

Using dynamic capabilities to shape markets for alternative technologies: A comparative case study of automotive incumbents

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ABSTRACT

This paper analyzes how incumbent firms act to shape markets for new technology alternatives. It introduces a framework that highlights important linkages between the dynamic market-shaping capabilities of individual firms and market-shaping processes on a system level. The framework is used to analyze the endeavors of two large heavy vehicle manufacturers to introduce two technology platforms—electrified trucks and trucks fueled by liquefied gas—as alternatives to traditional diesel-fueled trucks. The analysis shows how incumbent firms deploy market-shaping capabilities to claim legitimate positions in envisioned future markets. The paper concludes by pointing to the dynamism of market interactions in sustainability transitions, showing how firms induce system-level reconfigurations and how such reconfigurations induce changes at the level of the firm.

1. Introduction

“We do not have time to wait for the perfect solution to emerge. The various tracks must be able to run in parallel for a number of years to come.” (Senior advisor at the truck manufacturer Scania)

Transition studies have repeatedly emphasized the urgent need to accelerate sustainability transitions (Markard et al., 2020). A key for such acceleration is that alternative technologies that offer considerable environmental advantages can diffuse on mass markets. Defining markets as value-creating systems, transition studies have analyzed how the joint activities of a broad range of actors add up to market-shaping processes, altering market structures in support of upscaled technology diffusion (Dewald and Truffer, 2011; Ottosson et al., 2020). The definition of markets as value-creating systems is in line with marketing studies, which show how firms act and interact to shape markets (Nenonen et al., 2019). While marketing scholars tend to prefer organization-level analyses, assuming that firms are lead actors, most transition analyses are focused at the system level, studying socio-technical system reconfigurations (Geels, 2004). Still, transition scholars acknowledge the need for research on firms (Markard et al., 2012). To this end, transition studies have adopted the concept of dynamic capabilities (Teece and Pisano, 1994; Teece et al., 1997) to analyze the interactions between firms and the evolving systems they are embedded in (Hartman et al., 2017; Lieberherr and Truffer, 2015; Mousavi and Bossink, 2020; Stalmokaitė and Hassler, 2020). This stream of research has primarily targeted established firms—typically referred to as “incumbents”—and argued that the positions, resources, and influential power of these firms make them interesting to study (Ampe et al., 2021; Bohnsack et al., 2020; Borghei and Magnusson, 2018).

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While these transition studies have pointed to the relevance of incumbent firms and their dynamic capabilities, they have not explicitly focused on market-shaping processes. Looking at firms from a market-shaping perspective entails the assumption that markets are complex adaptive systems. Being embedded in these systems, incumbent firms can actively influence them (Mollinger-Sahba et al., 2020). To better understand the capacity of firms to exert such influence, Nenonen et al. (2019) suggest looking at those dynamic capabilities which enable firms to shape markets to their advantage. Using this as a conceptual lens promises insights into the intricate relationship between incumbent firms and other actors in evolving market systems, elucidating the interactive processes by which they establish new linkages and create value. In this context, dynamic capabilities refer to the ability of a firm to modify or reconfigure its resource base in interaction with other market actors (Eisenhardt and Martin, 2000). Employing a market-shaping perspective, we should find incumbent firms continuously using dynamic market-shaping capabilities to establish favorable market conditions. Marketing research that has investigated market-shaping suggests that firms should not be expected merely to adjust to evolving markets, but rather to take proactive steps to shape them (O'Connor and Rice, 2013; Storbacka and Nenonen, 2011b; Ulkuniemi et al., 2015). Starting from this presumption, this paper asks how incumbent firms deploy dynamic capabilities to shape markets in sustainability transitions.

To address this question, we use a comparative case study of markets for heavy transport vehicles. The uncertainty over the most promising ways to reduce carbon emissions from heavy transport has led incumbent vehicle manufacturers to invest in various alternative technologies in parallel (Scherrer et al., 2020). Papachristos (2017) noted that vehicle manufacturers might choose broad technology portfolios to supply different emerging markets simultaneously. The case at hand is no exception, as our analyzed incumbents have invested in various technology platforms utilizing alternative technologies. The paper analyzes efforts to establish markets for electric and liquefied gas-powered trucks, based on 57 interviews with key decision-makers from incumbent firms and other market actors directly involved in these efforts. The aim of the paper is to contribute to the emerging literature on market-shaping in transition studies by focusing on the role of incumbent firms and dynamic market-shaping capabilities.

The next section outlines the theoretical framework, comprising the key concepts of technology platforms, dynamic capabilities, and market-shaping. Section 3 explains the research methods, followed by Section 4, which offers detailed analysis of dynamic capabilities and to what extent the two incumbents have relied on them to shape markets for electric and liquefied gas-powered trucks. Section 5 discusses the central findings from the comparative case studies before the final conclusions are presented in Section 6.

2. Theoretical framework

2.1. Incumbents and technology platforms

Incumbent firms may be reluctant to commit their organization to novel technologies right away. Hence, they often seek dual strategies of preservation and niche development simultaneously (Berggren et al., 2015; Nykamp, 2017). Still, incumbents may offer considerable support for the development of a new technology when they expect competitive advantages from establishing a new product category (Budde et al., 2012). Particularly in the automotive sector, the commitment to innovative technologies appears strongly intertwined with expectations within the firm of attaining returns on investment and fulfilling market expectations (Sovacool et al., 2019; Sushandoyo and Magnusson, 2014). Even when an automotive firm's management has acknowledged the societal demand for greener products, the parallel development of new technological capability is required (Lee et al., 2006). Moreover, the evolution of the core technology will not be sufficient in itself to drive a transition forward. Often, the performance of a core technology relies on complementary innovations that stem from external actors (Adner and Kapoor, 2010).

Levinthal (1998) outlined that a variety of distinctive alternative technologies can manifest in an industry. In the European heavy vehicle industry, multiple alternative fuel technologies are under development in parallel (Anderhofstadt and Spinler, 2019; Scherrer et al., 2020). The various technological solutions that enable the reduction of carbon emissions from road transportation are integrated by manufacturers and their partners into complex technology platforms. Such platforms comprise complementary products and infrastructure to deliver functionality and offer value (Papachristos, 2017). For instance, electric vehicle platforms feature a large variety of interdependent components, and bottlenecks in one dimension can threaten the performance of the system (Helveston et al., 2019). Having the most efficient electric motors and the most energy-dense batteries is of little benefit if there is no workable solution for reliable charging. Ultimately, since no single organization is in control of the development, actors must interact in a dynamic way to combine their various resources and capabilities effectively.

