Towards Decarbonized Materials

A Case Study of the Transition to Low-Carbon Steel at a Truck OEM

Master's thesis in Management and Economics of Innovation

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SUMMARY

The transition to low-carbon materials is becoming an increasingly important part of industrial decarbonization. Steel is a particularly critical material in this transition due to its high carbon intensity and central role in manufacturing. This thesis explores how a European truck OEM can sustain momentum in its transition toward low-carbon steel, with a specific focus on the purchasing function and its role in supporting the adoption and diffusion of low-carbon materials. In doing so, the study contributes to the understanding of adopters in contemporary sustainability transitions. The study applies a qualitative case study design guided by a backcasting approach. Empirical material was collected through semi-structured interviews, a focus group, and documentary data. The analysis was informed by theories on sustainability transitions, transition management, and purchasing. The findings suggest that sustaining momentum requires recognizing the transition as a systemic process shaped by interconnected challenges across and beyond the value chain. Progress depends on strengthening collaboration and collective leadership across the steel ecosystem, while also addressing underlying paradigms and mindsets related to sustainability, value, and trust. The findings further highlight the importance of organizational conditions that create space for learning and experimentation, where ambidextrous structures support the gradual introduction and scaling of low-carbon steel within the truck OEM. The thesis further highlights purchasing organizations as important actors in sustainability transitions. By operating at the interface between upstream suppliers of innovation and downstream production, purchasing functions play an increasingly important role in supporting the diffusion of low-carbon solutions. This has also led purchasing to adopt new tools, practices, and organizational structures that are suited to long-term transformation processes characterized by uncertainty and experimentation.

Keywords: low-carbon steel, purchasing, sustainability transitions, backcasting, decarbonized materials, innovation, adoption

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Contents

1. Introduction

Decarbonization of materials is a critical component of achieving global climate targets. Steel, as a highly carbon-intensive and widely used material in industrial production, represents a particularly important area for intervention. Emissions from steel production represent approximately 7–9% of global carbon dioxide emissions (World Economic Forum, n.d.) and around 11% of Sweden's emissions (Tillväxtverket, 2024). Reducing emissions from steel production is therefore recognized as a key lever in the transition to a net-zero economy.

Technological pathways for decarbonizing steel are advancing, but a successful large-scale shift toward low-carbon steel is equally dependent on its adoption downstream in the value chain. The European Commission (2025) highlights coordination across industrial supply chains as a key enabler for decarbonizing the economy. Furthermore, adoption by first movers plays a central role in the scaling and commercialization of emerging low-carbon steel technologies (World Economic Forum, 2025). To better understand the role of industrial adopters in this transformation, this study examines the transition toward low-carbon steel at a European truck OEM.

As the electrification of the OEM's vehicles progresses, the decarbonization of purchased materials has emerged as a critical next priority in the company's broader sustainability strategy. The OEM has set an ambition to achieve a net-zero supply network by 2040, placing increasing emphasis on reducing emissions embedded in purchased materials and components. Since steel is a major contributor to the carbon footprint of commercial vehicles, the adoption of low-carbon steel is considered a key area for meeting internal sustainability targets.

At the focal truck OEM, strategic partnerships with low-carbon steel producers have laid the foundation for this transition. The company is now entering a phase in which low-carbon steel must move from pilot initiatives and limited volumes to large-scale implementation across components and product lines. However, this transformation brings substantial challenges. The transition is embedded within a broader system transformation characterized by uncertainty, interdependencies across the value chain, evolving market conditions, and significant investment requirements. This is also reflected internally at the truck OEM, where the transition toward low-carbon steel entails commercial challenges and new ways of working.

To explore the adoption of low-carbon steel, the study takes the perspective of the purchasing function at the truck OEM. As a key link between upstream steel producers and downstream vehicle production, the purchasing function plays an important role in shaping how low-carbon steel is introduced and scaled within the organization. Purchasing therefore becomes important for sustaining momentum in the transition despite the present challenges.

As the study focuses on the transition toward low-carbon steel at a firm level, it sits at the intersection between organizational studies and sustainability transition research. Given that businesses play an increasingly important role in sustainability transitions, there is a need to intensify research at the intersection between these two research areas (Köhler et al., 2019). The study further adopts a backcasting approach, which is considered useful when working with long-term transformations in complex systems (Rotmans et al., 2001). Rather than starting from the current situation, backcasting begins with the formulation of a desirable future state and then works backwards to explore key gaps, intervention areas, and strategies to realize the change (Holmberg and Larsson, 2018).

To capture the complexities and understand the interconnected factors along the entire production-consumption chain, the study also takes a systems thinking approach. While less common in organization and management studies, taking a holistic systems perspective is a central principle in sustainability transition research (Köhler et al., 2019). Within this field, sustainability transitions are understood as emerging through interactions between multiple actors across the value chain, where both technological development and downstream adoption are critical to system change (Rip and Kemp, 1998). By studying the transition toward low-carbon steel from the perspective of the purchasing function, the study connects broader societal decarbonization challenges with organizational-level practices and decision-making processes.

1.1 Purpose statement

The purpose of this study is to explore how the focal truck OEM can sustain momentum in its transition toward low-carbon steel. By analyzing this transformation from the perspective of the purchasing function, the study aims to deepen the understanding of adopters in contemporary sustainability transitions.

1.2 Research questions

To achieve the purpose of the study, this research adopts a backcasting approach in which relevant stakeholders reflect on a desirable future for the low-carbon steel transition and work backwards to identify present gaps, leverage points, and activation strategies. Based on this approach, a main research question and four sub-research questions have been developed and are presented in this section. A more detailed overview of the research questions is provided in Appendix A.

Main research question: How can the focal truck OEM sustain momentum in its transition toward low-carbon steel?

Sub-research questions based on backcasting:

RQ1: What does a desirable future state look like for the focal truck OEM when it comes to steel?

RQ2: What gaps and challenges currently hinder the transition to low-carbon steel?

RQ3: Where are the key leverage points for bridging these gaps and sustaining momentum in the transition?

RQ4: What strategies could help activate these leverage points?

1.3 Outline of the thesis

The thesis is structured into six chapters. Following the introduction, Chapter 2 presents the theoretical framework of the study, introducing theory on sustainability transitions, transition management, and purchasing as complementary lenses for understanding the transition toward low-carbon steel from the perspective of the purchasing function. Chapter 3 presents the methodology employed in the study, including the research design, case study approach, and methods used to gather and analyze the empirical data. Chapter 4 presents the empirical findings, which are structured around the sub-research questions derived from the four steps in the backcasting model. Chapter 5 discusses the empirical findings in relation to the theoretical framework and the study's main research question of how the focal truck OEM can sustain momentum in its transition toward low-carbon steel. Finally, Chapter 6 presents conclusions of the study.

2. Theoretical background

This chapter presents the theoretical perspectives that guide the analysis of the transition toward low-carbon steel at the truck OEM. The first section introduces sustainability transitions literature through the lenses of wicked problems and the multi-level perspective (MLP) framework, providing a foundation for understanding the complexity and systemic nature of decarbonization processes. The second section presents transition management literature, focusing on how actors can intervene in complex systems to drive transformations forward. This section includes perspectives on systems thinking, leverage points, system innovation, ambidexterity, collective leadership, and backcasting, thereby connecting organizational and management literature to sustainability transitions. The third section introduces purchasing literature to understand the perspective of the purchasing function and its current practices and tools for addressing sustainability-related challenges. Together, these three theoretical perspectives provide complementary lenses for exploring sustainability transitions in a business context from the perspective of a purchasing function.

2.1 Sustainability transitions

The need for sustainability transitions arises from the environmental and social impacts of existing systems of production and consumption which have contributed to large-scale pollution and environmental degradation. Although incremental improvements may reduce some environmental impacts, they are unlikely to be sufficient for addressing broader sustainability challenges. Elzen and Wieczorek (2005) argue that more radical innovation pathways may be needed, involving changes in technologies, infrastructures, logistics, legislation, and user behaviour.

Sustainability transitions refer to long-term and structural changes in the systems that provide essential societal functions, such as transport systems, energy systems, and industrial production systems (Elzen and Wieczorek, 2005; Geels, 2011). From this perspective, sustainability transitions can be understood as sociotechnical transitions because they involve changes in technologies, infrastructures, regulations, markets, user practices, and industry structures (Geels, 2011). The structural dynamics of sociotechnical systems and the mechanisms through which transitions unfold are further elaborated in the multi-level perspective (MLP) section.

Geels (2011) highlights several characteristics that make sustainability transitions different from conventional technological change. First, they are goal-oriented, as they are explicitly driven by societal challenges such as climate change and environmental degradation, rather than emerging only from commercial opportunities around new technologies. Second, sustainable innovations often struggle to compete with established technologies because they may not provide immediate user benefits and may be less attractive in terms of price or performance. Third, these transitions are essential in the sectors where incumbent firms hold strong positions through existing assets, infrastructures, markets, and capabilities.

2.1.1 Sustainability transitions as wicked problems

The complexity of sustainability transitions can also be understood through the lens of wicked problems. Wicked problems differ from more conventional problems because there is no shared or definitive understanding of what the problem is, nor a clear agreement on how it should be solved. Stakeholders often compete to frame the problem in ways that support their preferred solutions. As a result, the search for solutions becomes open-ended, while political conditions, resource constraints, and stakeholder positions continue to shift over time (Roberts, 2000).

This is highly relevant to sustainability transitions. At a general level, the need to reduce environmental harm may appear widely accepted. Climate change, resource depletion, and industrial decarbonization all point toward the urgency of transforming existing systems. However, when these broad goals are translated into practice, disagreement emerges over which technologies should be prioritized, who should invest, how costs should be shared, and which policy instruments should be used. Geels (2011) argues that sustainability transitions are purposive and goal-oriented, but also ambiguous and contested because actors may hold different views about the direction of change, the advantages and disadvantages of different solutions, and suitable policy instruments.

The wickedness of sustainability transitions is further intensified by their sociotechnical character. De Bruijn and Herder (2009) suggest that technical system dynamics and actor interests and perspectives should be analyzed alongside each other, as each reveals different aspects of the same problem. For sustainability transitions, this means that a new technology or material cannot succeed simply because it offers better environmental performance, it must also fit with other aspects and the interests of actors across the value chain.

Understanding sustainability transitions as wicked problems therefore shifts attention away from the idea of a single correct solution. It points to the need for learning, dialogue, coordination, and adaptive governance across actors. Roberts (2000) emphasizes that wicked problems require caution because no actor is fully "in control," and that bringing the "whole system in the room" can support social learning among stakeholders. This means that sustainability transitions cannot be managed through a linear problem-solving process. Progress therefore depends less on finding one final answer, and more on creating processes through which actors can learn, adjust, and coordinate action over time.

2.1.2 Multi-level perspective (MLP)

The multi-level perspective (MLP) is a framework for analysing long-term sociotechnical transitions. It conceptualises transitions as non-linear processes that emerge through interactions between three analytical levels: niches, sociotechnical regimes, and the sociotechnical landscape (Geels, 2011). These levels are not fixed categories, but analytical concepts used to understand how stability and change unfold within sociotechnical systems (Geels, 2002).

At the macro level, the sociotechnical landscape refers to a broader external context that shapes developments at the niche and regime levels (Geels, 2011). These include long-term trends such as climate change, geopolitical shifts, economic crises, and societal values. Landscape developments are usually slow and hard to change compared to other levels. It is also difficult for niche and regime actors to influence in the short term. However, changes at this level can create pressure on existing regimes and generate windows of opportunity for alternative technologies and practices (Geels, 2002; Geels, 2011).

At the meso level, sociotechnical regimes help explain why established systems tend to remain stable over time. Geels (2002) understands regimes as shared rule structures that guide how different actor groups think, act, and coordinate their activities. These rules help stabilize existing sociotechnical configurations by directing change along familiar development paths. This does not mean that regimes are static. Change can still take place, but it often occurs through gradual adjustments rather than radical shifts. However, when persistent problems or landscape pressures create tensions within existing systems, regime stability may weaken, opening up opportunities for niche innovations (Geels, 2002; Geels et al., 2017).

At the micro level, niches are protected spaces in which radical innovations can emerge and develop. These spaces may include R&D projects, demonstration projects, or small market niches where new technologies and practices are shielded from mainstream selection pressures (Geels, 2002; Geels, 2011; Smith, 2007). Geels (2002) emphasizes the importance of niches because they provide space for learning processes and for building actor networks that support emerging innovations. Over time, niche innovations may gain momentum when learning processes become more aligned, actor networks expand, and expectations become clearer and more widely shared (Geels, 2002; Geels, 2011).

A transition occurs when developments across these three levels become aligned. Landscape pressures may destabilise existing regimes and windows of opportunity can emerge for niche innovations to build sufficient maturity and support to be viable alternatives (Geels, 2002; Geels, 2011). Geels and Schot (2007) show that transitions may follow different pathways depending on the timing and nature of interactions between niches, regimes, and landscapes.

2.2 Managing and driving sustainability transitions

Given the complex and interdependent nature of transitions, the question then becomes how to actually manage and drive such transitions forward. This section aims to outline key insights from the growing body of literature related to transition management, system innovation, and systems leadership. Together, these streams of research provide conceptual tools for understanding how actors can intervene in complex sociotechnical systems in ways that enable long-term systemic change.

2.2.1 The need for a systems perspective

As transitions occur in an interconnected web of actors, material systems, and institutional structures, accelerating transitions hinges on the ability to see the larger system (Senge et al., 2015; Meadows, 2008; Rotmans et al., 2001; Ackoff, 1999; Sterman, 2002). However, this is far from intuitive for most people, as we are often inclined to take a reductionist approach in which large problems are divided into smaller ones and handled individually, rather than zooming out and examining the system as a whole (Holmberg, 2020). As Senge et al. (2015) note:

> In any complex setting, people typically focus their attention on the parts of the system most visible from their own vantage point. This usually results in arguments about who has the right perspective on the problem. Helping people see the larger system is essential to building a shared understanding of complex problems. This understanding enables collaborating organizations to jointly develop solutions not evident to any of them individually and to work together for the health of the whole system rather than just pursue symptomatic fixes to individual pieces. (p. 28)

This in turn means that, when dealing with complex problems, different perspectives need to be integrated from the outset (Holmberg, 2020). It also involves a process of recontextualizing the organization and recognizing that its success depends on contributing to the long-term viability and functioning of the larger system of which it is a part (Senge et al., 2015). This is, however, challenging due to the silo structures that are built within and between organizations (Holmberg, 2020).

