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REPORT

Challenges in implementing sustainable construction

The Dutch Building Agreement Steel as an example

Keynote at Eurosteel 2023 in Amsterdam

In response to the alarming environmental problems, there is a pressing need for a fundamental shift towards sustainable construction. However, limited attention has been given in the literature to the governance of this transformative change. The paper aims to address this research gap by investigating how the transition to sustainable construction can be realized despite the barriers encountered. The analysis focuses on the Dutch Building Agreement Steel as an illustrative case. By examining the governance structure of the Agreement and evaluating its results thus far, the study concludes that a collaborative network of partners has effectively developed a roadmap and performed accompanying activities to achieve the intended objectives. Nonetheless, a key challenge lies in mobilizing the entire construction steel chain and the government during the upcoming scale-up phase to actively adhere to the Agreement. This new form of network governance, facilitated by an independent intermediary, does not replace traditional public governance; rather, it complements it. The approach tested in the Netherlands holds potential for application in other contexts as well.

Keywords barriers; commissioning parties; Dutch Building Agreement Steel; environmental improvement; network governance; sustainable construction

1 Introduction

The escalating demand for environmentally-friendly practices creates an urgent imperative for the construction industry to capitalize on this moment, embrace new mindsets, and establish standards for transitioning towards a greener future [1]. As a sector encompassing the production of materials for buildings and infrastructure, the construction industry heavily relies on substantial quantities of materials, often of a weighty nature, such as stone, concrete, and steel. The extraction, processing, and transportation of these materials exert a considerable strain on the environment [2]. The industry is accountable for approximately 25 % of global CO_2 emissions [1] and causes air pollution, the release of toxic substances into water bodies, significant waste, and severe impact on the landscape [3]. To maintain a clean and safe living environment for future generations, a fundamental shift towards sustainable construction is imperative [4]. This implies that the construction industry will need to operate within the planetary boundaries, within which humanity can continue to develop [5], while concurrently pursuing economic prosperity and social equity [6].

The governance of this crucial shift towards sustainable construction has received limited attention in the existing literature. This paper aims to address this research gap by investigating how the transition to sustainable construction can be accomplished despite the barriers encountered. Specifically, the analysis focuses on the Dutch Building Agreement Steel, which sets high sustainability ambitions for the entire construction chain. Steel is chosen as the illustrative example due to its extensive use in the building sector, significant environmental impacts, and its role as a major contributor to carbon emissions, accounting for approximately a quarter of emissions in the building construction process. Given the magnitude of these impacts, there is an urgent need to develop a practical and viable path forward [1].

To begin, the paper will provide a background on the barriers that hinder the achievement of sustainable construction in general, with a specific focus on steel. Subsequently, a detailed description of the Dutch Building Agreement Steel will be presented. Finally, the outcomes of the case study will be discussed, and conclusions will be drawn regarding the generalizability of the findings.

2 Barriers for change

The transition towards a sustainable construction industry faces a myriad of challenges and complexities. The construction sector has traditionally been perceived as slow to adopt technological advancements and innovations [7]. This can be attributed to the traditional nature of construction activities and the industrial ecosystem's fragmentation. The construction process necessitates the involvement of numerous professionals, leading to a complex network of stakeholders. Additionally, construction supply chains are often intricate, relying on inputs and services from various sources, including providers of energy-intensive construction products such as steel, glass, aluminum, mineral products (cement, concrete, and concrete products), chemical products (asphalt, paint, varnish), and clay products (bricks and tiles). These materials are frequently sourced through trade with third countries [7]. Furthermore, the construction industry grapples with chronical issues such as project delays (affecting 70 % of projects), cost overruns (averaging 14 % of contract costs), and material waste generation (amounting to approximately 10 % of material costs) [8]. The transition towards a

sustainable construction ecosystem is further impeded by a range of barriers, the most significant of which include [7, 9]:

- a lack of regulatory requirements which would drive demand for circular approaches
- insufficient standards for secondary materials and lack of consensus on end-of-waste status
- challenges in comparing construction products using environmental criteria
- economic feasibility hindered by unfavorable market conditions and a dearth of financial incentives
- limited awareness within the construction industry

The steel construction sector encounters analogous commercial, structural, and regulatory barriers. The sector's typically narrow profit margins constrain steel producers willingness to invest in green technologies. Another obstacle stems from the fact that individual developers do not routinely account for emissions resulting from the steel they utilize. This situation arises due to a combination of factors, including the absence of industry standards, patchy regulation, and a lack of tools to measure embodied carbon. The third significant barrier to adoption pertains to the steel industry's services within a highly fragmented construction landscape [1]. Given this intricate context, effecting substantial change at scale becomes considerably challenging.