2.2. Dynamic capabilities and markets

One way to understand the interaction between firms and the markets they operate in is by analyzing dynamic capabilities (Teece and Pisano, 2003). The concept of dynamic capabilities is rooted in the resource-based view of the firm (Barney, 1991). According to this view resources are the sum of a firms' assets which allow attaining sustainable competitive advantages, while capabilities reflect the capacity of a firm to identify linkages between held resources and opportunities. Dynamic capabilities make it possible for firms to sense and seize opportunities, and thus sustain evolutionary fitness (Teece, 2007). When successfully deployed, dynamic capabilities enable a firm to respond to opportunities by quickly adapting and transforming their resources and routines (Zahra et al., 2006). According to Teece (2007), the true value of dynamic capabilities becomes visible in the attainment of competitive advantage.

Firms operating on evolving markets that encompass technological innovations may encounter a constant stream of business opportunities (Tongur and Engwall, 2014). Therefore, they will need to "innovate, adapt to change, and create change that is favorable to customers and unfavorable to competitors" (Teece et al., 2016, p. 18). This emphasizes the equal importance of responding to and

initiating changes by combining, integrating, developing, and building internal and external resources (Teece et al., 2016, 2007). Correspondingly, a firm's engagement in market-shaping encompasses deliberate (re-)configurations of resources to produce favorable market outcomes (Cova et al., 2021; Kachouie et al., 2018; Kindström et al., 2018). This, however, requires the deployment of dynamic capabilities focusing on their ability to shape markets by “shaping opportunities”, (Teece, 2007, p. 1319) and inducing market changes (Teece et al., 2016). Consequently, market-shaping capabilities emphasize the ability to proactively change markets and can thus be perceived as a subset of a firm's dynamic capabilities (Nenonen et al., 2019).

2.3. Market-shaping capabilities, processes and value outputs

A firm's market-shaping capabilities are manifested in the activities that it undertakes, and reflect its ability to engage with other stakeholders in the shaping of markets. Nenonen et al. (2019) propose a distinction between *triggering* and *facilitating* market-shaping capabilities. Whereas triggering capabilities generate new resource linkages, facilitating capabilities help firms determine how to apply triggering capabilities. Facilitating capabilities reflect the firm's capacity to discover value potential and mobilize resources. This encompasses *exploring*, which identifies system-level resources that can be recombined, and *experimenting*, which fosters learning. Moreover, facilitating capabilities entail *expressing* messages that resonate with relevant stakeholders and *engaging* external actors to redirect resources.

While facilitating capabilities are generic (Nenonen et al., 2019), triggering capabilities are linked to specific market-shaping processes. Actors engage in such processes to create value (Storbacka et al., 2016). Integrating concepts from marketing literature and transition studies, Ottosson et al. (2020) outline three system-level market-shaping processes: enabling exchange practices, proving the system, and constructing the narrative, which are interrelated through their respective value outputs. Table 1 combines these market-shaping processes with the capabilities proposed by Nenonen et al. (2019).

Firstly, enabling exchange practices facilitates market transactions. The result of these transactions is the *traded value* that the market actors can agree on at the time of the exchange (Ottosson et al., 2020). This value is generally expressed in monetary terms. A firm takes part in the process by changing the properties and scope of its products, by adjusting prices and pricing, and by selecting different market channels and transaction mechanisms, thus modifying the methods of matching supply with demand (Nenonen et al., 2019; Storbacka and Nenonen, 2011a). Secondly, proving the system shows that value creation is possible, and the output is a *demonstrated value*, which ensures that products have desired functions and qualities and that they can be supplied and used (Ottosson et al., 2020). To participate in this process, the firm investigates the receptiveness to new ideas. According to Nenonen et al. (2019) this is about reconfiguring networks and involves modifying own supply networks, as well as modifying customer-side features by approaching new customer groups, changing the work division between the firm and its customers, or altering the supporting infrastructure. Moreover, the firm modifies product provision by influencing providers of competing and complementary products, and by influencing the way these providers interact and cooperate. Thirdly, constructing the narrative is a future-oriented process that points to possibilities of value-creation. The output is *expected value* (Ottosson et al., 2020). Such value enrolls actors and legitimizes changes (Baker et al., 2019; Regany et al., 2021; Smith and Raven, 2012). Engaging in narrative construction, the firm contributes to the reformation of institutions by influencing market representations and norms (Kaartemo et al., 2020), sometimes via industry associations (Nenonen et al., 2019). Market representations include industry terminology, media portrayals, market research and statistics, key events, and awards. Norms, on the other hand, encompass technical standards, formal rules or laws, and social norms.

Fig. 1 summarizes the conceptual discussion in a framework that places the firm's three triggering capabilities for market-shaping around the center, with its facilitating capabilities to discover value potential and mobilize resources at the core. Deploying capabilities to co-create value in three market-shaping processes, the firm interacts with other actors on a system level. The three processes generate different kinds of value, which the firm captures. The figure shows how the firm's facilitating capabilities are generic, while the triggering capabilities are associated with specific market-shaping processes and value flows. Accordingly, redesigning exchange is associated with enabling exchange practices and traded value, reconfiguring networks is associated with proving the system and demonstrated value, and reforming institutions is associated with constructing the narrative and expected value.

3. Methodology

This paper uses a comparative case study design to analyze how two incumbent heavy vehicle manufacturers—Scania and Volvo Trucks (“Volvo”)—use their specific dynamic capabilities to shape markets for alternative technologies that may offer considerable

Table 1

Facilitating and triggering capabilities, market-shaping processes, and value outputs. Based on Nenonen et al. (2019) and Ottosson et al. (2020).

Facilitating capabilities	Triggering capabilities	Market-shaping processes	Value outputs
Discovering value potential Experimenting; Exploring	Redesigning exchange Developing products; Adjusting price or pricing; Modifying matching methods	Enabling exchange practices	Traded value
Mobilizing resources Expressing; Engaging	Reconfiguring networks Modifying own supply networks; Modifying customer-side features; Modifying provision	Proving the system	Demonstrated value
	Reforming institutions Influencing representations; Influencing norms	Constructing the narrative	Expected value