Nonetheless, actors aiming to contribute to long-term systemic change must rise to this challenge, as failing to adopt a systems perspective entails significant risks. Jay Forrester, founder of the field of system dynamics at MIT, described system behaviour as "counterintuitive" (Senge et al., 2015). In complex and non-linear systems, cause-effect relationships are often distant in time and space, making outcomes difficult to anticipate. Feedback loops, time delays, and the constantly evolving interactions within systems obscure links and make system dynamics hard to grasp through a superficial or purely linear understanding (Sterman, 2002). As a result, well-intended interventions, when undertaken without a systems perspective, may inadvertently exacerbate the very problems they seek to solve (Meadows, 2008).

Without a broader systems lens, there is also a tendency to engage in low-leverage, symptomatic interventions rather than addressing underlying root causes (Senge et al., 2015; Davelaar, 2021). Incremental change processes are unlikely to result in the systemic transformations required (Elzen and Wieczorek, 2005). Transitions require a reorientation of the system's underlying direction, not merely adjustments within its current trajectory

(Ackoff, 1999). Only by adopting a systems view can actors effectively identify root causes and design high-leverage interventions that address them (Meadows, 2008).

To learn about systems and build a shared understanding among collaborating actors, system mapping can serve as a useful tool (Senge et al., 2015). By mapping stocks, flows, interconnections, and feedback loops, actors can gradually gain a clearer view of system dynamics and, as a result, identify more effective intervention points (Sterman, 2002; Meadows, 2008; Senge et al., 2015). Effective system maps are typically developed in an iterative manner, where individuals with different perspectives review, challenge, and refine the model over time (Sterman, 2002). While these models can never be perfect representations of reality, they are at least conceptual frameworks that move us toward a more helpful and dynamic way of viewing the world than the ones we usually turn to. As Sterman (2002, p. 7) notes: "Where the world is dynamic, evolving, and interconnected, we tend to make decisions using mental models that are static, narrow, and reductionist."

2.2.2 Finding places to intervene in the system

Once a systems perspective has been established, the next question becomes where to intervene in order to shift the system in a more desirable direction. Given the depth and scale of transformation required for sustainability, interventions must be thoughtfully chosen to generate significant effects. Meadows (2008) uses the concept of *leverage points* to describe places within a complex system where a small shift can produce disproportionately large changes in system behaviour. Identifying and targeting such leverage points is increasingly regarded as crucial for enabling systemic change at the scale and speed needed (e.g., Davelaar, 2021).

Meadows (2008) further distinguishes between shallow and deep leverage points. Deep leverage points constitute the most powerful intervention sites, as changes at this level have the potential to fundamentally alter the direction and behaviour of the system. Shallow leverage points, in contrast, generate more limited effects, even though they are more frequently targeted in practice. Meadows characterizes interventions at this end of the spectrum as akin to "rearranging the deck chairs on the Titanic," highlighting their limited transformative capacity. In total, Meadows (2008) identifies twelve categories of leverage points, arranged hierarchically from deep to shallow leverage points.

Abson et al. (2017) group these twelve leverage points into four categories: parameters, feedbacks, design, and intent (see Table 1). Parameters refer to the mechanistic characteristics of a system, such as standards and taxes. Feedbacks concern the interactions between system elements that shape and regulate system dynamics. Design refers to the structural configuration of the system, including information flows, rules, and self-organizing networks. The deepest category, intent, relates to the paradigms, mental models, values, worldviews, and goals held by actors within the system, which ultimately guide its direction and development.

Table 1
Categorization of leverage points, ranging from 12 (most shallow) to 1 (deepest), adapted from Davelaar (2021, p. 729) and Abson et al. (2017, p. 32).

Category	**Leverage point number**	**Leverage point**
Parameters	LP12	Numbers
	LP11	Buffers
	LP10	Stock-and-flow structures
Feedbacks	LP9	Delays
	LP8	Balancing feedback loops
	LP7	Reinforcing feedback loops
Design	LP6	Information flows
	LP5	Rules
	LP4	Self-organization
Intent	LP3	Goals
	LP2	Paradigms
	LP1	Transcending paradigms

Davelaar (2021) uses the metaphor of an iceberg to describe deep and shallow leverage points and to illustrate that what can be seen above and around the waterline are results of deeper, underlying root-causes. Transformative change requires moving beyond events and observable patterns to address systemic structures, purposes, and ultimately the mental models from which systems arise. In contrast, a problem-focused orientation tends to emphasize short-term, symptomatic interventions aimed at visible issues, leaving the deeper structural causes unaddressed (Davelaar, 2021; Senge et al., 2015).

It is important to note that leverage points deeper down in the iceberg are not necessarily harder to change; they are rather less frequently targeted in practice. In fact, Meadows (2008) ranks the leverage points not only according to their transformative potential but also with consideration of the relative ease or difficulty of shifting them. As the author explains:

> You could say paradigms are harder to change than anything else about a system, and therefore this item should be lowest on the list, not second-to-highest. But there's nothing physical or expensive or even slow in the process of paradigm change. In a single individual it can happen in a millisecond. All it takes is a click in the mind, a falling of scales from the eyes, a new way of seeing. (Meadows, 2008, p. 163)

2.2.3 System innovation differs from system optimization

Transition literature distinguishes between *system optimization* and *system innovation*, where only the latter can lead to sustainability (Elzen and Wieczorek, 2005). While optimization focuses on improving the performance of existing systems, system innovation concerns more fundamental shifts in how systems are structured and oriented. As described by Rotmans et al. (2001), transitions are long-term, open-ended, multi-actor processes in which unsustainable systems are gradually phased out and new, more sustainable configurations emerge. Such processes cannot be planned in detail, but they can be influenced through experimentation and reflexive governance (Holmberg and Larsson, 2018).

System optimization follows a logic of refinement. It seeks efficiency gains, incremental improvements, and control within existing institutional arrangements (March, 1991). In learning terms, this resembles what Bateson (1972) describes as "doing things right" (Learning I). Such efforts are necessary for maintaining performance, but they tend to reproduce prevailing paradigms rather than challenge them. System innovation, by contrast, relies on moving towards "doing the right things" (Learning II) and "seeing the world in new ways" (Learning III) (Bateson, 1972).

Importantly, the argument is not to replace optimization with innovation. Both logics are necessary, and organizations capable of holding them simultaneously are described as ambidextrous (O'Reilly and Tushman, 2004). However, in the context of sustainability transitions, optimization alone is insufficient. Without the willingness to redesign the underlying structures of existing systems, efforts risk reinforcing the very dynamics that generate unsustainability (Meadows, 2008). Yet holding this ambidextrous stance – where organizations exploit current resources to safeguard present performance while simultaneously exploring new pathways – is a demanding task. As noted by Sterman (2002): “We are all passengers on an aircraft we must not only fly but redesign in flight.”

Holmberg and Larsson (2018) use the metaphor of a *cruise ship* and an *expedition* to illustrate how managing this tension requires different logics to coexist within an organization. The cruise ship represents the logic of system optimization – exploiting current capabilities through efficiency, stability, coordination, measurement, and control. This logic is highly effective when navigating known waters, where predictability and refinement are key. However, it lacks the flexibility required when entering more uncertain terrain. When the environment becomes unfamiliar and complex, sending out a smaller expedition vessel is both better suited and less risky than redirecting the entire cruise ship.

Navigating such uncharted waters requires experimentation and learning-by-doing (Rotmans et al., 2001; March, 1991). As argued by Holmberg (2020), leadership for sustainability transitions involves creating protected spaces where exploration can occur without being absorbed by the dominant optimization logic. These spaces enable actors to think beyond existing trajectories, deeper into root causes, broader across sustainability dimensions and stakeholder perspectives, and together across organizational and sectoral boundaries.

In an expedition, the question – rather than the organization – moves to the centre (Holmberg, 2020). Leadership shifts from decision-making to facilitation, from implementation to exploration, and from short-term problem solving to the co-creation of desirable futures (Holmberg, 2020; Senge et al., 2015). For this ambidextrous setup to create value, however, the learnings from the expedition must continuously be transferred, translated, and integrated back into the core organization through regular “docking” with the cruise ship (Homberg, 2020).

2.2.4 Catalyzing collective leadership through reflection and dialogue

When navigating the uncertain terrain that characterizes complex transitional processes, it becomes important to make use of the knowledge, insights, and perspectives that the organization collectively holds (Senge et al., 2015). This differs from more traditional, mechanistic approaches to change, where top leadership and outside experts inform and direct the change process (Ferdig, 2007). While this top-down approach may function in relatively stable and merely complicated environments, insights from complexity science show that change processes in complex environments occur through a bottom-up logic characterized by self-organization and adaptation (Andersson et al., 2014; Ferdig, 2007).

As a consequence, Senge et al. (2015) emphasize the importance of catalyzing “collective leadership within and across the collaborating organizations” to address complex systemic challenges. In dynamic and uncertain environments, it is not possible for anyone to fully “figure it all out at the top” (Senge, 1990); instead, thinking and acting must be integrated across multiple levels of the organization . Senge et al. (2015) explain that while this collective leadership cannot simply be manufactured or ordered, organizations can create conditions that make its emergence more likely. The authors further emphasize the importance of creating space for reflection and dialogue within the organization in this process, where different perspectives and insights are surfaced and collective creativity gradually emerges.

2.2.5 Starting from the future through backcasting

It is increasingly evident that prevailing approaches to change and technological development have not led to the sufficient system shifts needed for sustainability (Elzen and Wieczorek, 2005). Hence, there is a need for new and different approaches that more effectively can induce the system innovation needed. An approach that has been getting increasing attention is backcasting, which, for example, has been recommended by the Sustainable Development Solutions Network when it comes to working with Agenda 2030 and the SDGs (SDSN, 2015).

Backcasting is a methodology that involves starting from a desirable sustainable future and then exploring what is required to reach it (Holmberg and Larsson, 2018). A central premise of backcasting is therefore to view the future as something malleable, rather than something predetermined or predictable. Many change processes begin with how the situation looks today and then attempt to identify and optimize possible paths forward. This approach may work for incremental change, but when it comes to managing and driving complex transitional processes, methods such as backcasting have proven more effective. By freeing oneself from the constraints of the present situation, it becomes possible to open up new perspectives, break away from established patterns, and see the present in a new way. As highlighted by Stewart (1993):

> What is can be a great barrier to what could be, where those who want to move forward through bold and effective change should begin with the end – with where they want to be. (p. 98)

It should be noted that this vision-making process is not solely about formulating the overarching corporate vision but is applicable to a wide range of situations and levels within an organization (e.g., function, team, etc.) (Stewart, 1993). This is also echoed by Senge et al. (2015), who state that effective system change:

> … is not likely to come from leaders who seek to "drive" their predetermined change agenda. Instead, system leaders work to create the space where people living with the problem can come together to tell the truth, think more deeply about what is really happening, explore options beyond popular thinking, and search for higher leverage changes through progressive cycles of action and reflection and learning over time. (p. 30)

A key aspect of backcasting is that it is a principle-based rather than a goals-oriented approach (Holmberg and Larsson, 2018). The result of this first future-oriented step is thus not a set of concrete goals, but the development of guiding principles. Senge et al. (2015) note that creating space for this kind of engagement in genuine questions might come across as a passive act, but that organizations that dare and manage to do so can create a sense of direction and energy that propels change. Holmberg and Larsson (2018, p. 4) also emphasise that it "is rewarding for the transformative momentum to provide purpose and direction in transitional processes, if one manages to stay in the 'why' in an appropriate way".

Holmberg and Larsson (2018) explain how the backcasting process can be divided into four main steps (see Fig. 1). After the desirable future has been defined (step 1), the present situation is analysed in relation to that future in order to identify key gaps and challenges (step 2). Based on these gaps, potential leverage points are identified where relatively small interventions may have a large impact on closing the gap (step 3). In the final step, strategies are developed for working with these leverage points, often through processes of experimentation (step 4).

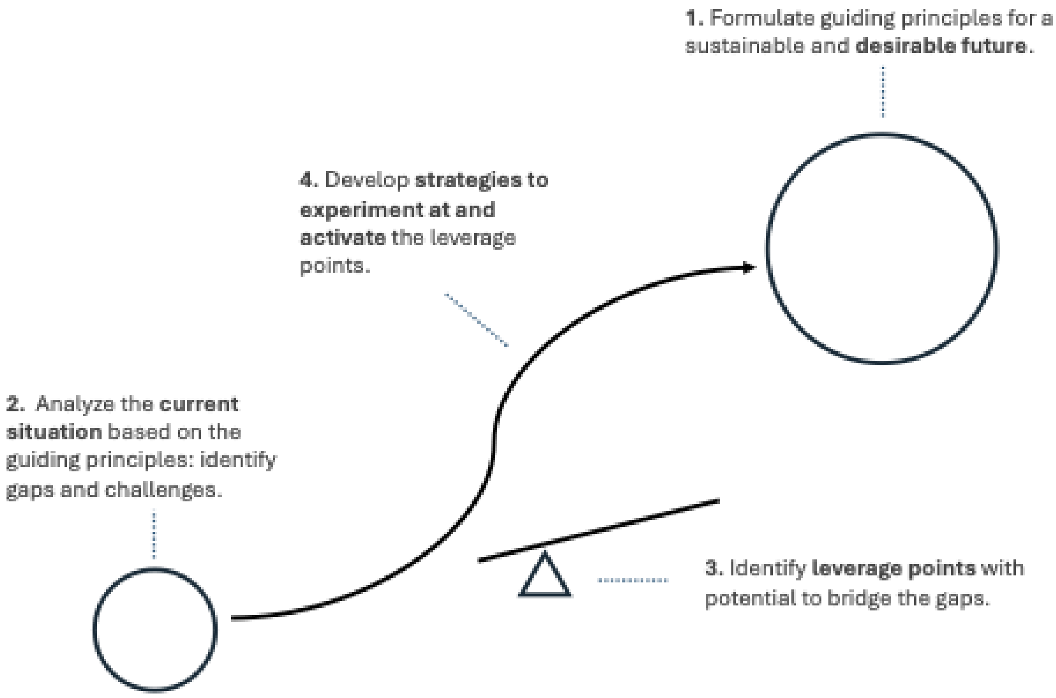

Fig. 1. Backcasting model, adapted from Holmberg and Holmén (2020).

