therefore, embody a competitive disadvantage. Based on this, products of companies that invest on specific projects or initiatives aiming at sustainability in different aspects should be safeguarded by specific policies, such as the ones already in place (e.g., CBAM and ETS market) provided that the requirements are feasible and agreed within the stakeholders and not only imposed. This situation may arise if policies are integrated or changed over the years in response to modified factors and conditions setting more ambitious goals with a stricter deadline.
5. Funding and associated costs: the research on new technologies, the investments in the building of new factories, ensuring tracking of the different raw materials and sources of energies and better safety and occupational conditions of workers involve high costs. Private initiatives as part of the R&D department of companies are one of the main activities to find new applications and methodologies but, real effective substitution and game changer technologies require firm commitments, substantial funding and collaboration between different entities (companies, RTOs, universities and public bodies).
   Therefore, relying on all the initiatives of private sector cannot be feasible both for the utmost importance for the steel sector in the EU (and worldwide) both in terms of production and direct and indirect employment and for the amounts required to follow the development of specific technologies from a low TRL level to practical application. Moreover, another important aspect is related to the long development time required (even 20–30 years) for most technologies. Companies' decisions and initiatives cannot rely only on private funds that are susceptible to market dynamics (e.g., global crises in the last few years) as this can lead to interruptions in the development. A

similar argument was recently proposed for the deployment of large-scale CCS in the Netherlands, claiming a leading role for governments [119].

6. Public policies and regulations: several directives, regulations and laws are spreading both in the national and international spheres with ambitious targets, especially in terms of reducing GHG emissions to tackle IPCC objectives (e.g., the Green New Deal and Fit for 55), enhancing the availability and share of renewable energy in EU market. However, a critical aspect is the feasibility of the target defined especially when modified over the years toward more ambitious ones (e.g., switching from 2030 and 2040 as important dates to 2025 and 2035 [98]. The urgency of taking practical actions identified by public bodies should be complemented by discussions with the sectors involved in substantial modifications not to take the risk of companies' negative impact. Sustainability comprises three pillars, and every policy aimed to embrace this term must consider and consider all these.

The steel sector is focusing most of its efforts on decarbonisation and "green" production while keeping the reduction of GHG emissions and energy efficiency as essential. This focus is undoubtedly caused by policies that arrange most key performance indicators (KPIs) toward this; therefore, there is the risk of confusing decarbonisation with sustainability. Indeed, decarbonisation is only one aspect of sustainability, and wider recognition is required. In addition to the well-known carbon footprint, other methodologies will have to find space in sustainability assessment, such as the ecological footprint and water footprint.

One of the best methods to consider more aspects is the LCA (from an environmental point of view) typically providing more impact categories than GWP alone, which can be complemented with LCC and S-LCA in providing a complete life cycle sustainability assessment to define the potential GHG emissions generated by a product or a process, but other categories can also support the identification of the most suitable solution depending on specific objectives to avoid burden shifting.

It is important to remember that this method estimates the potential impacts due to the embedded limitations and assumptions. Therefore, LCA analysis and related outputs (such as EPD, PEF, OEF and carbon footprints) do not represent the perfect image but rather give a shadow of the item under analysis. However, these results are built utilising the best methodologies available and must be considered reliable while evaluating the sustainability of the processes and products.

5. Conclusions and Outlook

The steel sector is committed toward challenging targets related to both the process itself and from a broader point of view that includes the environment, economy and society. These should be the focus for activities and initiatives in the future that attempt to find the best balance possible to ensure the best conditions for the environment and society. The United Nations adopting the Sustainable Development Goals paved the way for streamlining the sustainability efforts of public and private entities. Through the seventeen SDGs and their related targets, it is possible to verify how the undertaken initiatives may reflect on the broader goal of sustainability and to identify the critical areas for a company and the weaker ones that require further attention.

One critical point that is relevant for all sectors and, therefore, also the steel sector, is to consider the implications that different climate actions and other policies may have for other sustainability goals. Resources on earth are interconnected, and the most challenging aspect is obtaining and ensuring a balance or steady state, avoiding focusing on a single aspect. For instance, the transition to using renewable energies must face considerations, such as the availability of rare earth materials that are crucial for producing electrical circuits that strongly influence water pollution and social consequences in the area where extraction and processing occur. These impacts are often buried and not considered in the areas where the products are then utilised. Methods, such as life cycle assessment, can support companies and stakeholders in the evaluation of strategies with the aim to make aware decisions regarding the impacts.

The chance to share best practices, key issues and potential synergies between the involved players in the steel sector may be crucial to tackle the enormous challenges related to sustainability and the applications concerning SDGs. A knowledge platform can avoid duplicate efforts and help to find the best partners for each potential solution. The path toward sustainability is steep and challenging: the best results will be obtained only through the shared commitment of stakeholders.

In this context, digitalisation and the concept of Industry 4.0 [120] can be significant drivers for new applications and optimisation measures due to the availability of a large amount of data valid for monitoring and extracting information. Within the ESTEP platform, some initiatives are already in place due to the synergies created between the FG Circular Economy and Smart Factories aimed at sharing best practices through the organisation of dedicated workshops.

Evaluating the best practices already in place in other sectors can be an essential support toward developing effective strategies with the possibility of avoiding overlapping or effort repetitions that may slow down progress.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su15097521/s1.

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