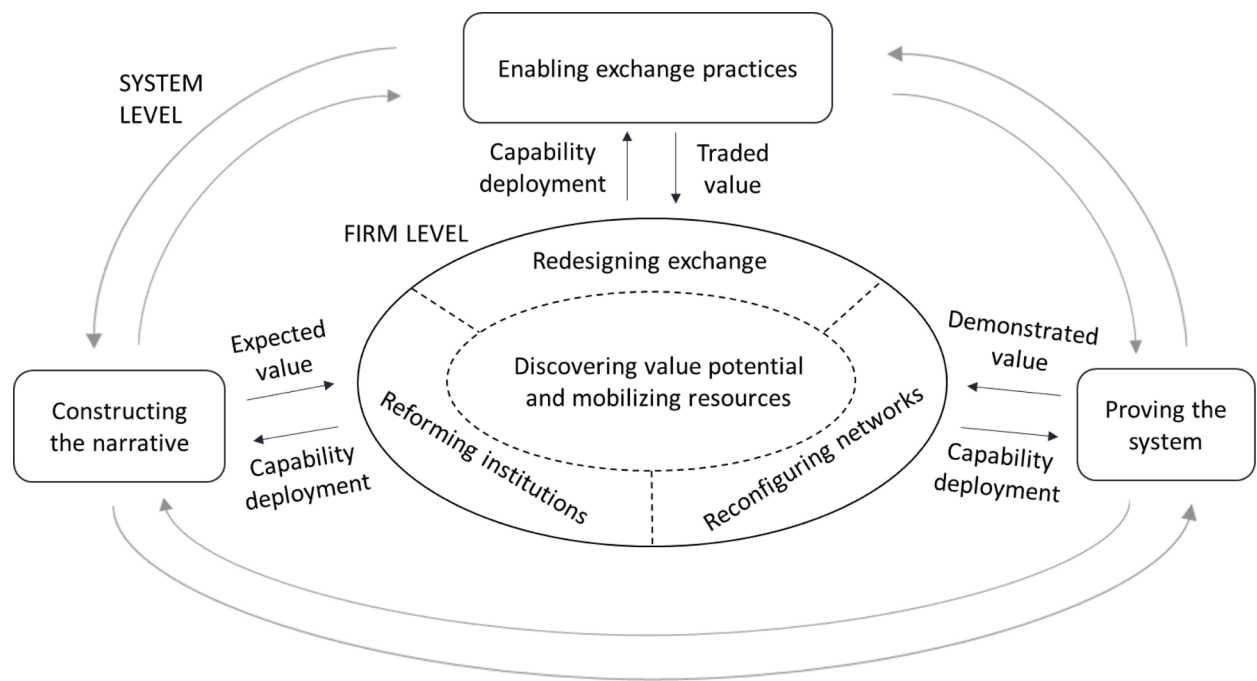


Fig. 1. System-level market-shaping processes, firm-level capabilities, and firm-system linkages.

environmental advantages. We start this section by motivating our research approach and explaining the rationale behind our case selection. We then describe the methods used for data collection and analysis.

3.1. Case study design and case selection

Case study research is effective to gain detailed knowledge about a specific phenomenon and makes it possible to analyze issues from different standpoints (Eisenhardt and Graebner, 2007). Applying a comparative research design enables studying the efforts of different incumbents in market-shaping processes for different technology alternatives. Given the focus on market-shaping, we decided to focus on those alternative fuel technologies already commercially available. We selected two leading international heavy vehicle manufacturers – Scania and Volvo – as focal case companies. Together they controlled over a third of the EU market in 2016 (EEA, 2018). Selecting these two incumbents provides opportunities to compare the deployment of market-shaping capabilities in the two separate market systems for electrified and liquefied gas trucks.

Electrified trucks enable local emission-free operations within a limited driving range, making them suitable for certain urban and regional transport missions (Liimatainen et al., 2019). Moreover, electrified trucks can considerably reduce carbon dioxide emissions (Zhao et al., 2016), improve working conditions for drivers, enable nighttime operations (Pelletier et al., 2018) and simplify vehicle maintenance (Sen et al., 2017). In this study, we use the term “electrified trucks” to denote both plug-in hybrid electric vehicles (PHEVs) and fully electric battery electric vehicles (BEVs).

Liquefied gas is currently the only alternative fuel that can compete with diesel in terms of driving range and can lower carbon dioxide emissions by up to 20 percent (Osorio-Tejada et al., 2017). However, the reduction calculations depend on assumptions in terms of fuel production and distribution, as well as vehicle technologies, and various studies show mixed results. According to Gustafsson and Svensson (2021), significant carbon dioxide reductions can only be achieved if the trucks run on renewable liquefied biomethane (LBM).

3.2. Data collection and analysis

The variety of activities involved in the market-shaping processes made it apt to base our case analysis on multiple data sources. The data on the shaping of markets for liquefied gas trucks was collected between 2017 and 2019, while the data underlying our analysis of the electrified truck market was collected between 2019 and 2021. The disparity in time spans is due to the differing maturity levels of the two technology platforms. Electrified solutions only entered a commercial stage as recently as 2020, while liquefied gas trucks have been commercially available from the case firms since 2017.

We conducted 57 interviews with representatives from 32 different actors across the markets for heavy transport vehicles. All interviews were semi-structured by means of interview guides and conducted face-to-face, by telephone, or as videocalls. The interviews lasted between thirty minutes and three hours. Interviews were audio-recorded, with exceptions in cases where interviewees

did not wish to be recorded. Recorded interviews were transcribed verbatim, while notes were taken for unrecorded interviews during or just after the interview. We conducted interviews broadly among actors in the two market systems, to capture the firm-system linkages (see Fig. 1.). We utilized an abductive research approach which sought to trace processes by establishing most plausible explanations for observations in our empirical material. This implies that data collection and analysis needed to evolve dynamically (Bennett and Checkel, 2015).

The respondents comprise key personnel at companies and organizations actively involved in either the electrified or liquefied gas market system; a full overview is provided in the appendix. The rationale for this sample profile is twofold. First, it helps minimize the scope for bias inherent in the answers from individual respondents or organizations. Interview-based research designs entail the challenge that answers are always *situated accounts* colored by interviewees self-image and what they consider socially acceptable (Qu and Dumay 2011). For example, single individuals may only hold limited insights into the rationale of company boards, are unwilling to disclose potentially harmful or sensitive information, and may not recall all aspects that influenced internal decision dynamics. To counter the risk of becoming overly reliant on previous responses, we interviewed additional actors engaged in market-shaping based on our evolving insights into both market systems. Second, the notion of markets as complex adaptive systems entails an underlying assumption that while a focal market actor can intentionally shape a market it requires the alignment and mobilization of a multitude of actors towards the envisioned market change (Flaig et al., 2021). In both of our cases, we investigate technology platforms that require the alignment and mobilization of different market actors and, ultimately, the effect of market-shaping is perceived by all actors constituting the market. Thus, the market-shaping cannot be investigated as isolated processes, only driven by the focal incumbents.

The interview data was coded and clustered based on our framework (Fig. 1) consisting of facilitating and triggering capabilities, market-shaping processes, and value outputs. Two authors categorized all interview data independently to boost intercoder reliability based on the concept of triggering and facilitating capabilities. As shown in Table 2, these codings enabled assessing and grouping the linkages between market-shaping capabilities and our interview data into clear indications, ambiguous indications, and absence of indication. In a second step the full research team harmonized conflicting codings and reviewed the data again to assess connections to the three value outputs. The analysis was from the start grounded in the theories presented in our theoretical model in section 2.3. However, following an abductive approach (Dubois and Gadde, 2002; Dubois and Gibbert, 2010), our analysis and the model evolved in an iterative manner as the case study analysis proceeded. To enable cross-checks of our inferences on the market-shaping processes, we attended several multi-stakeholder workshops, seminars, presentations, and study visits, which gathered participants from a wide array of market actors and covered a broad range of market-related topics. Our research group gained access to these events through active engagement with two national centers of excellence, namely the Biogas Research Center (<https://biogasresearchcenter.se/>) and the Swedish Electromobility Center (<https://emobilitycentre.se/>). This enabled us to triangulate the interview data with other data sources and validate our interpretations.