2.3 Purchasing process and considerations

In the conventional view, purchasing has often been associated with a linear process centered around the "five rights", whereby buyers are expected to secure the required goods and services under appropriate conditions of quality, quantity, delivery, service, and cost (Ellram et al., 2020). However, purchasing has increasingly taken on a more strategic role, extending beyond operational buying activities to include, for example, supplier relationship management and partnership formation (Ellram et al., 2020; Zsidisin and Siferd, 2001). In line with this broader role, Van Weele and Rozemeijer (2022) define procurement as the management of external resources needed to run and develop the firm's primary and support activities.

Van Weele and Rozemeijer (2022) describe the procurement process as a sequence of connected activities, as shown in Fig. 2. Bäckstrand et al. (2019) similarly discuss Van Weele's model as a widely used linear purchasing process model, divided into a tactical part, including specification, selection, and contracting, and an operational part, including ordering, expediting, and evaluation. The process starts when the organization defines what needs to be purchased. In the specification phase, the required material or product is described in terms of quality, logistics, maintenance, legal, environmental, and budget requirements. This stage is important because later purchasing decisions depend on how clearly and appropriately the requirement is defined (Van Weele and Rozemeijer, 2022).

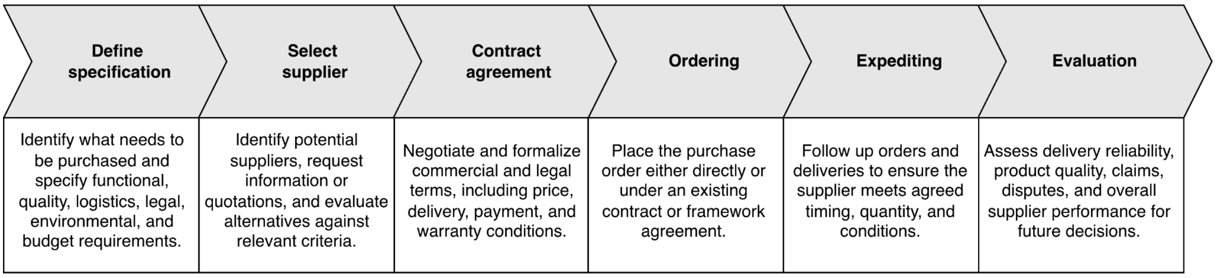

Fig. 2. Overview of the procurement process and key activities, adapted from Van Weele and Rozemeijer (2022, p. 31).

After the specification has been established, purchasing moves into supplier selection and contracting. Supplier selection involves identifying potential suppliers, requesting information or quotations, comparing bids, and assessing suppliers against relevant criteria. According to Van Weele and Rozemeijer (2022), supplier bids are evaluated by considering technical, logistical, quality, financial, and legal aspects. In this evaluation, price is not the only criterion. De Boer et al. (2001) show that supplier selection has become increasingly complex because purchasing decisions often involve broader supplier selection requirements, more alternatives, and increased demands for transparency. This creates a need for a more systematic and transparent approach to supplier selection.

One approach used to support such evaluations is total cost of ownership (TCO), which refers to all costs associated with a purchased product throughout its lifetime. This is important because the material or component with the lowest purchase price is not necessarily the cheapest option in the long run. TCO therefore provides a broader understanding of the cost consequences of choosing a particular supplier.. Once a supplier has been selected, the negotiation and contracting phase defines the commercial and legal conditions of the agreement, such as price, delivery terms, payment terms, warranty conditions, and possible penalty clauses (Van Weele and Rozemeijer, 2022).

The final part of the process concerns ordering, expediting and evaluation. In the ordering phase, the purchase order is placed either as a direct order or against an existing contract or framework agreement. However, the purchasing task does not end once the order has been issued. Expediting is needed to follow up the order and ensure that the supplier delivers according to the agreed time, quantity and conditions (Van Weele and Rozemeijer, 2022). This can involve checking the delivery status before the due date and following up delayed deliveries. After delivery, the supplier's performance is evaluated by reviewing issues such as delivery reliability, product quality, claims, and disputes. These records help update supplier files and support future purchasing decisions.

2.3.1 When sustainability comes into the purchasing task

Companies are increasingly expected to take responsibility for the environmental and social impacts associated with their suppliers (Seuring and Müller, 2008). As a result, purchasing decisions are no longer guided solely by traditional criteria such as price, quality, and technical specifications. Although these criteria remain important, they are not sufficient in sustainability-oriented purchasing. In addition to economic and technical considerations, companies must also account for environmental and social aspects, such as energy consumption, carbon emissions, and human rights (Van Weele and Rozemeijer, 2022).

Van Weele and Rozemeijer (2022) describe this development as "procurement with purpose", where purchasing has a broader aim than only cost savings and on-time delivery. In this view, purchasing decisions are also assessed according to whether suppliers and purchased products are aligned with the company's sustainability goals. This broader role is connected to the idea of people, planet and profit (Van Weele and Rozemeijer, 2022). The "people" dimension concerns issues such as labour conditions, health, safety, and social value creation. The "planet" dimension concerns the efficient use of energy, raw materials, and natural resources, as well as waste, reuse, reverse logistics, and carbon-emission reduction. The "profit" dimension refers to long-term economic performance in relation to the interests of different stakeholders.

To support this broader role, sustainability-oriented purchasing requires systematic tools and approaches. Seuring and Müller (2008) identify two main strategies in sustainable supply chain management: "supplier management for risks and performance", and "supply chain management for sustainable products". The first strategy focuses on using supplier evaluation, standards, monitoring, and audits to reduce environmental and social risks and improve supplier performance. The second strategy focuses on developing products with improved environmental qualities and creating competitive advantage, which may require closer cooperation with suppliers and attention to life-cycle impacts. Moreover, Van Weele and Rozemeijer (2022) identify supplier sustainability codes of conduct, supplier self-assessments, supplier sustainability audits, corrective action follow-up, and external sustainability standards as common ways to drive sustainability in supply chain relationships.

2.3.2 Purchasing and sourcing of sustainable materials

Sustainable material sourcing can be viewed as an application of sustainability-oriented purchasing, where environmental and social considerations are integrated into decisions about which materials and suppliers should be selected. Van Weele and Rozemeijer (2022) explain that purchasing may involve challenging specifications by discussing with internal users whether the specified product is truly fit for purpose. They also note that purchase specifications may include legal and environmental requirements related to both the product and the production process. Applied to sustainable materials, this means that purchasing may need to question whether the required function can be fulfilled by lower-carbon, recycled, or circular material alternatives, rather than automatically sourcing the conventional material originally specified. In this way, sustainable material sourcing extends the purchasing role from selecting suppliers to also shaping the material choices that influence the company's environmental performance.

Konys (2019) explains that green supplier selection is a multi-dimensional decision problem, where the assessment of suppliers should not only include service and material quality, but also suppliers' opportunities for sustainable development and their ability to follow green practices and technologies. In sustainable material sourcing, this complexity increases because materials may be described as low-carbon, recycled, or circular, but such claims can vary in how they are measured, documented and verified. This requires purchasing to be careful when comparing suppliers and material alternatives (Khan and Hinterhuber, 2025).

According to Khan and Hinterhuber (2025), purchasers may struggle to distinguish between certified sustainable products and products with unsupported environmental claims, partly because sustainability labels and certifications can be complex and difficult to compare. To reduce this risk, they emphasize the need for structured evaluation processes based on third-party verification, transparency, and recognized methods such as life cycle assessment (LCA) or product environmental footprint (PEF). They further emphasize the importance of requiring suppliers to provide verifiable documentation and of integrating accountability mechanisms into supplier contracts to strengthen the credibility of sustainability claims.

The need for verification is especially relevant in emerging low-carbon material markets, where definitions and standards are still developing. In the case of low-carbon steel, Muslemani et al. (2021) point out that uncertainty remains around how low-carbon steel should be defined, and what policy mechanisms are needed to support market development. They also argue that carbon accounting and assurance issues need to be resolved because unclear definitions and inconsistent accounting methods may create misleading claims or unintended outcomes. As a result, purchasing sustainable materials requires buyers to look beyond the material label and examine how sustainability performance is measured, verified and communicated, while also managing uncertainty related to availability, price premiums, production capacity and future standards.

3. Methodology

This section outlines the key methodological choices and how the research process was designed and implemented in practice. The intention is to make clear how the study was conducted, from the initial stages of framing the problem to the collection and analysis of empirical material. The research did not follow a strictly linear process, but developed through an ongoing interaction between empirical observations and theoretical perspectives, which influenced both the direction of the study and the interpretation of the findings. The following sections describe the research design, data collection, and data analysis in more detail, and explain how each step contributed to the overall development of the study.

3.1 Research design

This study adopts a qualitative case study design to explore how a truck OEM navigates the transition toward low-carbon materials. A qualitative approach is appropriate given the exploratory nature of the research, which seeks to understand organizational processes, interpretations, and decision-making in a complex and evolving industrial context. Rather than testing predefined hypotheses, the study aims to generate in-depth insights into how actors within the organization perceive and respond to the challenges of transitioning toward low-carbon steel.

The study is guided by an abductive approach, which allows for a continuous interplay between theory and empirical observations. In contrast to purely inductive or deductive approaches, abduction helps the researcher to iteratively refine theoretical understanding as new empirical insights emerge. This is particularly relevant in this study, as the phenomenon under investigation is still developing in practice and cannot be fully explained by existing theoretical frameworks alone. The abductive logic follows what Dubois and Gadde (2002) describe as a process of "systematic combining," where empirical fieldwork and theoretical development proceed simultaneously, and where the initial theoretical framework is continuously adjusted in response to empirical findings. In this study, existing theories, particularly backcasting and the multi-level perspective (MLP), serve as an initial analytical lens that guided the interpretation of the empirical material and supported the understanding of this transition. Fig. 3 illustrates the overall research process and the iterative relationship between theory and empirical work throughout the study.

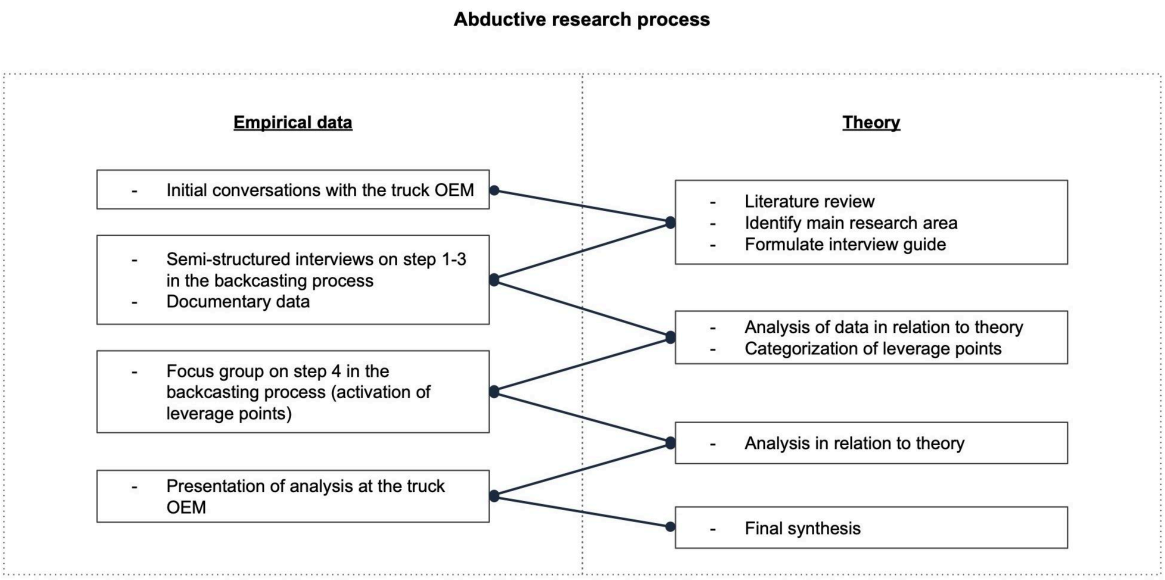

Fig. 3. Overview of the research process.

The process began with initial conversations with managers at the truck OEM. These discussions contributed to an early understanding of the organizational context, current challenges, and the role of low-carbon materials within the company. Based on these early insights, an initial exploration of the research problem was conducted to identify key challenges across different system levels and examine how factors influencing the transition toward low-carbon steel were expected to evolve over time. This exploratory phase helped structure the research problem and identify areas for further investigation.

The empirical process developed iteratively through two interconnected stages. First, semi-structured individual interviews were conducted to explore participants' experiences, perceptions, and reflections regarding the transition toward low-carbon steel. Insights from these interviews were subsequently synthesized into a set of desirable future, current situation, and leverage points related to the transition process. In the second stage, these leverage points formed the basis for a focus group workshop aimed at collectively exploring and discussing potential activation strategies for sustaining momentum in this transition. The combination of individual interviews and collective dialogue helped the study to capture both detailed individual perspectives and how ideas, tensions, and interpretations were collectively discussed within the organization.

The process concluded with a presentation of the research project to practitioners within the focal company. The purpose was to share the results and provide an opportunity for dialogue and reflection. While the presentation was not used as a formal data collection method, it enabled a final exchange with practitioners. Reflections from this exchange were considered during the final revision of the report.

3.2 Sampling strategy and data collection

Primary data was collected through semi-structured interviews, which serve as the main method of data collection. Semi-structured interviews were chosen because they provide a balance between structure and flexibility, allowing the researchers to ensure comparability across interviews while also enabling respondents to elaborate on their experiences and insights in depth (Bell et al., 2022). This flexibility is particularly important when studying complex organizational phenomena, where relevant issues may not be fully known in advance.

The interview guide was developed based on a backcasting logic, meaning that the questions were structured around a desired future state, in this case, the transition toward low-carbon steel, and then worked backwards to explore current challenges and leverage points in the system. This approach made it possible for the study to explore how participants think about future developments, current practices. and possible intervention strategies. The full interview guide is provided in Appendix B.