How to address and overcome these barriers, and the governance mechanisms required for achieving sustainable construction, have received limited attention in the existing literature. The number of publications on sustainable construction has significantly increased since 2010 [10]. However, most of these publications primarily focus on topics such as environmental management systems in the construction industry, identification and assessment of environmental aspects throughout the life cycle of construction products, technical aspects of sustainable construction, indicators of environmental performance, and environmental tools and certifications within the construction industry [11]. Nonetheless, the literature lacks comprehensive coverage of how to effectively eliminate these barriers and govern the transition towards sustainable construction, with particular emphasis on steel.

3 The Dutch Building Agreement Steel

3.1 Harnessing the potential of steel as sustainable building material

Steel is widely utilized as a primary framing material in buildings and finds application in various building components such as walls, roofing, fasteners, building services, substructures, and concrete reinforcement [12]. Compared to current construction practices, steel offers inherent advantages, including the potential for continuous recycling and reuse, as well as benefits such as dry construction methods resulting in less health hazards and waste, speed of construction, quality, durability and material efficiency [12, 13]. However, the use of steel as a building material also gives rise to negative effects, notably significant environmental impacts throughout the product's life cycle. This includes substantial CO_2 emissions during steel production and severe environmental consequences associated with acidification, eutrophication, ozone layer depletion, toxicity, and resource depletion [12]. Additionally, the reuse of steel and the adoption of recycled steel in the Dutch building sector are not common practices, with the exception of low-grade applications such as concrete reinforcement. Similarly, design and construction practices often neglect the circularity potential of steel products through intelligent, modular, and adaptive design approaches. The challenge lies in effectively harnessing the considerable potential of steel as a sustainable building material, as anticipated in the literature [14].

3.2 The design of the Dutch Building Agreement Steel

In order to reach ambitious sustainability targets, a voluntary partnership of stakeholders representing the entire steel chain within the Dutch steel construction sector has been formed. They have recognized the need to formulate and implement a program that strives for sustainable steel. The Agreement encompasses diverse interests, connecting organizations throughout the value chain and ensuring collective implementation of the stated ambitions. The fundamental premise of the Agreement is to uphold the quality and safety of steel products in construction, including resistance to external influences and other essential requirements. The knowledge organization *Bouwen met Staal* has assumed leadership in this initiative and has enlisted an independent chair to facilitate the governance of the transition process.

The execution of the Building Agreement Steel (BAS) has been divided into four distinct phases:

- Preparing Phase (September 2021–March 2022): This phase involves the preparation and signing of the Building Agreement Steel.
- Building Phase (March 2022–December 2023): During this phase, the coalition focuses on developing a comprehensive roadmap, appropriate standards, an agreed-upon environmental assessment methodology, a monitoring tool, an innovation program, and procurement requirements.
- Scaling-Up Phase (2024–2026): In this phase, the coalition aims to implement the roadmap through collaboration with commissioning parties, utilizing their procurement procedures.
- Mainstreaming Phase (2026–2030): The Building Agreement Steel seeks to become the new standard within the industry during this phase.

The governance structure of the Agreement and the results achieved thus far are further explored below.

3.3 Results achieved thus far

The preparing phase commenced with the establishment of a coalition of willing stakeholders representing the entire steel value chain, including commissioning parties. This collaborative effort has resulted in the formation of a core group comprising 24 partners, who officially signed the Building Agreement Steel in March 2022 [15]. The signatories have formulated three key sustainability ambitions deemed crucial for delivering substantial sustainability gains within the Netherlands:

- CO_2 reduction and application of renewable energy and energy saving measures throughout the supply chain
- Retaining the value of steel through developing the highest possible level of circularity
- Reducing the environmental impact of substances that pose risks to both human health and the environment

Specific ambitions and target objectives were slated to be developed in the subsequent phase, known as the building phase. Notably, the extraction of raw materials from external sources has been recognized as a driver of biodiversity loss, environmental pollution, and potential violations of human rights. While the parties involved acknowledge the gravity of these concerns, proactive measures are already being undertaken within the framework of the Dutch IMVO (International Corporate Social Responsibility) Covenant for the metal sector and through initiatives such as the *Responsible Steel* Initiative. These initiatives reflect a commitment to address the social and environmental impacts associated with raw material extraction in the steel industry.