4. Case analysis

The analytical model presented in Section 2.3. guides the structure of this section. Each of the four case descriptions starts from the facilitating capabilities serving a vital foundation for discovering value potential and mobilizing resources. In a second step the case descriptions overview the three potential value outputs (traded, demonstrated and expected value) that may become attainable by redesigning, reconfiguring, and reformulating the market systems.

4.1. Market-shaping for electrified vehicles at Scania

4.1.1. Discovering value potential and mobilizing resources

For Scania, *exploring* value drivers in logistics has great strategic importance to understand the value potential of heavy vehicle electrification. Charging trucks from electrical grids shifts role allocations in the transport industry, raises new technological challenges, and heightens uncertainty among the organizations involved. Consequently, the utilization of *triggering capabilities* relies on the *exploration* of emergent electrified urban transport in commercial demonstrations, and of the differences between BEVs and PHEVs. Scania builds on *experimenting* to highlight the value potential of electrified trucks, both to outside actors and to Scania insiders. An interviewee from the senior management team revealed that Scania hold internal discussions on which path the organization should follow, making it important to use successful experiments to highlight the promises of electrification. A major transport buyer involved in such experimentation argued that the experience with electrified trucks is vital to adjust their overarching transport strategy. A senior Scania manager highlighted that the strategic goal of their *experimenting* is to challenge the mindset of customers and regulators to be open to innovative business models. Representatives of two involved haulers argued depending on collaboration with Scania to evaluate the impact electrification has on their business. A senior Scania engineer pointed out the unconventional character of electrified trucks for Scania allowed to “[stick] my nose outside of Scania for the first time.” The engineer explained that this newfound openness links to attempts to increase serendipity at Scania and adjust operational routines to the challenges associated with electrified vehicle development.

To mobilize resources from a wider network, Scania rely on their *expressing* capabilities. For instance, they communicate data from their demonstrations and highlight social benefits in their project reporting and during presentations at industry events. The benefits they express include improvements in transport efficiency, better working conditions for professional drivers, and reductions in urban noise and air pollution. *Engaging* key customers and other societal partners in demonstrations is important for Scania to promote the transition to electrified trucks. For example, Scania support their lead customers who operate in the new market to promote the change

publicly. Moreover, Scania directly engages with scientists, policymakers, and even direct competitors during demonstration projects to support their lead customers' efforts to electrify their fleets.

Seen holistically, Scania uses the four facilitating capabilities *experimenting*, *exploring*, *expressing*, *engaging* extensively in the electrified vehicle market system. This appears to be linked to a significant ambiguity on where value can be discovered in an emerging market and how new linkages can be created to attain a favorable market position.

4.1.2. Using triggering capabilities to create value

To enable traded value, Scania are consciously *developing* their electrified products and integrating their experience from extensive customer-based vehicle testing. Since battery size is the biggest cost driver in vehicle electrification, Scania are optimizing their vehicles accordingly. For instance, to reduce the need for large and expensive batteries, Scania are using a geofencing system to ensure that PHEVs only run on electricity in areas where the benefits of doing so are the greatest. As interviewees from multiple organizations repeatedly explained, Scania need to increase their involvement with customers to understand their individual requirements. Sales representatives face a situation where customers with greater flexibility to adjust routes are suited to operating BEVs, while other customers are better served with PHEVs. To generate traded value, Scania pay close attention to the implications of electrification for their *pricing* practices. During our interviews, customers voiced concerns about the uncertain financial implications linked to fleet electrification. To respond to such concerns, Scania plan new leasing models for batteries to reduce financial risks. Furthermore, a hauler and transport buyer argued that it is vital for Scania to justify the higher purchase cost of their electrified vehicles with the possibility of extending operation into the nighttime.

Scania are *modifying their own supply networks* by engaging with new partners from universities, start-ups, and charging equipment manufacturers to demonstrate the value of their electrified vehicles. This becomes apparent in their efforts to integrate new external knowledge concerning geofencing software, new tools for efficiency and noise measurement, and purpose-built charging solutions. Scania use system demonstrations to *modify customer-side features* and improve their customers' competences in handling electrified vehicles. Interviews with the first electrified vehicle customers suggest that Scania seeks to empower them to adjust their operational routines in accordance with new challenges uncommon to diesel vehicles. Scania appears to work closely with their partners to mitigate potential negative implications for drivers' safety, operational efficiency, labor cost, fire hazards, or nocturnal noise emissions.

At present, much of the future value is less quantifiable. Haulers and regulators are fairly skeptical, as no major fleets of electrified trucks exist. Thus, Scania rely on their capabilities in terms of *influencing norms* to legitimize their technology. This is manifested in the manner Scania represent their electrified products publicly and use public events and expert forums to justify their technology choices. Additionally, Scania leverage the advertising resources of one of their key customers to promote nighttime deliveries and construct a positive narrative for the wider public. *Influencing norms* around electrified trucks appears particularly vital for Scania in heightening expected value. At logistics firms, for instance, the collaboration with Scania triggers changes in their perception of PHEV technology. A manager at one hauler explained how the company had warmed to the idea of electrification as they discovered new possibilities to adjust their operational routines and improve drivers' working environment by reducing stress and noise levels.

In general, we find Scania deploying triggering capabilities extensively to co-create value with other actors in the electrified vehicle market system. To create traded value, they appear invested towards technology development and finding well-adjusted pricing models. To generate demonstrated value they reconfigure supply networks and provide support to customers in gradually gaining experience with electrified vehicles. Moreover, to develop expected value and gain legitimacy for their technology in the transport industry and among policy makers, Scania aims at reforming institutions.

4.2. Market-shaping for liquefied gas vehicles at Scania

4.2.1. Discovering value potential and mobilizing resources

Scania rely heavily on their facilitating capabilities to discover the value potential of liquefied gas vehicles. Here, Scania's *exploring* of new value opportunities does not solely focus on national or geographically proximal markets but encompasses an international perspective. Latin America is of particular interest to Scania, due to a substantial number of sugarcane mills and the associated access to substrates for biomethane production. This illustrates Scania's ability to comprehend the wider market system and to use *exploration* to discover untapped value potential. However, due to considerable environmental and market uncertainty in the countries involved, Scania employ an explorative strategy to test new ideas and discover value potential. As a senior manager explained, Scania do not prioritize any one fuel technology over another but develop country-specific product portfolios based on the market response. In other words, Scania embrace serendipity by allowing the market response to guide technology selection on national levels. Additionally, another manager emphasized the extensive organizational changes Scania underwent to become more sustainability-driven in their business practices. This indicates how Scania deploy their *experimentation* capabilities to sell an idea internally by showing value potential and mobilize the requisite resources for market-shaping.