The sampling strategy was purposive. Participants were initially selected based on their direct involvement in purchasing of steel and sustainability-related activities within the organization to ensure relevance to the research aim. Initial conversations with purchasing managers at the truck OEM helped identify individuals with relevant knowledge and experience related to the transition toward low-carbon steel. Consequently, the selection of participants was guided by the richness and relevance of the insights they could contribute, rather than by predefined sample size criteria (Bell et al., 2022).

Sample size evolved throughout the research process. Decisions about the number of participants were guided by considerations such as the representativeness of key perspectives and the point at which additional data becomes repetitive (Biernacki and Waldorf, 1981). In total, ten interviews were conducted across two distinct but related organizational groups. Six participants were drawn from a team specifically focused on low-carbon material purchasing (referred to as Team A), while four participants were from a more traditional purchasing team focused on metals (referred to as Team B). This division allowed the study to capture differences and tensions between emerging and established practices within the organization. Each interviewee was anonymized using a coding system ranging from interviewee A1 to A6 and interviewee B1 to B4 to ensure confidentiality while maintaining clarity.

Following the individual interviews, a focus group was conducted with seven of the participants from the individual interviews, in order to further explore and collectively discuss the preliminary findings from the interviews. The purpose of the focus group was to facilitate collective reflection and support the development of actionable strategies. The focus group setting enabled participants to interact, challenge, and build upon each other's perspectives, thereby generating richer insights into shared understandings and organizational dynamics (Bell et al., 2022).

The session was structured around the preliminary themes and leverage points derived from the interview analysis, which were presented to participants as a foundation for discussion. Building on these insights, a set of questions was developed to stimulate reflection and forward-looking dialogue. Participants were then asked to evaluate and select the two questions they considered most strategically important, defined as those with the greatest perceived potential to influence the transition process. This prioritization step helped focus the discussion on issues of highest strategic relevance. The subsequent discussion focused on collaboratively exploring how these prioritized questions could be activated in practice. Through this process, the focus group functioned as a generative space for co-creating context specific strategies and exploring systemic interdependencies across the value chain.

In addition to the interviews and focus group, two complementary sources of empirical material were included to support the analysis and interpretation of the interview findings. These consisted of an internal presentation, referred to as Document 1, and a publicly available article, referred to as Document 2. Document 1 presents a pilot project in which a reconfiguration of the value chain enabled both cost reductions and a significantly reduced carbon footprint. Document 2, a publicly available article written by Gardé and Delobelle (2026), addresses the role of early adopters in the transition toward low-carbon metals. Both documents relate to the organization's work with low-carbon materials and were selected to provide additional context to the empirical setting. These materials also helped strengthen the credibility of the study and supported triangulation across data sources.

3.3 Data analysis

The collected data was analyzed using the Gioia methodology, which provides a systematic approach for developing concepts and building theory from qualitative data (Gioia et al., 2012). The analysis began with the transcription of all interviews, followed by an initial coding phase in which first-order concepts were identified. At this stage, the analysis remained closely tied to the participants' own language, aiming to capture how they described their experiences and perspectives.

In the next stage, these first-order concepts were reviewed and compared to identify patterns and similarities across the data. Concepts that reflected similar ideas were grouped together and gradually refined into more consistent and descriptive labels. Through this process, second-order themes were developed, representing a more interpretive level of analysis. While still grounded in the empirical material, these themes reflect the researcher's effort to organize and make sense of the data beyond the participants' original wording. Finally, the second-order themes were further synthesized into aggregate dimensions, representing higher-level theoretical groupings. This step involved bringing together related themes into broader concepts that capture overarching patterns in the data and support theory development.

Throughout the analysis, emerging themes were iteratively compared with existing theoretical frameworks, particularly the multi-level perspective (MLP) and backcasting. These frameworks were used to support the interpretation and refinement of the themes. This iterative movement between data and theory helped to develop insights that are both grounded in the empirical material and connected to existing literature. Tables were developed to organize and visualize the relationships between first-order concepts, second-order themes, and aggregate dimensions. These tables supported the progression from raw data to more abstract concepts and helped maintain transparency throughout the analytical process. The resulting tables are presented in chapter 4.

The focus group data was analyzed using the same overall approach. The discussions were transcribed and reviewed to identify key strategies and proposed actions. Similar to the individual interview analysis, relevant statements were grouped and compared to identify recurring patterns and shared priorities. These were then synthesized into a set of activation strategies, showing how participants suggested addressing the key leverage points identified in the earlier analysis.

3.4 Research quality

Since this study adopts a qualitative case study design, research quality was assessed using criteria suitable for this type of research. Bell et al. (2022), drawing on Lincoln and Guba (1985) and Guba and Lincoln (1994), explain that conventional reliability and validity criteria are less suitable for qualitative research because they are based on the idea that there is one fixed social reality to be captured. This is relevant for the present study, as the transition toward low-carbon steel is understood through the perspectives and interpretations of different organizational actors. For this reason, the study considers trustworthiness and authenticity as key criteria for evaluating this study (Bell et al., 2022; Lincoln and Guba, 1985; Guba and Lincoln, 1994).

Trustworthiness includes credibility, transferability, dependability, and confirmability (Bell et al., 2022). In this study, credibility was supported through the use of multiple sources of empirical material. The primary data consisted of semi-structured interviews and a focus group, while two complementary documents were also included to provide additional context and support triangulation. The interviews made it possible to capture individual experiences and interpretations, while the focus group allowed participants to collectively reflect on preliminary findings and further develop potential activation strategies. It was also supported by a final presentation of the findings to practitioners within the company. The presentation provided an opportunity for dialogue and reflection, and practitioners' comments were considered during the final revision of the report. In this way, the study did not rely on one single type of empirical material, but combined several sources and practitioner feedback to strengthen the interpretation of the findings.

Transferability refers to the extent to which the findings provide enough contextual detail for readers to judge whether they may be relevant to other settings (Bell et al., 2022). Since this study is based on a single qualitative case study, transferability was supported by providing descriptions of the empirical context, including the focal OEM, the purchasing function, the low-carbon steel transition, and the challenges across upstream, internal, downstream, and exogenous dimensions. The findings are therefore not presented as universally generalizable, but as analytically transferable to other industrial firms facing similar challenges in sustainable material transition and value chain transformation.

Bell et al. (2022) describe dependability as involving an audit trail, where records of the research process and analytical decisions are kept to make the study more traceable. In this study, dependability was supported by describing the research design, sampling strategy, data collection, and data analysis. The research questions, interview guide, data collection, and analysis were also aligned with the backcasting logic used in the study. In addition, the use of the Gioia methodology helped create a systematic connection between the empirical material and the final themes presented in the findings. The research process was documented through interview transcripts, coding structures, and summary tables.

Confirmability was supported through a transparent and iterative analytical process, in which the analysis moved abductively between empirical material, emerging themes, and existing theory. This helped ensure that the findings remained grounded in the empirical material, rather than being shaped only by the researchers' own assumptions or by the theoretical frameworks used in the study (Bell et al., 2022). The use of direct quotations in the findings further supports confirmability by showing how interpretations are connected to participants' own accounts.

Authenticity was also considered, as the study aims to represent different perspectives within the organization and show the complexity of the transition rather than presenting a single simplified view. By including participants from both a low-carbon material purchasing team and a traditional purchasing team, the study captured different priorities, tensions, and interpretations within the purchasing organization. The focus group further created space for participants to discuss and develop strategies collectively.

4. Empirical findings

This section presents the empirical findings, structured around the four sub-research questions derived from the backcasting framework used in this study. These correspond to four overarching dimensions: (1) desirable future, (2) present situation, (3) leverage points, and (4) activation strategies. Table 2 provides a summary of the themes within each dimension, followed by a more detailed presentation of each theme in the sections below.

Table 2
Overview of themes in each step of the backcasting process.

Aggregate dimension	**Themes**
Desirable future	Normative factors Commercial factors Regulatory factors
Present situation	Opportunities Challenges related to exogenous context Upstream challenges Internal challenges Downstream challenges
Leverage points	Parameters Feedbacks Design Intent
Activation strategies	Perception of relationship between sustainability and cost Downstream demand

4.1 Desirable future

The desirable future dimension captures how respondents imagine a future state in relation to low-carbon steel at the truck OEM. It reflects the motivations behind the transition and the direction that current actions are intended to support. The section is structured around the three themes: (1) normative factors, (2) commercial factors, and (3) regulatory factors, each of which is further explored in the following sections. Finally, a cross-factor synthesis of these themes is developed. A summary of the derived concepts in each theme is provided in Table 3.

Table 3
Overview of themes and concepts in step one of the backcasting process (desirable future).

Theme	Concepts
Normative factors	Global decarbonization Corporate decarbonization Meaningful individual work
Commercial factors	First-mover advantages Supply risk mitigation Increased resilience Carbon pricing preparation
Regulatory factors	Regulatory preparedness

4.1.1 Normative factors

Normative factors refer to the values, ethical considerations, and beliefs that underpin and motivate the transition to low-carbon steel. Rather than being driven primarily by economic efficiency or regulatory requirements, these motivations are grounded in perceptions of what is right, desirable, and worth pursuing from a societal and environmental perspective. In the empirical material, normative factors emerge across three interconnected levels: global decarbonization, corporate decarbonization, and meaningful individual work.

Respondents connect the transition to low-carbon steel at the truck OEM to global decarbonization by recognizing steel as a key lever for reducing global greenhouse gas emissions. In this way, the motivations extend beyond firm-level objectives to encompass the broader societal-level transition to low-carbon steel. As interviewee A6 explained, “It's also worldwide, steel represents between 7 and 8% of the global CO2 emission in the world. So that is the reason why, for us, it is key to decarbonize this material.”

Interviewees also recognize low-carbon steel as a key lever for achieving corporate net-zero targets. While this is closely linked to global decarbonization, it reflects a shift in focus from the broader societal-level steel transition to firm-level ambitions. Respondents describe how much of the decarbonization effort at the focal OEM has focused on reducing emissions in the use phase, primarily through electrification. However, as these efforts progress, increasing attention is being directed toward emissions embedded in materials and production. In this context, steel stands out as a critical material, as highlighted by interviewee A2:

> Let’s say flat steel is around 50% of our [material] footprint today on its own. Half of the footprint, meaning that it is the single biggest material we use. So if we do not do that on steel, then we will never achieve our ambition.

Finally, normative factors are also reflected at the individual level, where engagement in low-carbon steel initiatives is linked to a search for meaningful and purpose-driven work. Interviewees describe a desire to contribute to broader societal and environmental goals through their professional roles. As interviewee A3 expressed, “Before, it felt a bit meaningless … so I was quite personally curious to work on something which could be meaningful in a way.” This suggests that the transition to low-carbon steel is driven not only by organizational targets, but also by individual aspirations to align work with personal beliefs about sustainability and positive impact.

4.1.2 Commercial factors

Commercial factors refer to the strategic and economic considerations that motivate the transition to low-carbon steel. These motivations reflect how firms position themselves within evolving market conditions and anticipate future constraints and opportunities. The empirical findings indicate that commercial factors can be understood across four main drivers: first-mover advantages, supply risk mitigation, increased resilience, and carbon pricing preparation.

First, several respondents highlight the potential for first-mover advantages in adopting low-carbon steel. Early engagement is seen as a way to secure preferential access to limited supply, establish strong partnerships with suppliers, and potentially benefit from favorable pricing conditions. This positioning is perceived as a source of competitive advantage in a market that is expected to become increasingly constrained and differentiated. As interviewee B1 noted, “There should be some kind of competitive advantage in this. If you manage this well, […] and be early in doing so, you will have an advantage.” This reflects a strategic logic in which timing and proactivity are central to capturing value in the emerging low-carbon steel market.

Second, the transition is also motivated by concerns related to supply risk mitigation. Respondents emphasize the uncertainty surrounding future availability of low-carbon steel, particularly given increasing demand and limited production capacity in the near term. Securing access to sufficient volumes is therefore seen as a way to reduce exposure to potential shortages and disruptions. In this sense, engaging early with suppliers and committing to low-carbon steel is not only a sustainability initiative but also a way to ensure continuity in production and avoid future bottlenecks.

Third, interviewees point to increased resilience as a key commercial benefit. By engaging deeper into the steel value chain, firms can improve their understanding of material flows, production processes, and potential risks. This closer collaboration strengthens the firm's ability to respond to disruptions and adapt to changing conditions. As interviewee A1 explained, "We are not experts in raw material. We are buying it through other people. But when you discuss with these guys [suppliers], you understand a lot." This highlights how knowledge development and relationship-building contribute to a more robust and resilient supply chain.

Finally, carbon pricing preparation emerges as an important driver. Respondents anticipate that rising carbon costs will significantly impact material prices in the future, making emissions-intensive inputs increasingly expensive. Transitioning to low-carbon steel is therefore seen as a way to prepare for and mitigate these cost increases. Even though the carbon tax today is low, the respondents forecast that the tax will be significantly higher after 2030. This reflects a forward-looking approach in which the firm seeks to manage cost-related risks by proactively adjusting their material strategies.

4.1.3 Regulatory factors

Regulatory factors refer to motivations linked to existing and anticipated policy developments shaping the transition to low-carbon steel. Unlike commercial factors, which are primarily concerned with market conditions and business strategy, regulatory factors relate to how firms interpret and prepare for evolving legislative and institutional requirements. In the empirical material, these motivations are connected to expectations of stricter climate policies and emerging regulatory frameworks affecting the industry.

A desirable future was associated with readiness for a changing regulatory environment. Rather than reacting to new climate-related requirements once they are implemented, respondents emphasized the importance of anticipating policy developments and adapting early to reduce uncertainty regarding future compliance requirements. Document 2 highlights policy instruments such as the Carbon Border Adjustment Mechanism (CBAM) and the European Union Emissions Trading System (ETS) as developments reshaping conditions in the steel market. Greater clarity regarding the direction and pace of these regulations was described as important for enabling firms to assess future requirements and make informed decisions.