Following the signing of the Building Agreement Steel, the core group of partners embarked on the building phase. During this phase, all necessary activities essential for progressing to the subsequent scaling-up phase are prepared. These activities encompass the development of a roadmap with specific ambitions and target objectives, as well as the creation of supporting instruments such as standards and an environmental assessment methodology. Additionally, a monitoring tool, an innovation program, and procurement requirements have to be devised. The core group of 24 partners played a pivotal role in supporting the process, convening regularly for working sessions every three months to facilitate the elaboration of these activities. To ensure effective oversight of the Agreement's execution, a steering board was appointed with the responsibility of supervising the implementation. The first task undertaken was the development of a roadmap. Initially, the key areas were identified where substantial CO_2 improvements can be achieved. This process culminated in the synthesis presented in Fig. 1, providing an overview of the major focal areas. Figure 1 reveals that significant opportunities for CO_2 improvements exist in the steel industry, structural design, steel structures, and recycling/reuse.

To explore the key improvement opportunities and assess their potential impact, the core group of partners formed subgroups. The first subgroup focused on the steel industry.

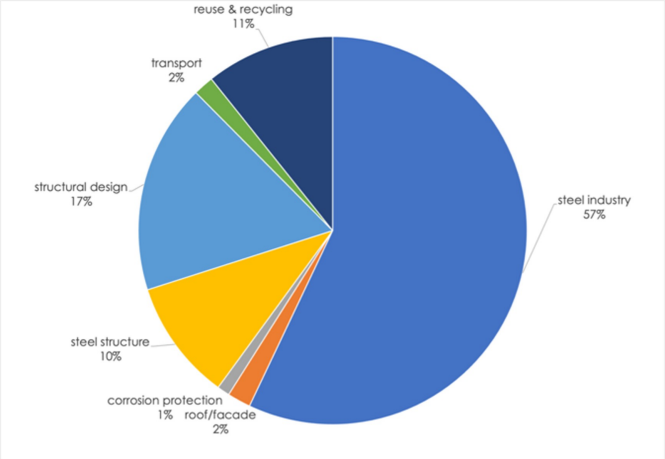

Fig. 1 Overview of the CO_2 impact share of activities in the Dutch steel construction sector

Notably, major European steel companies have expressed their intention to establish low-CO_2 steel factories equipped with advanced furnace technologies powered by either natural gas or hydrogen [1]. Because the Agreement does not influence this development, the timeline set by these major European steel companies for implementing these low-CO_2 steel factories was adopted as a given parameter. The circular design subgroup addressed the key options for circularity that can effectively reduce CO_2 emissions and minimize the use of virgin steel through improved design and construction practices. The reuse and recycling subgroup explored strategies to increase the percentage of steel reuse and promote the utilization of recycled steel. Additionally, considerations were given to the steel structure (particularly high strength steel) and the use of coatings in two other subgroups.

The overall assessment of the potential CO_2 reduction exceeded initial expectations, revealing a significant and attainable reduction of approximately 75–86 %, dependent upon the perspective of economic growth. This highlights the significant potential for reducing CO_2 emissions within the Dutch steel construction sector. These findings and prioritized options were translated into a roadmap, outlining the necessary environmental improvement steps to be implemented from 2023 to 2030 [16]. This roadmap is presented in Fig. 2. Importantly, Fig. 2 serves as the basis for formulating progressively stricter procurement terms over time. The active involvement of commissioning parties is vital in this endeavor, as their influence can drive the market towards sustainable practices [1, 13].

Addressing the challenge of securing binding commitments from all public and private commissioning parties to align with the ambitions of the Agreement has proven to be a significant undertaking. Despite efforts made by the chair of the Agreement on behalf of the participants, requests to the national government to enforce these commitments have thus far been unsuccessful. The Dutch government's main argument revolves around the decentralization of many tasks, including procurement. Consequently, a coalition of willing commissioning parties is currently being mobilized to assume collective leadership in driving change. By uniting