Early on, Scania leveraged their *engaging* capabilities to shape the market for gas vehicles. They had realized that a customer would not suddenly adopt a new fuel without understanding the benefits and the differences between the different technologies. Accordingly, they focused on helping customers operate liquefied gas vehicles successfully. In other words, Scania aimed to grow the new market by moving customers into the liquefied gas market. A sales manager of a major gas companies confirmed this arguing "we are in close cooperation [with Scania] in both meeting customers, but also sharing experiences and thoughts about where stations should be to make this happen." Additionally, Scania leverage their *expressing capability* at a range of market events, where they invite key stakeholders including competitors and gas suppliers to foster collaboration, promote the new market, and incentivize participation in

the market-shaping process of the biomethane market. For example, Scania quantify and communicate the benefits of gas engines based on their role in boosting fuel efficiency and reducing carbon footprints.

In sum, Scania rely extensively on their facilitating capabilities in the market for liquefied gas trucks. They maintain a global focus towards discovering value potential, seeking to identify promising country-specific strategies and successful experimentation to justify chosen strategies internally. To mobilize resources, they are actively engaging existing customers, rely on the support of gas suppliers and are seeking to quantify the advantages of liquefied gas trucks.

4.2.2. Using triggering capabilities to create value

Our data indicates that, at present, Scania are only *redesigning the exchange* to ensure traded value to a limited degree outside of initial product development. They take a reactive stance, and activities regarding this triggering capability appear motivated by the gas supply and incentive structure in the respective country. As a manager explained, discovering value potential is most central at this stage, since “there is no silver bullet” in the current transition towards sustainable transport. The only clear exception regards the dynamic capability of *modifying matching methods*, as Scania provide dedicated training programs to increase knowledge of gas vehicles at local dealerships.

Scania are employing their *triggering capabilities* by *modifying customer-side features* to demonstrate the value of adopting liquefied gas trucks. One manager described how they employ a partnership model to describe the market system. By doing so, Scania induce potential buyers of gas trucks, as well as their customers’ customers and fuel suppliers, to carry out small-scale projects to prove the added value of a gas transport system. Other activities to *reconfigure networks* were not observed in our study, suggesting a moderate utilization of this capability set at Scania.

Scania seek to *influence the norms around* gas-based vehicles and heighten value expectations. To this end, Scania employ dedicated sustainability managers who engage in lobbying activities with different governmental agencies and authorities to ensure that gas trucks are perceived as a competitive, feasible, and sustainable alternative. A senior manager at a gas company seemed to confirm this by arguing “we have very regular contacts with them [Scania] in storytelling and promotion regarding gas trucks”. Interestingly, the interviewed Scania managers portrayed Scania as proactively creating and shaping the gas market, while simultaneously implying that the success of a market for liquefied gas vehicles is exclusively dependent on the government’s decision on incentive structures for biomethane.

In general Scania appear to use triggering capabilities to a limited degree in the liquefied gas market. To gain traded value, Scania seem focused on training their sales teams. Efforts to reconfigure networks arguably remain moderate as they concentrate on demonstrating value by building customers’ confidence in gas supply networks. Furthermore, Scania appear to focus mostly on lobbying policy makers to ensure expected value remains sufficiently high to legitimize their liquefied gas vehicles.

4.3. Market-shaping for electrified vehicles at Volvo

4.3.1. Discovering value potential and mobilizing resources

In terms of electrified trucks, Volvo’s market offerings are restricted to BEVs. To shape markets for BEVs, Volvo employ *exploring* capabilities to gain strategic insights into the value potential of electrification. An important part of this is investigating different market segments and areas of application. For example, interviewees from two waste management firms confirmed how Volvo had focused on waste collection early on, because the routes are predictable and a great deal of braking energy can be recovered. Still, the preference for nighttime charging in this application has made it necessary to explore ways to avoid daytime fast charging. Furthermore, *experimenting* capabilities have been central to understanding the requirements of shaping markets and establish new value potential for Volvo. Experimentation appears to have been vital in gaining early feedback from customers and transport buyers on the first series production vehicles. The municipal waste managers Volvo collaborate with in Hamburg stress that real-world experiments with pilot vehicles are necessary for all stakeholders due to the high degree of uncertainty. A Volvo manager confirmed the importance of *experimenting* with different vehicle configurations and asking customers for their feedback from a business perspective.

Volvo rely heavily on *engaging* to mobilize resources to promote the change. As a senior engineer explains, “When you work with these electrified transportation solutions, you need to collaborate a lot with [...] the whole [...] triple helix.” The benefits of engaging with key players in the logistics industry are highlighted when considering demonstration projects. For instance, a local hauler’s positive experiences of such collaboration were widely disseminated and encouraged the international uptake of BEVs. This is also intricately connected to the *expressing capabilities*. Volvo benefit from professional drivers affirming how electrification improve their work environment during demonstration projects. Focusing on the work environment appears an ideal way to mobilize resources, as the transport sector is suffering a shortage of qualified professional drivers and electrified trucks outperform diesel trucks on parameters such as noise and vibration.

Overall, Volvo appear to not use all facilitating capabilities to the same extent. While Volvo rely heavily on *exploring* capabilities to discover value potentials, the *experimenting* is focused more on assessing performance and technological maturity. To mobilize resources Volvo, seem to deploy market-shaping capabilities for both related categories by *engaging* key customers and suppliers in demonstration projects and using project results in *expressing* the benefits of electrification publicly.

4.3.2. Using triggering capabilities to create value

To enable exchange and generate traded value, the use of *triggering capabilities* such as *developing products* is vital. A senior project manager for Volvo explained that their experiences from demonstrations informed a strategic decision to create a separate business unit for the development of BEVs to meet new customer needs. The restructuring efforts at Volvo also suggest that the manufacturer is

modifying both pricing practices and matching methods. An executive team member highlighted that the adjustments made in internal structures are motivated by tapping into new sources of income. He asserted that this approach allows Volvo to extend the scope beyond supplying BEVs, towards offering extensive support for the configuration of vehicle fleets and adjusting leasing and service contracts individually.

To demonstrate the value of their BEV technology in urban applications, Volvo rely on *modifying own supply networks*. Our interviewees explained that Volvo build on a large network of new suppliers and have set up a separate unit focusing on electric vehicle components. Here, the generation of demonstrated value relies on being able to take learnings from demonstrations to optimize and adapt technical components initially developed for buses. To mobilize vital resources, Volvo rely heavily on *modifying customer-side features* to demonstrate the value of their technology. For example, the lessons learned at a local hauler operating a BEV have been transferred to their international parent organization, who distribute the new knowledge on the changes needed to working routines and infrastructure requirements across their Europe-wide hauler network.