Long-term regulatory signals were also seen as important for supporting investments throughout the value chain, as suppliers may be more willing to commit resources when future policy conditions become more predictable. From this perspective, early adaptation to emerging regulation is viewed as a way to prepare for future institutional requirements and navigate the transition to low-carbon steel within an evolving regulatory landscape.

4.1.4 Cross-factoral synthesis

While commercial and regulatory factors frequently appear in the interviewees' descriptions of the motivations behind the transition to low-carbon steel, the empirical material suggests that normative factors constitute the core driving force. As Interviewee B1 noted, "to protect society and the earth … I think it's the main driver for most people". In contrast, the current regulatory environment was generally not perceived as sufficiently strong or clear to actively push the company to accelerate the transition. Interviewees instead described a high degree of uncertainty regarding when and to what extent future regulation will place pressure on the industry.

Similarly, respondents emphasized that customers are currently not demanding low-carbon steel to any significant extent, limiting immediate commercial pressure for transition. At the same time, several interviewees strongly emphasized the potential commercial benefits associated with the new ways of working triggered by the transition. Engaging more deeply in the value chain, for example, was highlighted as a practice accelerated by the transition to low-carbon materials, while also generating beneficial side effects such as increased resilience and understanding. This suggests that the commercial value of low-carbon steel is often understood from a longer-term strategic perspective rather than through immediate financial returns.

However, adopting such a long-term perspective was also described as challenging within the purchasing organization, where decision-making is often shaped by short-term cost considerations and operational priorities. This creates a tension between the immediate economic logic guiding purchasing activities and the more uncertain long-term strategic motivations underpinning the transition to low-carbon steel. The strong emphasis on immediate operational performance and cost was also highlighted as a barrier to engaging in the transition based on normative considerations. As a result, respondents emphasized the importance of finding a path forward in which commercial performance and continued decarbonization can be mutually reinforcing.

4.2 Present situation

Findings from the second step of the backcasting process illustrate how respondents perceive the present situation in relation to the transition toward low-carbon steel. Overall, the findings highlight both opportunities and challenges associated with the ongoing transition across the value chain and broader external context. The findings can be organized into five overarching themes: (1) opportunities, (2) challenges related to the exogenous context, (3) upstream challenges, (4) internal challenges, and (5) downstream challenges. A summary of the different themes is provided in table 4.

Table 4
Overview of themes and concepts in step two of the backcasting process (present situation).

Theme	**Concepts**
Opportunities	Purchasing well-positioned Offtake agreements and demand commitments Dedicated low-carbon material purchasing team Integration of sustainability into procurement processes and contracts Knowledge development Reconfiguration of industry
Challenges related to exogenous context	Uncertain regulatory landscape Fragmented decarbonization efforts Geopolitical instability Lack of common definitions for low-carbon steel Limited effectiveness of regulation

Table 4 continued on the next page.

Table 4 (continued)
Overview of themes and concepts in step two of the backcasting process (present situation).

Theme	Concepts
Upstream challenges	Substantive industry transformation Industry under development Capital-intensive transition Technological and material limitations Monopolistic situation Supplier fatigue Supplier's resources constraints Lack of transparency, standards, and data reliability
Internal challenges	Historically limited raw material competence Learning new ways of working Buyer fatigue Dominant purchasing logic Competing organizational priorities Short-term vs. long-term tensions Technical conservatism and risk aversion
Downstream challenges	Conservative market Separation from end consumers Lack of customer-perceived value Immature market for low-carbon steel solutions Low customer willingness to pay Increased competitive pressure

4.2.1 Opportunities

The findings highlight several opportunities that position the focal OEM favorably in sustaining momentum in the transition toward low-carbon steel. One empirical insight is that the purchasing function appears to be well-positioned to work with systemic change of this kind. Interviewees emphasized, for example, its strong internal and external connectivity, as well as its role in bridging different functions and actors. Through its influence over sourcing decisions and supplier selection, purchasing is able to shape development trajectories and support the integration of low-carbon materials into the organization.

The foundation for the transition has also been laid through the establishment of offtake agreements and demand commitments with low-carbon steel producers. These long-term purchasing commitments help secure access to low-carbon steel while reducing supplier risk and enabling investment and scaling of production capacity. As interviewee A6 explained: "We don't want to take the risk of not having access to green steel due to scarcity, so we decided to buy in advance." The interviewee further explained how the decision to make an offtake agreement with a low-carbon steel startup that had not yet reached full production capacity was made "to support this startup, because also they need to have this offtake agreement in order to get some support from the bank."

Another key organizational enabler is the establishment of a dedicated team focused on low-carbon materials. A central feature of this team is its work with directed buy set-ups, where the OEM becomes more directly involved in upstream material sourcing and supplier selection, differing from traditional purchasing structures that primarily operate through tier 1 suppliers. The creation of the team also appears to strengthen organizational focus and coordination by allocating specific resources and responsibilities to the transition to low-carbon materials. Rather than treating low-carbon materials as a secondary issue alongside operational procurement activities, the team enables more strategic and long-term engagement with sustainability-related initiatives, supplier collaboration, and capability development. This organizational development is also reflected in how such teams are perceived internally, as noted by interviewee B2:

> They separated the department and gave it [the decarbonized material team] a different purpose, mainly to focus on this rather than operational tasks. They also have operational responsibilities, but I think it's good that they separated them and gave them this specific role.

Sustainability considerations are also increasingly integrated into all procurement processes and contractual arrangements. This includes embedding sustainability criteria in supplier selection, incorporating requirements into early-stage RFQs, and aligning contracts with environmental objectives. Such practices enable purchasing to operationalize sustainability goals and ensure that low-carbon considerations are systematically reflected in sourcing decisions.

These developments have also contributed to increased knowledge creation within the organization. Through closer interaction with upstream actors, purchasing gains deeper insights into production processes, material characteristics, and emissions profiles. This learning process enhances the organization's overall understanding of low-carbon materials and supports capability building. As noted by interviewee A1: "But the good news is that we are ready. We have the trained people, we have the knowledge. Now it is more about helping our suppliers build that knowledge."

Beyond the organizational level, respondents also reflected on broader system-level opportunities. The transition is expected to contribute to a reconfiguration of the industry, where technological developments and new production pathways may enable the entry of new actors and increase competition. As interviewee A6 stated: “Thanks to this green hydrogen, it is giving the possibility for new players to come, which is super good for buyers, because it gives more competition.”

4.2.2 Challenges related to exogenous context

The findings highlight several challenges related to the broader exogenous context in which the transition toward low-carbon steel is embedded. These challenges reflect the uncertainty and complexity of the external environment, where developments beyond the organization’s direct control influence the pace and direction of the transition.

A key challenge concerns the uncertain regulatory landscape. Respondents describe how varying and evolving policy developments create difficulties in planning and decision-making. The lack of stable and predictable regulation reduces clarity in the transition environment and may weaken incentives to invest in low-carbon solutions. As interviewee A6 noted “There is a risk to demotivate the decarbonization spirit if there is no stable regulation.”

In addition, the transition is characterized by fragmented decarbonization efforts across regions. As noted by interviewee A2, “Everything has completely changed with the change of administration […] now the momentum is not there in North America”. Differences in policy priorities and regulatory approaches create misalignment, which complicates coordination and slows down progress. Geopolitical developments further shape the transition context. Respondents point to how external events, such as the pandemic and geopolitical conflicts, shift attention and resources away from sustainability and decarbonization priorities. These dynamics contribute to an environment in which long-term transition efforts must compete with more immediate concerns.

Another challenge relates to the lack of common definitions for low-carbon steel. The absence of standardized definitions for terms such as green, low-carbon, and fossil-free steel creates ambiguity and limits alignment across stakeholders. This makes it more difficult to compare alternatives, assess progress, and establish shared expectations within the value chain. As explained by interviewee A6:

> You will see a lot of green steel, low-emission steel, but there is no definition in fact. [...] for me, it’s key to have a kind of standardization in order to have the same wording. If not, you will not be able to compare.

Finally, respondents highlight the limited effectiveness of existing regulatory measures in addressing key economic challenges associated with the transition. While regulation is recognized as an important driver, current policies are perceived as insufficient to overcome structural barriers, such as the cost premium of low-carbon steel and challenges related to international competitiveness. As noted by interviewee A2:

> However, for this to work effectively, carbon pricing would need to be implemented globally. If it is only applied in Europe, it may support the transition within the region, but it also risks reducing the competitiveness of European players, particularly in export markets.

4.2.3 Upstream challenges

The upstream part of the value chain presents a set of challenges linked to the complexity of producing and scaling low-carbon steel. Many of these challenges are rooted in the early-stage development of the industry, where both technologies and supply structures are still evolving.

A central challenge concerns the substantive transformation required within the steel industry itself. The transition toward low-carbon steel involves a fundamental shift away from long-established production methods based on coal and blast furnace technologies toward new processes such as hydrogen-based direct reduction (H-DR). Such changes require the restructuring of deeply embedded industrial systems, infrastructures, and production practices, creating significant inertia within the industry. As interviewee A6 explained:

> To do this transformation and to make more green steel in the future, it’s a big, big transformation. We have always been making steel the same way by using coking coal and iron ore. And now to make this transformation and to use the green hydrogen, it’s really a revolution.

The interviewees further emphasize that the low-carbon steel industry is still under development and characterized by a high degree of uncertainty. Technologies, production systems, and value chain structures are still evolving, while production is increasingly dependent on developments in adjacent systems such as renewable electricity and green hydrogen infrastructure. As these supporting systems develop unevenly across regions, uncertainty regarding supply availability, scalability, and future market conditions remains high.

In addition, the transition is highly capital-intensive. The projects currently being developed to scale the H-DR technology require substantial financial investments, making economic viability and long-term profitability key concerns for producers. This creates uncertainty regarding the pace and scale of industry development. As highlighted by interviewee B1:

> But I think it will be for sure the biggest challenge for all these green steel suppliers, how do we create enough cash flow? How do we create enough volume in this market to start generating a positive cash flow? Because today the investments are so enormous.

The availability of low-carbon steel alternatives also remains limited due to the early stage of industry development. Respondents described how suppliers initially focus on producing a narrower range of steel grades before gradually expanding their product portfolios as production capabilities mature. As a result, certain grades and specifications are not yet widely available in low-carbon alternatives. This creates challenges for purchasing organizations seeking to increase the share of low-carbon materials while maintaining technical and quality requirements.

Another challenge relates to the current market structure for low-carbon steel, which is characterized by a limited number of suppliers. This creates a monopolistic situation in which suppliers hold relatively strong bargaining power, contributing to premium pricing and, in some cases, lower service levels. As interviewee B2 described:

> I think that there should be more players in the market. [...] They are basically dictating all the conditions that they want. [...] And on top of this, their service is very bad, we have issues with them when we cannot get any price out of them for months sometimes.

At the supplier level, respondents further highlighted increasing pressure linked to expanding sustainability requirements. The growing number of environmental expectations, reporting demands, and compliance activities adds complexity to suppliers' operations and, in some cases, contributes to what interviewee A2 described as "supplier fatigue." Suppliers are expected not only to reduce emissions, but also to provide detailed sustainability-related information and documentation throughout the supply chain. At the same time, many suppliers are described as facing resource and capability constraints that limit their ability to respond to these demands. This includes difficulties in sourcing low-carbon materials, measuring carbon footprints, and reporting emissions consistently. As interviewee A1 explained:

> He [a supplier] does not even report his carbon footprint. And he's telling me, 'I will not report it. I have other problems, and we don't have a person dedicated to this'. The point is that you need to train people. People are not trained to understand what a carbon footprint is.

These challenges are further complicated by limited transparency and the absence of standardized and reliable emissions data. Variations in accounting methods, reporting practices, and data availability make it difficult for purchasing organizations to assess and compare suppliers' sustainability performance. Incomplete visibility into upstream emissions further increases uncertainty in decision-making processes. As reflected by interviewee A2:

> The problem is when someone upstream does not measure, and then someone in between only measures what they ask the component supplier to give you. But then you miss the upstream parts.

4.2.4 Internal challenges

The findings highlight several internal challenges associated with the transition to low-carbon steel. These challenges relate to historically established structures and priorities, the need to develop new competencies and ways of working, and tensions between operational demands and long-term sustainability ambitions.

Traditionally, purchasing has focused primarily on managing relationships with tier 1 suppliers, with limited engagement further upstream in the value chain. As a result, competence related to raw materials and upstream production conditions has historically been limited. As interviewee A3 reflected, “Normally, we have very limited expertise in the raw materials, because before it was never needed.” However, respondents also describe how the establishment of a dedicated team focused on decarbonized materials has helped strengthen internal knowledge and increase organizational attention toward upstream sustainability issues.

The findings further indicate that the transition toward low-carbon materials requires the organization to adopt new practices, processes, and ways of working. Buyers are increasingly expected to engage more closely with upstream suppliers, manage sustainability-related information, and coordinate across a broader range of internal and external actors. This shift challenges established routines and requires new forms of learning and collaboration. As interviewee B4 stated, “We will never achieve our high targets by going the same way as we have always done.” Similarly, interviewee A3 highlighted the difficulty of moving beyond established practices: “Now we realize that sometimes we want to know a bit more, but since we’ve been living in this system for a very long time, it’s sometimes very challenging.”

At the same time, respondents describe how sustainability-related responsibilities are often added on top of existing operational demands. Buyers remain responsible for ensuring cost efficiency, quality, and delivery performance, while simultaneously managing increasing sustainability requirements and reporting demands. As interviewee A4 explained, “we haven’t changed what we’re supposed to deliver, but we’re adding another layer of complexity on top of it.” This growing scope of responsibilities creates challenges in managing workload and priorities, as interviewee A3 noted: “if you just put it on top of what you need to do anyway, it will always be very difficult.”

These challenges are closely connected to the dominant logic that has traditionally guided purchasing activities. Purchasing has historically been oriented toward operational performance objectives, while driving sustainability transitions only more recently become integrated into purchasing strategies. As described in Document 2, “Traditionally focused on cost, quality and delivery, industrial purchasing strategies are now undergoing a marked evolution, incorporating sustainability as a central consideration.” Despite this shift, respondents emphasized that operational pressures continue to dominate day-to-day decision-making. As interviewee A1 explained, “And often, unfortunately, [sustainability] is not a priority. To have goods on time with quality and at the right costs, it’s the priority of every buyer.”