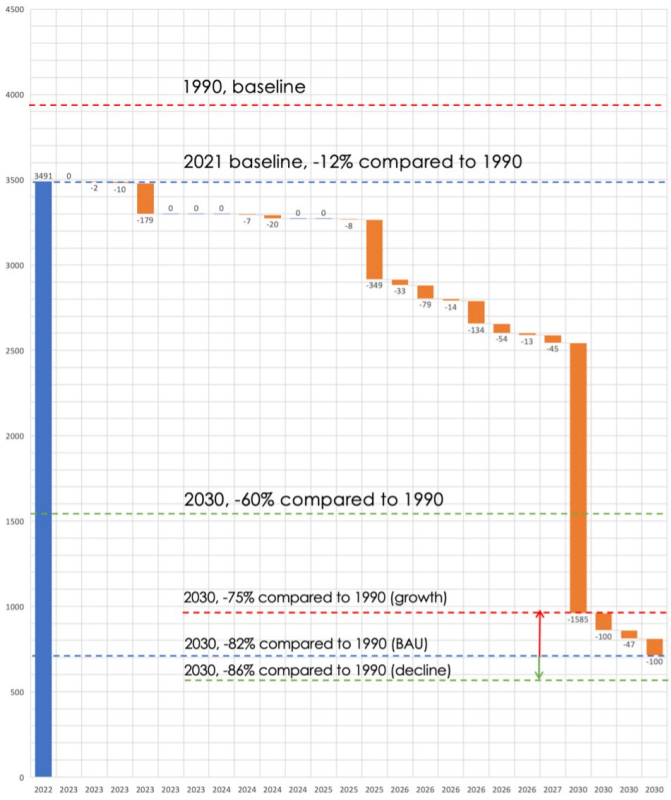

Fig. 2 Roadmap to reduce CO_2 emissions in the steel construction value chain by 2030

their efforts and demanding higher environmental performance from the steel sector, the frontrunners in the market will serve as catalysts for progress. As successful innovations are demonstrated, a wider range of market parties can adopt these innovations as well. It is hoped that this approach will ultimately persuade the government to align procurement requirements across the industry through the implementation of stricter regulations. Given the heavily regulated nature of the construction industry, departing from the current norm of regulations is essential to facilitate the transition towards sustainable construction steel.

With the exception of the challenge of steering the market through commissioning parties, the majority of activities required for the upcoming scale-up phase are nearing completion. The development of a monitoring tool is underway, with collaboration between a core group of commissioning parties. Standards for steel quality generally do not impede implementation of sustainable steel, except for a few specific cases that are currently under discussion and appear to be resolvable. Recently, a Dutch Technical Agreement titled "Reuse of Construction Steel" (NTA 8713:2023) was issued, providing guidelines for the reuse of steel elements. Although a consensus has not yet been reached on a tool to measure the embodied carbon, common ground will be found within half a year. Furthermore, a significant innovation program known as *Green Steel* has recently obtained government approval and received a substantial subsidy of 124 million euros. Although the Agreement did not play a prominent role in its preparation, it is expected to reap substantial benefits from the ongoing advancements and breakthroughs resulting from this program. As the activities of the building phase draw closer to completion, it is anticipated that the Agreement will successfully transition into the scale-up phase by the end of 2023.

4 Discussion

The Dutch Building Agreement Steel highlights that achieving a transition to sustainable steel necessitates a systemic change involving the active participation of all relevant actors. No single actor can single-handedly accomplish this transformation. Ideally, the change process commences with a coalition of willing partners who recognize the imperative of collective action. In the regulated and intricate market of construction steel, the driving force behind change lies with the commissioning parties. A group of frontrunners can accelerate sustainable innovations through their purchasing power. However, to ensure widespread adoption, regulatory reforms are necessary to mainstream these innovations. By harmonizing procurement requirements for the broader peloton of market participants, a level playing field can be established, promoting market fairness and creating certainty regarding the demand for sustainable steel. This, in turn, encourages new entrants to scale up their efforts in line with the sustainability ambitions.

The Dutch case also reveals that the transition process towards sustainable steel construction follows a sequential progression through four distinct phases: preparatory, building, scaling- up, and mainstreaming. It is important to recognize that this process is cyclical, as it necessitates multiple iterations of increasingly comprehensive improvements before reaching the final mainstreaming phase, which aims to establish a fully circular system. Governing this transition is akin to embarking on a journey with a clear destination but no pre-defined path. It requires a flexible approach to achieve the set goals effectively. Given the diverse interests and stakeholders operating in separate silos, the appointment of an intermediary, such as the chair of the Agreement, becomes crucial. This intermediary, referred to as a transition broker, plays a pivotal role in steering the process, aligning the involved parties, and accelerating the transition. By facilitating collaboration and fostering coordination among the various actors, the transition broker helps navigate the complexities and facilitate the progress towards sustainable construction steel [17].

The governance approach employed in this case study combines elements of public governance and network governance. The national government assumes the role of safeguarding the common good and is responsible for formulating environmental policies, setting policy goals, and developing appropriate instruments. However, to effectively implement these policies, network governance plays a vital role in accelerating the change process [17]. Network governance involves the collaborative efforts of a network comprising willing parties who exemplify and promote the desired changes. It is important to note that network governance does not replace public governance; rather, it complements it. This approach entails a goal-oriented and

formalized framework facilitated by a transition broker. The transition towards more sustainable steel involves a dynamic interplay between various stakeholders, including the steel value chain itself, commissioning parties, research institutes, and national and local governments.