Volvo's efforts to create expected value build on *influencing representations* of BEVs at transport industry events. Volvo have started in urban segments, where range requirements are low, before gradually extending their electrification efforts to larger vehicle segments as battery technology evolves. The careful crafting of this narrative included a shift away from including any hybrid alternatives and towards rapidly phasing out diesel engines entirely within the next vehicle cycle—first in urban applications, and eventually in most other segments too. Volvo are working towards *influencing norms* to maintain a positive narrative around BEVs. For example, by testing in vehicle segments prone to reliability issues, such as waste collection, Volvo signal technology maturity to industry insiders. Moreover, Volvo profit from the collaboration with pan-European logistics firms, as they contribute to lobbying efforts seeking policy change in favor of fully electric trucks. Interviewees emphasized the role played by state-supported charging infrastructure, policies promoting nighttime operation, or carbon pricing mechanisms in mobilizing resources.

In general, Volvo use all three triggering capabilities and addresses all three value outputs. Volvo seek traded value from their BEV by focusing on product development and *adjusting pricing practices*. For demonstrated value, focus rests on establishing dedicated supply networks and supporting customers adaptation. Moreover, Volvo create expected value by nurturing positive representations of BEV and by altering existing norms in vehicle segments where electrification appears to offer the most advantages over conventional trucks.

4.4. Market-shaping for liquefied gas vehicles at Volvo

4.4.1. Discovering value potential and mobilizing resources

Volvo have been applying their *exploring capabilities* to discover value potential and strategically position their liquefied gas vehicles. While much of Volvo's gas strategy is based on responding to increasing customer interest, they are also leveraging several overarching trends to shape the market for liquefied gas vehicles to their advantage. Volvo anticipate a decline in sales of compressed gas vehicles as municipal vehicles and waste trucks increasingly become electrified and more stringent EU policy encourages transport buyers to adopt alternatives. According to one Volvo manager, many transport buyers perceive liquefied gas as a viable and mature alternative for long-haul and heavy-duty transport. The active *experimenting* to discover value potential appears to have been limited at Volvo. For example, one manager stated that they let the markets decide on the "long-term winners," due to constraints on firm resources, which may suggest that experimentation occurs through embracing serendipity. Arguably, this could indicate that Volvo awaits promising outcomes from the market before they act upon them and commit resources.

To mobilize resources, Volvo have continuously employed their *expressing capabilities* to attract customers. Even before Volvo began developing engines for liquefied gas vehicles, they had been shaping the market by aligning major energy and gas companies to their envisioned future. Multiple interviewees pointed out that customers operating diesel vehicles are skeptical about the reliability, fuel efficiency, and refueling infrastructure requirements of liquefied gas vehicles. A Volvo manager explained that to reassure customers, sales promotion has been performed jointly with gas suppliers. He claimed this helps to alleviate concerns over the required infrastructure and allows to attest the value of the firm's technology solutions. Furthermore, Volvo are *engaging* leading stakeholders in the transport sector and gas market to promote the change. Within the firm, the rationale appears to be to identify those actors who have the power to change the wider market system. For instance, the close engagement with Swedish food retailer Axfood served as a role model for other transport buyers. After Axfood had become the first company to integrate liquefied gas vehicles into their fleet in 2018, other big customers soon followed, including a leading Swedish supermarket chain in 2019.

In sum, Volvo's deployment of facilitating capabilities indicates a rather passive stance. Much of Volvo's activities are oriented towards capturing value while minimizing resource expenditures. This becomes evident due to Volvo being rather reactive in their exploration and experimentation their focus on *expressing capabilities* and delegating the value creation to other stakeholders in the system.

4.4.2. Using triggering capabilities to create value

To generate traded value, Volvo bid to *redesign exchange* practices. A Volvo manager argued that they focus on modifying existing business models. To this end, they rely on capabilities to *develop their products* by including services around spare parts and the second-hand market into the truck's underlying value proposition. The manager argued that if Volvo are to convince customers to switch to liquefied gas vehicles, it will not be enough to simply sell them a new engine technology. Instead, the firm must create a new bundle to enable traded value.

Our interview data suggests a strong focus on *modifying customer-side features* as triggering capability to demonstrate value. Here, managers at Volvo highlighted the importance of working closely with customers' customers, as they determine the conditions for

Volvo's direct customers. For example, when transport buyers change their requirements and ask haulers to use alternative-fuel vehicles, this impacts haulers' business models, and ultimately Volvo's too. Moreover, Volvo seem to have started their market-shaping by cooperating on promotion with gas actors in the respective countries, to ensure the necessary infrastructure and gas volume is provided to customers who are interested in operating liquefied gas vehicles. Additionally, as one manager pointed out, Volvo know that they cannot maintain a liquefied gas market for heavy vehicles on their own, and thus try to include actors from other established markets to further develop the market. As another manager noted, having just one vehicle manufacturer or a single gas supplier poses a significant risk to market growth, as any strategic change for either actor might result in the collapse of the entire market.

Volvo show strong awareness of the role that policy incentives play in creating expected value. Therefore, they seek to *influence representations and norms* by lobbying for extensive support for biomethane. In an interview with a major gas provider this was describe as a vital step to "create success stories" with "well-known companies" to influence representations successfully. As one key manager at Volvo expressed, "We need to make the politicians, and people in general, understand that trucks are not big cars." Here, Volvo's aim is to generate expected value by delineating the boundaries of their product against other products and demarcating their market boundaries. In their view, "Electricity is not needed in all types of transport and all types of vehicles," which indicates that their market-shaping capabilities do not interfere with each other, as they are constructing distinct narratives for gas and electrified vehicle markets.

To summarize, Volvo appear to be more proactive when deploying triggering capabilities. Volvo not only modify their business models to generate traded value, but also strongly focus on aligning the market system. Thereby, Volvo attempt to *reconfigure networks* by collaborating with different stakeholders and fomenting strong partnerships in order to demonstrate the system's value. Additionally, Volvo focus on gaining political support by attempting to *reform institutions* that in turn create expected value.

The overview provided in Table 2, highlights differences and similarities in the two incumbent firms' deployment of market-shaping capabilities for the two technology platforms. The sections of the table displaying the *facilitating capabilities*, indicate that incumbents across all market systems rely extensively on *expressing* and *engaging* capabilities for *mobilizing resources*. Only for the *experimenting* capabilities the table shows differences between the incumbents' approaches towards *discovering value potential*. When examining the deployment of *triggering capabilities*, the incumbents appear to be more active in *reforming institutions* than *redesigning exchange* or *reconfiguring networks*. However, when comparing columns on *Scania electrified trucks* and *Volvo electrified trucks* with those on *Scania liquefied gas trucks* and *Volvo liquefied gas trucks* the discrepancies between the technology platforms become apparent. Considerably more triggering capabilities are deployed for electrified vehicles, with the clearest examples being the extensive *adjusting of prices* and *modification of own supply networks*. Exceptions to this trend are found regarding *modifying customer-side features* and *influencing norms* which illustrate that the incumbents engage in these two *triggering capabilities* across both technology platforms.