Several respondents also highlighted how competing organizational priorities reinforce these tensions. Issues related to cost efficiency, speed, and short-term operational performance often receive greater organizational attention, particularly during periods of economic pressure. As interviewee B4 reflected: “Right now, we speak a lot about speed and cost. So a few years ago, when we had record numbers, I think everybody was talking about sustainability.”

This creates tensions between short-term and long-term perspectives. While sustainability initiatives often require upfront investments and longer time horizons, purchasing decisions are still frequently driven by short-term financial and operational considerations. Respondents described how the higher initial costs associated with low-carbon materials and implementation efforts create challenges in balancing sustainability ambitions with competitiveness and economic performance.

Respondents also highlight technical conservatism and organizational risk aversion as barriers to the adoption of new materials and technologies. In particular, deeply embedded beliefs regarding safety and quality appear to create resistance toward low-carbon and recycled materials. In the truck industry, where safety considerations are critical, established standards and a strong quality-focused culture contribute to skepticism toward unfamiliar materials and production methods. As a result, new materials are often subject to extensive testing and validation processes before implementation, increasing both cost and lead times and slowing the adoption of low-carbon solutions. As interviewee A2 described:

> Because they have the mental models, they have the view that [steel] scrap is crap, meaning that it's not a good quality. And as we have the culture of … safety is in the DNA and the quality is first, which have developed a very risk averse [attitude], to the extreme … there is this belief that it cannot be as good. That means they want to over-check and over-validate things. Very costly, very slow.

4.2.5 Downstream challenges

The findings also highlight several downstream challenges related to market demand, customer preferences, and competitive dynamics. Respondents describe the market for low-carbon steel solutions as still being at an early stage of development, characterized by weak customer pull and limited willingness to pay for sustainability-related product attributes.

A central challenge concerns the conservative nature of the truck industry and its customer base. Trucks are primarily viewed as operational and business-critical assets, meaning that purchasing decisions are largely driven by considerations such as cost, performance, reliability, and operational efficiency. Respondents describe the industry as generally slow in adopting innovations and new technologies, as interviewee A4 explained, “It's a very conservative business […] if you look at the truck industry, changes is not something that they're asking for.”

This challenge is further reinforced by the separation between end consumers and purchasing decision-makers. Unlike consumer-oriented markets, trucks are typically purchased based on commercial and operational requirements rather than personal values or sustainability preferences. As interviewee B1 described:

> But the tricky thing with trucks is that the decision is not made by a consumer. Sometimes consumers are more value-driven and guided by beliefs or principles, and they may accept paying a premium. But trucks are almost always based on business needs, so it is very much about the money for them.

The findings also indicate that low-carbon steel currently offers limited customer-perceived value. Unlike product features that directly affect vehicle performance or functionality, the use of low-carbon steel remains largely invisible to the customer and does not significantly alter the end product from a user perspective. This makes its value more difficult to communicate and reduces its influence on purchasing decisions. As interviewee A2 explained, “If you go from grey to green, it is the same product at the end. So that means it is less tangible.” This aspect is also highlighted by interviewee A5, which compares low-carbon steel with other technologies aimed at reducing carbon emissions:

> If you buy an electric vehicle, it feels different to drive, and you have less vibration. It’s a completely different technology, and it’s a very visual and physical impact. But if you buy green steel, you don’t see that it’s there.

As a result, customer demand for trucks produced with low-carbon steel remains limited, contributing to the immature state of the downstream market. Several respondents emphasized that customers are generally unwilling to pay price premiums associated with low-carbon materials. As interviewee B4 explained, “Our customers are not willing to pay extra for it. They will not pay more for our truck just because it is more CO_2-neutral than a competitor’s truck.” Similarly, interviewee A6 noted that “The final customer is not prepared, so the market is not mature regarding buying a vehicle using low CO_2 emission steel.”

These challenges are further intensified by increasing competitive pressure within the industry. Respondents described how growing international competition from other fast-moving truck OEMs reduces the possibility of transferring higher material costs to customers. This creates additional pressure to balance sustainability ambitions with competitiveness and profitability, limiting the commercial viability of low-carbon steel solutions in the current market context.

4.2.6 Cross-factoral synthesis

Taken together, the findings indicate that the focal OEM has undertaken substantial preparatory work that positions the organization well for the large-scale implementation of low-carbon steel. Organizational initiatives such as the establishment of a dedicated decarbonized materials team, the implementation of directed buy set-ups, and increased engagement further upstream in the value chain have strengthened both coordination and understanding of raw materials and upstream production conditions. In parallel, off-take agreements and demand commitments have contributed to securing future supply and supporting the development of emerging low-carbon steel producers.

At the same time, the findings show that the momentum of the transition is affected by several challenges across the value chain and beyond it. Increasing competitive pressure has contributed to a stronger organizational focus on speed, cost, and short-term competitiveness. The fragmented geopolitical landscape and uneven global decarbonization efforts contribute to uncertainty regarding how the system transition toward low-carbon steel will develop. In addition, limited regulatory pressure and the still immature state of upstream supply chains further reduce predictability surrounding the pace, direction, and scalability of the transition.

The findings further suggest that many of the identified challenges are interdependent and cannot be understood in isolation. Upstream supplier conditions and cost structures are closely connected to downstream challenges related to the transfer of cost premiums. This indicates a need to address the transition from a broader value chain perspective rather than focusing on separate parts independently. In particular, the findings point toward the importance of simultaneously reducing the cost of low-carbon solutions while strengthening downstream customer demand and willingness to pay. Internal organizational barriers are also highlighted as important to address in order to sustain momentum in the transition.

4.3 Leverage points

Findings from the third step of the backcasting process illustrate the leverage points identified by respondents that could support progress toward the transition to low-carbon steel. Rather than focusing solely on barriers, this step shifts attention toward actionable opportunities within the system where the focal company can contribute, influence outcomes, or catalyse broader change. The identified leverage points can be grouped into four levels, following the categorization proposed by Abson et al. (2017): (1) parameters, (2) feedbacks, (3) design, and (4) intent. Finally, a cross-factor synthesis is provided. A summary of the section is presented in Table 5.

Table 5
Overview of themes and concepts in step three of the backcasting process (leverage points).

Theme	Concepts
Parameters	Carbon pricing
Feedbacks	Pricing transparency and dialogue Standardization and measurement alignment
Design	Value chain reconfiguration Project roadmap alignment Stimulate downstream demand Sustainability champions Spaces for learning and experimentation Showcasing of successful low-carbon steel cases
Intent	Thinking outside the box Trust and collaborative culture Mindset shift recognizing low-carbon steel as a strategic opportunity Sustainability importance mindset shift Relation between sustainability and cost perception

4.3.1 Parameters

In the empirical data, carbon pricing emerged as the central parameter-level leverage point for supporting the transition toward low-carbon steel. Respondents emphasized the importance of strengthening carbon pricing mechanisms and related financial incentives in order to improve the competitiveness of low-carbon alternatives relative to conventionally produced steel. Several respondents also highlighted the need for increased clarity and predictability regarding how carbon pricing mechanisms will develop over time, as this would increase the "cost of inaction" (interviewee A2) and create stronger incentives for investment and transition activities. Overall, these interventions are viewed as measures for improving the financial viability of low-carbon alternatives within existing market conditions.

4.3.2 Feedbacks

At the feedback level, respondents identified leverage points connected to feedback loops and how actors respond to one another over time. In these cases, progress emerges through recurring interactions across the value chain, where one development can trigger another and gradually reinforce the broader transition. The leverage points raised at this level relate to pricing transparency and dialogue, as well as standardization and measurement alignment.

When it comes to pricing transparency and dialogue across the value chain, respondents describe the need for clearer information regarding price premiums, cost drivers, and the economic implications of low-carbon steel. Greater transparency is seen as enabling more informed discussions between buyers and suppliers, reducing uncertainty and supporting more aligned decision-making. As interviewee A2 explained:

> Because if you [the suppliers] are not transparent, then you do not know what you are paying for. So you have no visibility, you don't know the cost drivers, so you have no view on when that will become competitive.

Greater visibility into cost structures may also reinforce adoption over time. When buyers better understand what drives the price premium and how competitiveness may improve in the future, confidence in sourcing decisions can increase. This may encourage earlier commitments and demand signals, which in turn can support scale effects and further improve commercial viability. Improved dialogue may also clarify how the costs and benefits of the transition are shared across the value chain.

A second leverage point relates to standardization and measurement alignment. Respondents highlighted the importance of shared definitions, comparable carbon accounting methods, and consistent reporting frameworks for low-carbon steel. Greater alignment in how emissions are measured and communicated was viewed as essential for improving comparability between suppliers, increasing credibility in sustainability claims, and enabling more confident purchasing decisions. Over time, such consistency may reinforce market trust and facilitate wider adoption.

4.3.3 Design

When it comes to the design level, leverage points related to system structures were identified. In the empirical data, respondents identified several opportunities related to value chain configurations, organizational coordination, and internal ways of working in order to support the transition toward low-carbon steel.

A key intervention area raised by the interviewees is the downstream part of the value chain. Since low-carbon steel often, at least in the short term, comes with a price premium, there is a need to frame the value proposition in a way that makes it possible to transfer some of the costs to downstream customers. Since the benefits of low-carbon steel are not always directly visible in the end product, demand cannot be assumed to emerge automatically from the material change itself. Instead, uptake may depend on how low-carbon steel is translated into forms of value that resonate with customers, such as sustainability performance or reputational gains. As interviewee B1 describes, it is about making customers "make those decisions consciously." Notably, attracting downstream customers to manage the cost premiums of low-carbon steel further reinforces purchasing's boundary-spanning role, as explained by interviewee A6:

> So this is really interesting that now we have contact with the sales department. Because when you are a buyer, you are in contact with mostly all the company except the sales department … but now with this decarbonization, we have this contact.

Another leverage point at this level concerns the reconfiguration of structural linkages within the value chain. The pilot project outlined in Document 1, for example, is an illustrative case where a reconfiguration of the existing value chain led to both cost reductions and a reduced carbon footprint. In this case, a cost increase from a tier 1 supplier triggered a collaborative problem-solving process. As a first response, a cost engineer from the focal truck OEM became involved, and a joint cost workshop with the tier 1 supplier was conducted. However, this resulted only in incremental improvements, which led to a decision to engage further upstream in the value chain and involve the steel mill (tier 3 supplier). In this process, it became evident that the steel mill had a letter of intent from the focal OEM to supply low-carbon steel from their plant.

A three-part dialogue between the focal OEM, the tier 1 supplier, and the steel mill was initiated, ultimately resulting in a directed buy set-up and the removal of the intermediary raw material distributor (tier 2 supplier). This, in turn, lowered the price for the tier 1 supplier and resulted in a significantly reduced carbon footprint. An important part of the process was visualizing the downstream supply chain for the tier 3 supplier. By doing so, the focal OEM could illustrate the significant volumes from the tier 3 supplier that ultimately went to the OEM and thereby leverage its purchasing power.

Within the organizational context, another highlighted leverage point was the activation of sustainability champions. While all departments share the same corporate climate targets, respondents described how different departments tend to assign them varying levels of importance in their day-to-day work. From this perspective, stronger momentum may require committed individuals within major departments who are empowered to represent sustainability priorities and translate them into everyday decisions and actions. As interviewee A3 describes:

> I think it is more like each big department should be empowered in a certain way, like kind of having their own representative. [...] I think it should be some kind of personal accountability in each big department to be involved in that, because otherwise it is not moving.

The empirical findings also suggest that a potential leverage point is to create more space for learning, experimentation, and reflection around the transition to low-carbon steel. This relates to the challenge of managing sustainability transitions alongside the already demanding operational responsibilities of buyers. As the transition to low-carbon steel entails the need for new knowledge creation and the development of new solutions and ways of working, respondents emphasized the importance of working within less constrained routines, structures, and processes. This perspective is also brought forward in Document 2, which highlights how "inside organizations, budget cycles and legacy key performance indicators can slow adoption."

This need for greater flexibility is reflected in how respondents describe projects as important spaces for exploration. Interviewee A1, for example, describes how they prefer to implement low-carbon steel within projects, as their longer time frames allow for experimentation and investigation of alternative set-ups and business models, as well as co-creation with suppliers. Interviewee B3 also emphasizes how the early stages of projects involve searching, exploring solutions, and assessing feasibility in order to identify configurations that can support implementation.

The findings further point toward the importance of improved mapping and visualization of upcoming projects and sourcing activities in order to integrate decarbonization opportunities into existing initiatives at an earlier stage. Respondents described how increased visibility regarding future sourcing activities could create better opportunities to align identified low-carbon steel possibilities with ongoing organizational processes. As interviewee A3 explained, “It could work much better if you have an excellent mapping about all upcoming projects and sourcings. Because then you already have these existing trains, where you can just jump in.”

Finally, respondents highlighted the importance of consistently showcasing successful low-carbon steel cases in order to build credibility and organizational momentum over time. Demonstrating tangible examples of successful implementation was described as important for creating confidence, reducing resistance, changing perceptions, and gradually strengthening organizational support for the transition. As interviewee A3 reflected, “Even if it's a small win, but it's like consistent, then it's much easier to convince this huge machine to turn in a certain direction.”

4.3.4 Intent

At the intent level, the empirical data points to leverage rooted in the underlying values, paradigms, and mindsets that shape organizational behavior. Rather than focusing on specific instruments or structural arrangements, this level concerns how the transition to low-carbon steel is understood, prioritized, and framed within the organization and across the value chain.

One important leverage point concerns the organizational capacity to think beyond existing structures and conventional ways of working. Respondents suggested that established routines and dominant ways of approaching purchasing and supplier relationships can limit the ability to respond to sustainability challenges and identify new solutions. Progress toward low-carbon steel was therefore described as dependent on developing a greater openness toward experimentation, alternative business models, and new forms of collaboration. As interviewee B4 reflected, “we need to think out of the box” in order to meet the high climate targets set by the OEM.

A second intervention area relates to the importance of trust and collaborative culture across the value chain. Several respondents described the transition as dependent on stronger cooperation across organizational boundaries, where openness, transparency, and shared values enable more effective joint action. As interviewee A2 explained, “I think the changes are first, as I say, culture. So change in openness and trust and cooperation, collaboration. I mean, it is all that needs to be in place for real [progress], across players, across the full ecosystem.”