A comparative study encompassing 16 different countries has shed light on the significant added value of network governance. However, the effectiveness of this approach in supporting public governance is contingent upon the specific socio-cultural and political context [18]. The findings indicate that the network approach, as tested in the Netherlands, has the potential for broader application in various contexts. Consequently, it can be inferred that the construction sector worldwide has the opportunity to make substantial progress towards sustainability by embracing new forms of network cooperation among relevant stakeholders, alongside effective government leadership. By combining these approaches, transformative changes can be realized, fostering sustainable practices and achieving shared ambitions in the construction industry on a global scale.

References

[1] Assuncão, P.; Boland, B.; Burns, T.; D'Avolio, E.; Graham, A.; Imhorst, F.; Koester, I.; Kühl, C.; Sullivan, R.; Ulanov, A. (2022) *Net-zero Steel in Construction: The Way Forward.* New York: McKinsey&Company.

[2] Circular Construction Economy Transition Agenda (2018) *Circular Construction Economy, Building towards the Circular Economy in the Netherlands Together; Making a Fundamental Change.* The Hague: Transition Agenda Circular Economy.

[3] Burgan, B. A.; Sansom, M. R. (2006) *Sustainable Steel Construction.* Journal of Constructional Steel Research 6, pp. 1178–1183.

[4] Hamilton. I., Kennard, H., Rapf, O, Kockat, J. and Zuhaib, S. (2020) *Global Status Report for Buildings and Constructions.* Nairobi: United Nations Environmental Programme for the Global Alliance for Buildings and Construction.

[5] Rockström, J. (2009) *A Safe Operating Space for Humanity.* Nature 461, p. 472.

[6] World Commission on Environment and Development (1987) *Our Common Future.* Oxford: Oxford University Press.

[7] Papadaki, I.; Moseley, P.; Staelens, P.; Horvath, R.; Nieto Sanz, O.; Lipari, M.; Gutierrez Velayos, P., Vaananen, H. (2023) *Transition Pathway for Construction.* Brussels: European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs Directorate H – Ecosystems III: Construction, Machinery & Standardization.

[8] Md Hussin, J.; Abdul Rahman, I.; Hameed Memon, A. (2013) *The Way Forward in Sustainable Construction.* International Journal of Advances in Applied Sciences 2, no. 1, pp. 31–42.

[9] Gan, X.; Zuo J.; Ye, K.; Skitmore, M.; Xiong, B. (2015) *Why Sustainable Construction? Why not? An Owner's Perspective.* Habitat International 47, pp. 61–68.

[10] Det-Udomsap, A.; Hallinger, P. (2020) *A Bibliometric Review of Research on Sustainable Construction, 1994–2018.* Journal of Cleaner Production 254, p. 120073.

[11] Araújo, A. G.; Pereira Carneiro, A. M.; Perez Palha, R. (2020) *Sustainable Construction Management: A Systematic Review of the Literature with Meta-analysis.* Journal of Cleaner Production 256, p. 120350.

[12] Labory, F.; Vassart, O.; Cajot, L–G. (2009*) Sustainability of Buildings Made of Steel.* Conference Paper Luxembourg, Esch-sur-Alzette: ArcelorMittal R&D. https://www.researchgate.net/publication/278673238

[13] Barrett, Byrd Associates (2023) *Steel Construction; Sustainable Procurement.* London: Steel for Life and British Constructional Steelwork Association (BCSA).

[14] Hauke, B.; Kuhnhenne, M.; Lawson, M.; Veljkovic, M. (eds.) (2016) *Sustainable Steel Buildings: A Practical Guide for Structures and Envelopes.* New Jersey: Wiley-Blackwell.

[15] 24 Parties Representing the Construction Chain Steel (2022) *Construction Agreement Steel; Valuechain-wide Agreement towards a Circular Economy.* Zoetermeer: Building with Steel. https://bouwakkoordstaal.nl [accessed on: 9 July 2023]

[16] Hoekstra Bonnema, B.; Den Hollander, J.P. (2023) *Building Agreement Steel; Roadmap with Prioritized Options Towards 2030.* Zoetermeer, Bouwen met Staal (Building with Steel).

[17] Cramer, J. (2020) *How Network Governance Powers the Circular Economy; Ten Guiding Principles for Building a Circular Economy, Based on Dutch Experiences.* Amsterdam: Amsterdam Economic Board.

[18] Cramer, J. (2022) *Building a Circular Future; Ten Takeaways for Global Changemakers.* Amsterdam: Amsterdam Economic Board.

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