5. Discussion

This section discusses the underlying technological factors that may have influenced the two incumbent firms' capability deployment in the two market systems. Furthermore, it compares the strategic approach of the two incumbents towards shaping the two market systems. Finally, it underlines our contribution to the discussion of dynamic capabilities during transition processes.

Table 2

Overview of triggering and facilitating capabilities identified per case

A plus sign (+) indicates the clear presence of an activity in our interview data, while a minus sign (-) indicates its absence. A tilde sign (~) indicates cases where an activity has a limited presence in the data coding.

	Scania electrified trucks	Scania liquefied gas trucks	Volvo electrified trucks	Volvo liquefied gas trucks
Facilitating capabilities				
<i>Discovering value potential</i>	+	+	~	~
Exploring	+	+	+	+
Experimenting	+	+	~	~
Mobilizing resources	+	+	+	+
Expressing	+	+	+	+
Engaging	+	+	+	+
Triggering capabilities				
<i>Redesigning exchange</i>	+	~	+	~
Developing products	+	~	+	+
Adjusting price / pricing	+	-	+	-
Modifying matching methods	-	+	+	-
Reconfiguring networks	+	-	+	~
Modifying own supply network	+	-	+	-
Modifying customer-side features	+	+	+	+
Modifying provisions	-	-	-	-
Reforming institutions	+	~	+	+
Influencing representation	+	-	+	+
Influencing norms	+	+	+	+

5.1. Cross-case technology comparison

Overall, the incumbents have displayed different technology choices in each market system. In particular, Volvo have spent considerable resources on developing a compression ignited gas engine which, due to minimal diesel injections, maintains the fuel efficiency and driving and service characteristics of conventional trucks. In contrast, Scania utilized mature spark ignition engines, despite the potential drawbacks for vehicle performance and driving characteristics. In the electrified market system, Volvo confined their development efforts to BEVs as early as 2017, while Scania are still offering PHEVs alongside BEVs.

Comparing the two market systems, it becomes evident that both incumbents devote more market-shaping efforts to electrified vehicles than liquefied gas vehicles. A plausible reason for this difference is the different technology platforms underlying the two market systems. The introduction of liquefied gas vehicles is associated with major changes in terms of fuel supply and accordingly, [Ottosson et al. \(2020\)](#) have shown how incumbents in the fossil gas industry have been deeply involved in the shaping of markets for liquid biomethane. Collaboration with gas suppliers is vital for automotive incumbents to retain value from their combustion engines, as ensuring access to refueling infrastructure reassures haulers of the demonstrated value of the vehicles. However, the liquefied gas vehicles are still based on traditional internal combustion engine technology.

By contrast, the introduction of BEVs on a large scale entails a major technology shift for the incumbent vehicle manufacturers, which could render existing capabilities in capturing value from internal combustion engine technology obsolete. Moving away from combustion engine technology in the electrified market system challenges incumbent vehicle manufacturers, yet simultaneously offers new opportunities for value creation. The observed deployed market-shaping capabilities in the electrified market system suggests that much activity is aimed towards *modifying own supply networks*. Our interviews indicate that these strategic choices can possibly be explained with a need to demonstrate value by adding new services. For example, Scania and Volvo have begun preparations to provide haulers with special software for route optimization and vehicle charging solutions. These observations also find support in previous studies on the development of electric trucks and electric road systems ([Tongur and Engwall, 2014](#)).

5.2. Cross-case comparison of incumbent firms

Our analysis highlights profound differences in the approaches towards exchange practices in the market system for liquefied gas vehicles. Volvo target their capability deployment towards product development, adjusting the bundle of technology and services. By contrast, rather than emphasizing product development, Scania focus on *modifying matching methods*. They have been training designated sales specialists for their local dealerships. Interestingly, our analysis suggests that Scania managers describe policy incentives in local markets, rather than their own activities, as the decisive factor for the creation of traded value. These observations stand in contrast with the picture in electrified market systems, where both incumbents deploy a broad range of market-shaping capabilities. One motivating factor for both incumbents appears to be addressing the complexities that electrification entails, as conventional business practices on both the customer and the manufacturer side come under challenge.

Two patterns emerge when comparing the incumbents. First, regardless of the manufacturer and market system, there is an emphasis on *modifying customer-side features*. This underlines the importance of proactively engaging with customers and empowering them to adjust their operational routines when transitioning to alternative vehicle technologies. Second, both manufacturers exhibited a clear separation in terms of the relevance of modifications in their own supply networks for shaping the two markets. In the electrified market system, both manufacturers are making organizational rearrangements to integrate new expertise and resources. Volvo, for example, have created an entirely new business unit. Arguably, success in demonstrating value for electrified vehicles hinges more on internal resource reconfiguration, than for liquefied gas vehicles.

The most extensively used *triggering capabilities* relate to creating expected value by reforming institutions. Scania actively influence norms by challenging values associated with conventional diesel trucks. Moreover, for their electric vehicles, Scania seek to influence representations at large public events and rely on key transport buyers to run major advertising campaigns—something we did not observe for their liquefied gas trucks. Volvo, however, seem deeply committed to *reforming institutions* for both technologies. This observation may link back to the clear technology choices at Volvo: prioritizing single technologies for both market systems arguably makes it easier to construct congruent narratives that will convince risk-averse haulers.

Seen holistically, the two incumbents follow different market-shaping strategies. Scania place market feedback center-stage. Their approach to the gas vehicle market appears to be driven by a logic of discriminating between local markets rather than technology platforms. Similar patterns emerged for electrified vehicles, where Scania are still *experimenting* with PHEVs and BEVs and seeking feedback from key customers. In combination, these two observations may explain Scania's focus on *facilitating capabilities* to discover value potential across market systems. Volvo, in contrast, appear to maintain a clear separation between the market systems for electrified and gas vehicles, and focus on realizing their envisioned markets separately. In other words, Volvo appear to discriminate less clearly between different national markets. Consequently, Volvo are deploying their *triggering capabilities* to *reform institutions* more consistently, seeking to create expected value internationally in both market systems. These differences may be linked to a prioritization of selected products and technology at Volvo, whereas a Scania manager explicitly stated that they “do not prioritize.” Interestingly, while they offer two competing technology platforms (electrified and liquefied gas), Volvo clearly distinguish the platforms as serving different markets. This difference may indicate that Volvo hold a clearer vision for liquefied gas vehicles, while Scania maintain flexibility through continued *exploration* and *experimentation*. However, Scania's more active deployment of *facilitating capabilities* on the market for gas vehicles could also indicate a more substantial commitment towards this technology platform.

In sum, our framework allowed us to analyze the current levels of commitment and activity of the respective incumbents towards a specific technology. This gave us a snapshot of the incumbents' current market-shaping activity within the transition to alternative

technologies. Our cross-case analysis indicates that both incumbents are more committed to the electrified vehicle platform, but also noticeably more active in shaping the market system for these vehicles.