Interviewee A2 further describes how suppliers have traditionally been reluctant to share information about material compositions and cost structures in order to avoid reverse engineering, and "That’s why it’s a big black box. I give you an offer, you like it, you select me, then I want to improve it, but don’t ask me. Now it’s completely different.” This perspective is also emphasized in document 2, where the authors note that “decarbonization is a collective effort” and that “cooperation and trust unlock speed.”

The findings also point toward the importance of a mindset shift in relation to how low-carbon steel is strategically understood within the organization. Several respondents emphasized that low-carbon steel should not only be viewed through the lens of short-term cost increases, but rather as a long-term strategic opportunity linked to future competitiveness, regulatory preparedness, and risk reduction. This perspective is also reflected in document 2:

> Though early volumes can carry a green premium, the narrow view of ‘price today’ misses the long-term advantages […] When the total cost of ownership includes future CO_2 prices and compliance risks, low-carbon metals often become the prudent bet.

Related to this, respondents also emphasized the importance of viewing sustainability as equally important as more traditional dimensions such as cost, quality, delivery, and safety. This was described as requiring a broader organizational mindset shift, where sustainability becomes integrated into core decision-making rather than treated as an additional or secondary concern. As interviewee A6 explained, “It's very key now to consider that sustainability is a feature equal, at same level as the other features.”

Finally, the findings suggest the importance of strengthening the perception that sustainability does not necessarily need to come at a higher cost. Several respondents highlighted how existing assumptions regarding sustainability and increased costs may limit organizational willingness to pursue alternative solutions. Instead, respondents emphasized that challenging established ways of working can create opportunities where sustainability improvements and economic benefits coexist. Referring to the pilot project outlined in document 1, where a reconfiguration of the supply chain resulted in both cost reductions and a reduced carbon footprint, interviewee B4 reflected:

> Normally we are getting from our suppliers that ‘yeah we can make it more sustainable but it will cost like 10% more’. This is an example where we, by challenging the current way of working, could make it greener and still to a better price.

4.3.5 Cross-factoral synthesis

Taken together, the findings indicate that respondents identify leverage points across multiple levels of the system, ranging from regulatory interventions and market incentives to organizational structures, value chain relationships, and individual mindsets. What is notable is that a large share of the identified leverage points are situated within the design and intent categories. This suggests that respondents perceive the transition toward low-carbon steel not only as a technological or economic challenge, but also as dependent on broader shifts in organizational structures, collaboration patterns, and underlying ways of thinking.

Several of the identified leverage points point toward the importance of challenging existing assumptions and perceptions surrounding sustainability, as well as developing new ways of working and thinking across the value chain. This includes a broader mindset shift in relation to how sustainability is understood and prioritized within the organization, but also a cultural shift toward more collaborative and trust-based relationships both within the focal OEM and across the broader ecosystem. In this sense, the findings indicate a movement away from more transactional relationships toward deeper forms of collaboration, transparency, and joint problem-solving. The findings therefore suggest that sustaining momentum in the transition toward low-carbon steel may depend not only on technological development and regulatory support, but also on the ability to create organizational and value chain conditions that support learning, experimentation, collaboration, and long-term thinking.

4.4 Activation strategies

In the fourth step of the backcasting process, activation strategies for two of the identified leverage points were explored: (1) the perception of the relationship between sustainability and cost, and (2) downstream demand. These leverage points were selected by the respondents in the focus group as the most important and feasible areas for intervention. The section presents different potential activation strategies related to each of these leverage points and concludes with a cross-factor synthesis. A summary of the section is provided in Table 6.

Table 6
Overview of themes and concepts in step four of the backcasting process (activation strategies).

Theme	Concepts
Perception of relationship between sustainability and cost	Mindset shift across the value chain Increased understanding of cost drivers and pricing structures Challenging established ways of working Influencing and coordinating the value chain Consolidation of volumes and strategic partnerships Long-term decision-making and business cases Inclusion of risk perspectives in decision-making Strategic framing of supplier communication
Downstream demand	Keeping cost increases as low as possible Strengthening the value proposition Quantifying and visualizing CO_2 impact Linking low-carbon steel to customer sustainability targets Creating niche pilot initiatives and lead markets Leveraging public procurement and regulatory support Showcasing successful cases Public funding and joint cases

4.4.1 Perception of relationship between sustainability and cost

A central theme in the focus group discussion was the need to challenge the prevailing perception that increased sustainability always leads to higher costs. Respondents emphasized that this perception exists not only internally within the focal OEM, but across the broader value chain, where suppliers often associate sustainability-related requests with automatic price increases. Several respondents therefore highlighted the importance of creating a broader mindset shift regarding how sustainability initiatives are understood and framed throughout the supply chain. As interviewee A3 explained, “we could have some commodities or raw materials where it simply could be no premium for turning green.”

Similarly, interviewee B4 emphasized the importance of making suppliers view sustainability-related initiatives not only as additional demands, but also as strategic opportunities that can strengthen long-term relationships with the OEM and create future business opportunities.

Several activation strategies discussed by respondents focused on increasing understanding and transparency regarding cost drivers and pricing structures. Respondents emphasized the importance of critically assessing where cost increases actually originate from rather than automatically attributing them to sustainability requirements. As interviewee A4 explained, “there could be anything that is behind the change and then it's easy to attribute it to sustainability.” Similarly, interviewee A2 described how suppliers may sometimes treat sustainability as an opportunity to increase prices without a clear underlying cost rationale. In response, respondents highlighted the importance of strengthening internal capabilities to analyze pricing structures, challenge supplier assumptions, and identify opportunities where sustainability improvements may instead create efficiencies and cost reductions.

The findings also point toward the importance of influencing and coordinating the broader value chain in ways that support more favorable conditions for low-carbon steel implementation. Suggested strategies included guiding tier 1 suppliers toward low-carbon steel suppliers and sourcing alternatives, facilitating connections and collaboration between suppliers, and improving sourcing structures in order to strengthen purchasing power and create better pricing conditions. Related to this, respondents also highlighted the importance of consolidating volumes and strengthening collaboration with trusted strategic partners that have clear sustainability roadmaps. As interviewee A3 explained, utilizing larger global purchasing volumes with selected suppliers “can bring better prices.”

Another recurring theme concerned the importance of adopting a longer-term perspective when evaluating sustainability-related investments and cost increases. Respondents emphasized that the current price premiums associated with low-carbon steel should be understood in relation to future developments, where larger production volumes, scaling effects, and increased market maturity may reduce costs over time. Interviewee B3, for example, reflected that while low-carbon steel is currently more expensive, prices may eventually “match or even go lower” as volumes increase. Several respondents also emphasized the importance of incorporating the “cost of inaction” into decision-making processes, including future carbon pricing, geopolitical risks, supply chain disruptions, and the strategic value of securing long-term supplier relationships and production capacity early. Related to this, respondents suggested the use of longer business cases and investment horizons that account for lifecycle effects, future market developments, and long-term competitiveness rather than focusing only on short-term part price increases.

The findings further indicate that communication and framing play an important role in shaping supplier responses. Respondents described how sustainability-related requests are often interpreted by suppliers as signals that the OEM is prepared to accept higher prices. As interviewee A1 explained, asking suppliers for “a potential green steel possibility” may unintentionally communicate that “green steel possibility equal price increase.” Respondents therefore highlighted the importance of becoming more strategic in how sustainability-related requests are framed and discussed with suppliers in order to avoid reinforcing assumptions that sustainability automatically implies increased costs.

Finally, respondents emphasized the importance of showcasing successful examples where sustainability initiatives have generated both environmental and economic benefits. Several participants described how visible success stories can help challenge existing stereotypes and strengthen organizational confidence in low-carbon solutions. As interviewee A5 explained, sustainability may also involve reducing material use, lowering weight, or improving efficiency rather than only adopting more expensive materials. Related to this, respondents highlighted the importance of making successful cases more visible throughout the organization in order to normalize low-carbon solutions and gradually shift organizational perceptions regarding the relationship between sustainability and cost. Respondents also discussed the possibility of applying for public funding together with strategic partners in order to reduce financial risks and support joint sustainability-related projects across the value chain.

4.4.2 Activation of downstream demand

The other central theme in the focus group session was the need to strengthen downstream demand for trucks incorporating low-carbon steel. Respondents emphasized that downstream demand and cost are closely interconnected, as the willingness of customers to adopt low-carbon solutions is strongly influenced by price levels and perceived customer value. Several respondents therefore highlighted the importance of keeping cost increases associated with low-carbon steel as limited as possible, while simultaneously strengthening the value proposition toward customers.

A recurring discussion concerned the challenge that low-carbon steel and reduced CO_2 emissions remain relatively intangible for customers compared to more visible product features. Respondents therefore emphasized the importance of making the sustainability value offering more concrete, measurable, and visible to customers. Suggested strategies included quantifying and visualizing the carbon footprint of trucks and actively communicating sustainability-related benefits in sales and marketing processes. As interviewee A5 explained, one possibility could be to display the CO_2 footprint of trucks and associated options “like when you book a flight.”

Similarly, interviewee A1 emphasized the importance of more actively promoting trucks incorporating low-carbon steel in order to gradually normalize and strengthen market demand for such solutions. Respondents also highlighted the importance of connecting low-carbon steel to customer-specific sustainability targets and reporting requirements. As interviewee A4 explained, trucking companies themselves face increasing sustainability expectations, meaning that low-carbon trucks may help reduce emissions within their own operations and reporting activities.

Several respondents further emphasized the importance of strengthening communication, education, and awareness-building activities toward customers. As interviewee A2 explained, “customers have to be educated about that from our marketing, sales and communication.” Related to this, respondents highlighted the importance of framing low-carbon steel not only as a sustainability feature, but also in relation to broader customer value dimensions. However, respondents also emphasized that total cost of ownership (TCO) remains a central decision criterion for customers. As interviewee A3 explained, “there is no way to compete with something having pretty much the same performance but costing less.”

Another activation strategy discussed by respondents concerns the creation of niche pilot initiatives and lead markets that can help stimulate demand and demonstrate feasibility. Respondents referred to examples from the bus industry, where public procurement requirements and targeted policy initiatives have helped accelerate the adoption of electric vehicles and other sustainability-related solutions. As interviewee A3 described, specific requirements tied to grants or public fleet procurements may create protected market spaces where low-carbon solutions can be tested and gradually scaled. Similarly, interviewee A2 emphasized the potential role of regulators and public procurement in creating lead markets that actively demand low-carbon solutions and thereby contribute to broader market development over time.

4.4.3 Cross-factoral synthesis

The findings from the focus group indicate that while changing the perception that sustainability leads to higher costs and stimulating downstream demand were identified as the most important leverage points, respondents also viewed many of the other identified leverage points as closely connected to these two areas. Respondents further emphasized that the two explored leverage points are themselves strongly interdependent. Stronger customer demand may help reduce cost premiums through increased scale and market maturity, while lower costs are simultaneously important for strengthening customer willingness to adopt low-carbon solutions. This highlights the interdependent nature of the transition and the need to adopt a systems perspective when working with interventions.

The strong focus on cost and demand illustrates the importance of implementing low-carbon steel in ways that align with existing commercial realities and competitiveness requirements. While respondents acknowledged the challenges associated with this, they also expressed optimism regarding the possibility of realizing the transition within these conditions. However, doing so was described as requiring new ways of thinking and working, as well as the development of creative solutions that make sustainability and economic performance mutually reinforcing rather than conflicting objectives. Several respondents also emphasized the importance of creating change across the entire value chain and broader ecosystem, where the focal OEM can act as a catalyst for collaboration, learning, and market development. In this sense, the transition was described as extending beyond traditional organizational and functional boundaries, where purchasing-related sustainability initiatives are increasingly connected both further upstream and further downstream in the value chain.

5. Discussion

This chapter analyzes the empirical findings in relation to the main research question and the study's purpose of examining how the focal truck OEM can sustain momentum in its transition to low-carbon steel. This discussion is structured around five key themes: (1) adopting a systems perspective, (2) targeting deep leverage points, (3) aligning impact and commercial performance, (4) pursuing dual roles through an ambidextrous set-up, and (5) building trust and catalyzing collective leadership. Each theme is discussed by integrating empirical insights with relevant theoretical perspectives.

5.1 Adopting a systems perspective

The findings suggest that the transition toward low-carbon steel constitutes a systemic challenge rather than merely a matter of technological substitution. Respondents repeatedly emphasized the interdependence between upstream supply conditions, downstream market demand, internal organizational dynamics, regulatory developments, and broader geopolitical changes. This aligns with sustainability transition literature, which emphasizes that transitions involve the reconfiguration of interconnected sociotechnical elements rather than isolated technological change (Rotmans et al., 2001). Consequently, the findings highlight the importance of adopting a systems perspective that enables actors to understand relationships across the broader ecosystem and work for "the health of the whole system" (Senge et al., 2015).

The empirical findings further suggest that the purchasing function is already accustomed to adopting a systems perspective and well-positioned to drive systemic change. Because of its external and internal connectivity, purchasing has a broad understanding of system dynamics and a bridging function that enables the alignment of actors, interests, and activities across organizational silos. Such integrative capabilities have been highlighted as critical for transformative sustainability work (Holmberg, 2020). In addition, purchasing's involvement throughout the product life cycle, from early-stage innovation to aftermarket activities, together with its purchasing power, strengthens its ability to influence upstream actors and shape developments beyond the boundaries of the firm. Given that transitions of this kind require system innovation rather than solely technological advancements, this positioning places purchasing in an important role in enabling and accelerating change.

What is particularly notable in the findings is that purchasing appears to adopt an even more boundary-spanning role in the transition toward low-carbon steel. Respondents described how purchasing increasingly engages further upstream in the value chain through closer interaction with raw material suppliers and low-carbon steel producers, while also strengthening downstream connections through increased collaboration with functions such as sales. This indicates that the transition is reshaping the role of purchasing from primarily managing transactional supplier relationships toward increasingly coordinating and aligning actors across the broader value chain. In this sense, purchasing can be understood as contributing to the development of "a configuration that works" (Rip and Kemp, 1998) across the low-carbon steel value chain.

Using the multi-level perspective (MLP) as an analytical lens, the findings indicate that a destabilization process of the current sociotechnical regime has started to take place within the broader steel system. The transition can be understood as being in an "era of ferment," characterized by high levels of uncertainty and evolving system configurations (Geels, 2010). Respondents repeatedly emphasized uncertainty related to geopolitical developments, fluctuating regulatory pressure, and decreasing decarbonization momentum in certain regions, suggesting that landscape-level pressures are present but uneven and unstable.

At the same time, what is particularly notable in the findings is the increasing connection between niche-level actors, such as emerging low-carbon steel producers, and incumbent regime actors such as the focal OEM. In this sense, it becomes evident how "elements are gradually linked together" (Geels, 2004) through new forms of collaboration, experimentation, and value chain coordination. Importantly, the findings also support the idea that increasing system uncertainty creates opportunities for actors to influence how the emerging system configuration develops before new forms of lock-in occur (Geels, 2010).

5.2 Targeting deep leverage points

A notable finding in the study is the strong emphasis respondents placed on leverage points situated within the design and intent categories. Rather than focusing solely on technological solutions, economic incentives, or operational adjustments, respondents repeatedly highlighted the importance of changing mindsets, assumptions, collaboration patterns, and organizational culture in order to sustain momentum in the transition toward low-carbon steel. This aligns with Meadows (2008), who argues that deeper leverage points related to paradigms, goals, and values often hold greater transformative potential than more shallow interventions targeting parameters alone. What is particularly notable is that respondents themselves repeatedly gravitated toward these deeper forms of intervention, despite previous research suggesting that deep leverage points are often overlooked in favor of more immediate and tangible interventions (Meadows, 2008; Davelaar, 2021; Abson et al., 2017).

At the same time, the findings indicate that existing paradigms and dominant assumptions continue to create inertia within the transition. Respondents repeatedly described how established purchasing logics, risk-averse organizational cultures, and assumptions that increased sustainability necessarily leads to higher costs act as barriers to change. While respondents emphasized that internal perceptions regarding low-carbon steel and sustainability appear to be gradually shifting, these developments were still described as constrained by existing structures, routines, and ways of thinking. Abson et al. (2017) similarly emphasize path dependency in human action, where deeply embedded assumptions and institutionalized behaviors contribute to reproducing existing system dynamics over time. From this perspective, sustaining momentum in the transition toward low-carbon steel may depend on actively challenging underlying assumptions and reducing cognitive and organizational barriers that reinforce the current system.

The findings further suggest that targeting deep leverage points requires iterative learning, experimentation, and the development of new ways of working rather than the implementation of predefined solutions or fixed blueprints. Respondents emphasized that there are few clear templates for how the transition should be managed in practice, suggesting that the key may not be to replicate exact solutions, but rather to adopt the underlying mindset that enables experimentation, collaboration, and adaptation. Furthermore, the identified leverage points were emphasized as being highly interconnected. This aligns with the perspective of Abson et al. (2017), who argue that leverage points are interdependent and that there is no simple mechanistic relationship between individual interventions and systemic change. Taken together, the findings suggest that sustaining momentum in the transition toward low-carbon steel may depend less on optimizing isolated interventions and more on gradually transforming the underlying paradigms, mindsets, and values that shape the development trajectories.

5.3 Aligning impact and commercial performance

Rather than moving directly toward solutions, this study initially took a step back to explore the underlying rationale and motivations behind the transition toward low-carbon steel. This aligns with the perspective of Holmberg and Larsson (2018), who emphasize the importance of “staying in the ‘why’” when working with transformative sustainability challenges. The findings suggest that both normative and commercial motivations are important drivers of the transition. This reflects the normative directionality highlighted in sustainability transition literature, which may create tensions when sustainability ambitions are pursued within commercial contexts historically shaped by competitiveness and financial performance (Köhler et al., 2019).

Importantly, however, the findings suggest that sustainability ambitions and commercial performance are not necessarily contradictory. Respondents repeatedly emphasized the importance of viewing the transition toward low-carbon steel as an opportunity to rethink and reconfigure supply chains in ways that can maintain or even reduce costs over time. The findings also indicate that perceptions of commercial viability are highly dependent on time perspective. Several respondents described how short-term competitiveness pressures, cost premiums, and increasing market uncertainty create tensions regarding the pace and commercial feasibility of the transition. However, respondents also emphasized that many sustainability-related opportunities become more visible when adopting a longer-term perspective. This includes securing quantities at favorable price levels, increasing resilience, preparing for future carbon pricing mechanisms, and reducing supply chain risks. This shift in focus toward long-term value creation is also emphasized by Senge et al. (2015) as a key condition for driving systemic change.

In this sense, the findings suggest that aligning sustainability ambitions and commercial performance may depend less on eliminating tensions and more on developing organizational capabilities to navigate the trade-offs between short-term operational performance and long-term strategic positioning. Geels (2010) acknowledges the difficulties in making such judgments during eras of ferment, as “the accompanying flux, uncertainty and fluidity complicate cost-benefit calculations in those periods.” This underscores the importance of maintaining flexibility and adaptability when navigating the transition, something emphasized in transition management literature (Elzen and Wieczorek, 2005; Rotmans et al., 2001). It also points toward the importance of integrating different perspectives and viewpoints, as diverse perspectives strengthen the collective ability to navigate uncertainty and complexity effectively (Senge et al., 2015).

5.4 Pursuing dual roles through an ambidextrous set-up

The study highlights that sustaining momentum in the transition toward low-carbon materials requires purchasing to simultaneously pursue two different organizational logics: maintaining operational efficiency while also enabling long-term transition-oriented experimentation and learning. This aligns with the concept of organizational ambidexterity, which involves balancing exploitation of existing capabilities with exploration of new opportunities (O'Reilly and Tushman, 2004). While traditional purchasing activities are primarily oriented toward optimization, cost efficiency, quality, and delivery performance, the transition toward low-carbon steel requires space for experimentation, uncertainty, and the development of new ways of working that may not generate immediate or easily measurable results.

In this context, the establishment of a dedicated decarbonized materials team can be understood as an ambidextrous organizational response. The findings suggest that the team creates space for exploratory activities connected to the transition to low-carbon materials. At the same time, the team remains closely connected to the broader purchasing organization, enabling new learnings and practices to be integrated into operational activities. This resembles the distinction described by Holmberg and Larsson (2018) between the "cruise ship" and the "expedition," where organizations simultaneously need structures that ensure operational stability and structures that allow exploration and adaptation under uncertain conditions.

The findings indicate that maintaining this ambidextrous balance may be critical for sustaining momentum in the transition. While the close integration between the decarbonized materials team and the broader purchasing organization facilitates organizational learning and coordination, it also creates a risk that exploratory transition work becomes absorbed by the dominant optimization logic of the operational organization. As a result, experimentation, learning, and long-term transition-oriented initiatives may become deprioritized in favor of short-term operational performance. The findings therefore suggest that sustaining momentum may depend on maintaining organizational structures that provide sufficient space for exploration while remaining connected enough to enable the diffusion and integration of new practices across the organization.

5.5 Building trust and catalyzing collective leadership

The results indicate that sustaining momentum in the transition requires a shift from transactional and firm-centric approaches toward more collaborative forms of ecosystem coordination characterized by trust, transparency, and collective leadership. Respondents repeatedly emphasized that the transition cannot be realized through isolated organizational initiatives alone, but instead depends on stronger collaboration across the broader value chain. This aligns with systems thinking perspectives emphasizing the importance of “thinking together” across organizational boundaries when addressing complex sustainability challenges (Holmberg and Larsson, 2018). In this sense, the transition toward low-carbon steel can be understood as a systemic transformation process that requires coordinated action and shared learning across multiple actors.

A particularly notable finding is the described shift from more transactional supplier relationships toward increasingly collaborative and trust-based forms of interaction. Respondents emphasized how traditional supplier relationships have often been characterized by secrecy, limited transparency, and reluctance to share information related to costs, sourcing structures, and material compositions. However, the transition toward low-carbon steel appears to create increased need for openness, collaboration, and joint problem-solving across the value chain. In this context, trust becomes an important enabling condition for deeper forms of coordination, experimentation, and long-term collaboration between actors.

The findings further suggest that the focal OEM increasingly takes on a catalyst and orchestrating role within the broader ecosystem. Rather than only managing suppliers through transactional purchasing relationships, purchasing increasingly contributes to connecting actors, aligning interests, and facilitating collaboration across organizational boundaries. This aligns with the perspective of Senge et al. (2015), who emphasize the importance of catalyzing collective leadership when addressing systemic sustainability challenges. In this sense, sustaining momentum in the transition toward low-carbon steel may depend less on unilateral firm-level optimization and more on the ability to build collaborative capacity, trust, and shared direction across the wider ecosystem.

6. Conclusion

The transition toward low-carbon steel is not only a question of replacing one material with another. For the focal truck OEM, it represents a broader shift in how the company understands purchasing, supplier relationships, customer value, and its own role in an emerging industrial transformation. This study set out to examine how the focal OEM can sustain momentum in its transition toward low-carbon steel. The findings suggest that sustaining momentum requires recognizing the transition as a systemic process shaped by interconnected challenges across and beyond the value chain.

Key areas for sustaining momentum include strengthening the perception that sustainability does not necessarily need to cost more, adopting a long-term perspective in decision-making, and stimulating downstream demand for low-carbon solutions. Progress therefore depends on the ability to work across organizational boundaries and catalyze collective leadership among actors in the steel ecosystem. The study further indicates that the transition is not only technological, but also cultural, requiring changes in underlying paradigms and mindsets related to sustainability, value, and trust. Finally, the transition also depends on organizational conditions that create space for learning and experimentation, where an ambidextrous set-up enables the gradual introduction and scaling of low-carbon steel within the truck OEM.

The study further has several theoretical and practical implications. First, it strengthens the emerging idea that incumbent regime actors can be active drivers of industry transformations and change the regime from within (Köhler et al., 2019). This stands in contrast to the increasingly outdated view of incumbent firms as solely regime defenders. As shown in the study, the truck OEM actively works to create the conditions necessary for a large-scale shift toward low-carbon materials. The findings therefore reinforce the idea that firms and businesses are important forces in realizing sustainability transitions. What is important to note, however, is that organizations themselves are heterogeneous. The study shows that perspectives on the transformation differ significantly within the organization, where both defenders of the status quo and active transition drivers coexist. This suggests that a more nuanced perspective on firms in sustainability transitions is needed, where organizations are understood as arenas in which different priorities, perspectives, and degrees of engagement exist alongside one another.

Second, it highlights purchasing organizations as important actors in sustainability transitions. As we enter a period where innovations rapidly need to be deployed and diffused at scale to accelerate decarbonization, linkages between producers and adopters of new technologies become increasingly important. Purchasing plays a key role in this context, as it operates at the interface between upstream suppliers of innovation and the downstream part of the value chain. By facilitating the diffusion of innovation, purchasing is taking on a new role in addition to its core procurement function. This development also requires purchasing to adopt new tools, practices, and ways of working that are better suited to long-term transformation processes characterized by uncertainty and experimentation. The findings further suggest that an ambidextrous organizational set-up, with dedicated structures focused on decarbonization efforts (such as the decarbonized materials team in this study), can support firms in balancing existing operational demands with the exploration and gradual scaling of low-carbon solutions.

Finally, the study also points toward potential new directions for future research. The findings suggest a need to extend the focus beyond innovators, producers, and first-level adopters of low-carbon steel. While the transition is primarily driven by normative ambitions, it must also be realized within a commercial context. The initially higher costs associated with early phases of transitions therefore need to be distributed in a viable manner across the value chain. In this regard, stimulating demand for low-carbon solutions downstream from actors such as the focal OEM emerges as a key area for intervention. To explore this further, Strategic Niche Management (SNM) (Rip and Kemp, 1998) could, for example, be applied to examine how protected spaces for low-carbon steel vehicles can be created and gradually scaled.

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Appendix A. Overview of research questions

RQ	Role	Weight	Data collection method	Theoretical concepts	Output format
RQ1	Surfacing perceptions of desirable future and motivations behind the transition	15%	Semi-structured interviews	Backcasting, vision making	Concepts grouped into the categories of normative, commercial, and regulatory factors
RQ2	Surfacing opportunities and challenges in present situation	40%	Semi-structured interviews; Documentary data	MLP, systems thinking, ambidexterity	Concepts categorized into opportunities, challenges related to exogenous context, upstream challenges, internal challenges, and downstream challenges
RQ3	Identifying leverage points	25%	Semi-structured interviews; Documentary data	Leverage points, iceberg model, system innovation	Leverage points grouped into the categories of parameters, feedbacks, design, and intent
RQ4	Developing activation strategies for the leverage points	20%	Focus group	Dialogue, reflection, collective creativity	List of ideas to activate the two prioritized leverage points

Appendix B. Interview guide

The interview guide below presents the main themes and example questions used during the semi-structured interviews. The guide was developed based on a backcasting logic and structured around three stages: envisioning a desirable future, reflecting on the present situation, and identifying potential leverage points for accelerating the transition. The questions presented below were primarily used to initiate and guide the conversations rather than to function as a fixed interview script. As the interviews followed a semi-structured format, participants were encouraged to elaborate on topics they considered relevant, and additional follow-up questions were asked depending on the direction of the discussion and the participants' areas of expertise.

Step 1 - Desirable future

Questions:

- What does a desirable future state look like for the truck OEM when it comes to steel?
- Why is the transformation to green steel important?

Step 2 - Present situation

Questions:

- How does the steel system that the truck OEM is part of look today? (Sketch/map if helpful.)
- How has the transformation at the truck OEM unfolded so far (e.g., key milestones, ongoing processes, pilot projects, etc.)?
- Based on the guiding principles of a desirable future, what do you view as the most important challenges in the present situation when it comes to the transition to green steel at the truck OEM?

Step 3 - Leverage points

Questions:

- Looking at this system and the challenges identified, where do you think interventions would have the greatest impact in accelerating the transition to green steel?
- For example, if you had the ability to change one thing in the system tomorrow, what would it be?
- Are there, for example, underlying systemic structures, paradigms, or mental models that sit beneath those challenges?
- Is there anything important about the transition to green steel that we haven't talked about but that you think we should understand?

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