5.3. Theoretical interpretation

Previous transition studies have shown how the capabilities of incumbent firms explain divergent investment patterns and strategies in industries (Darmani et al., 2017; Ottosson and Magnusson, 2013). Other studies have indicated positive relationships between incumbent firms' dynamic capabilities and their technological innovation efforts (Hartman et al., 2017). Moreover, transition studies suggest that dynamic capabilities make it possible for incumbent firms to reorient their businesses towards decarbonization (Stalmokaitė and Hassler, 2020). Our analysis complements and extends these studies by showing how incumbent firms deploy dynamic capabilities to establish favorable market conditions for alternative technologies. Such a focused analysis opens up new insights into interactions between evolving market systems and firm-internal dynamics. For instance, our analysis showed how Scania designed their own market strategy for liquefied gas vehicles around governmental incentives, with only a minor focus on restructuring internal routines. By contrast, in the case of electrified vehicles, both Scania and Volvo actively shaped their environments by *engaging* in the construction of positive narratives and making a serious effort to mobilize resources with the intention to drive internal changes in their own organizations. These findings underline the importance of accounting for the possible divergence in engagements of incumbent firms in specific transition processes and different market systems. Furthermore, our findings highlight the importance of being aware of the idiosyncratic distribution of market-shaping capabilities between incumbent firms belonging to the same industry.

Marketing research emphasizes the relational character of markets, arguing that value is a result of co-creation in interactive systems. This research goes beyond the buyer–seller dyad to include a variety of actors in the analysis (Storbacka et al., 2016). In our cases, the focal vehicle manufacturers engaged with a broad set of actors to create value in market-shaping processes. Each of the engaged actors will contribute own ideas about priorities and responsibilities to these processes. Consequently, our analysis shows how the vehicle manufacturers often delegated crucial tasks to other central market actors or even policymakers at different levels, letting them take the lead in the market-shaping on their behalf.

The concept of dynamic capabilities draws attention to the sensing and seizing of opportunities, and to the reconfiguration of resources, thus explaining how firms build on their established resources to remain competitive in fast-changing environments (Teece, 2007). For a large firm like a heavy vehicle manufacturer, the resource base is often quite diverse. This means that resource reconfiguration is a critical strategic process that makes it possible to respond to external changes. By bringing in dynamic capabilities as a conceptual lens to analyze market-shaping and by distinguishing between different kinds of value, the analysis highlights the interactive nature of evolving markets. It shows how the incumbent firms consistently deployed market-shaping capabilities to create demonstrated value and nurture the construction of narratives that would describe promising future markets. An important aspect of these narratives was the expected value attached to sustainability, as jointly defined by the actors involved in the market-shaping. Even if the scope of the envisioned markets may be limited today and the possibility to capture traded value from market exchanges therefore is restricted, it made strategic sense for the incumbents to engage in the creation of both demonstrated and expected value. By referring to such value, they could justify further investments, both within their internal organizations and in the communication with external actors.

6. Conclusion

Based on a comparative case analysis of the endeavors of two heavy vehicle manufacturers to introduce alternatives to traditional diesel-fueled trucks, this paper has addressed the question of how incumbent firms deploy dynamic capabilities to shape markets in sustainability transitions. The analysis emanated from a definition of markets as value-creating systems (Dewald and Truffer, 2011; Ottosson et al., 2020), with firms taking leading roles by deploying dynamic capabilities (Nenonen et al., 2019). Dynamic market-shaping capabilities is a novel conceptual lens in transition research that makes it possible to elucidate firm-system linkages, thus highlighting vital interactions in market-shaping processes. Our analysis showed how the capabilities deployed by the firms fostered system-level market-shaping, and how the value that they captured from the market-shaping processes supported internal legitimation in the firms. Hence, the analysis points to the dynamism of market interactions in sustainability transitions, showing how firms induce system-level reconfigurations (cf. Geels, 2004) and, correspondingly, how such system-level reconfigurations induce changes at the level of the firm.

Studies of markets in sustainability transitions research have hitherto focused on the system level. This paper has contributed to this research by presenting a lower-level analysis, outlining and applying a framework that highlights critical firm-system linkages. Drawing on dynamic capabilities and marketing literature, the analysis illustrates how incumbent firms interact with other stakeholders to shape markets. Presenting a focused analysis on how such firms engage in market-shaping processes, the paper points to a critical temporal dimension of markets in sustainability transitions. The system reconfigurations associated with sustainability transitions means that existing market positions of incumbent firms will be open for redefinition and renegotiation. For the incumbent, this may result in both threats and opportunities, to which it must respond. Moreover, the prospect of system reconfigurations leaves ample room for projection, interpretation, and strategic maneuvering. This paper shows how incumbent firms can respond proactively with the ambition to shape markets. In particular, it points to the critical deployment of market-shaping capabilities to reform institutions. This is because such deployment makes it possible for incumbents to claim legitimate positions in envisioned future markets.

This paper has outlined a framework that highlights important linkages between the market-shaping capabilities of individual firms and market-shaping processes on a system level. This has been used in a comparative case analysis of the introduction of alternative

technologies by large incumbent firms. To further extend the understanding of firm-system linkages in the shaping of markets in sustainability transitions, future studies can apply the framework in comparisons of different kinds of firms and organizations, e.g., incumbents vs. new entrants, large vs. small firms, public vs. private. Future studies may also address different industries and different markets (e.g., product, services, consumer, business-to-business), and analyze the dynamic interplay between business strategies and transformative mission-oriented policies in the shaping of markets.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Interviews on gas vehicles (2017–2019)

Year	Actor category	Company/organization	Role/title	Setup	Duration
2017	Vehicle manufacturers	Vehicle manufacturer A	Environment and Innovation Director	Face-to-face	65 min
		Vehicle manufacturer B	Business Development Manager	Face-to-face	70 min
	Infrastructure providers for liquefied gas	Gas producer and supplier B	Business Development Manager	Face-to-face	60 min
		Gas producer and supplier C	Chief Sustainability Officer	Face-to-face	60 min
		Gas grid owner and operator A	Sales Director	Face-to-face	50 min
		Gas producer and supplier D	Business Development Manager	Face-to-face	60 min
		Gas producer and supplier E	Business Development Manager	Face-to-face	55 min
	Interest groups for liquefied gas	Biomethane advocacy coalition A	Business Development Manager	Face-to-face	45 min
		Lobby organization A	CEO	Telephone	40 min
	Infrastructure providers for liquefied gas	Gas producer and supplier F	CEO	Face-to-face	60 min
		Gas producer and supplier E	Business Development Manager	Face-to-face	65 min
2019	Vehicle manufacturers	Vehicle manufacturer B	Head of Product Affairs & Product Director	Face-to-face	75 min
		Vehicle manufacturer B	R&D Manager	Face-to-face	30 min
	Suppliers to vehicle manufacturers	Vehicle manufacturer A	Environment and Innovation Director	Telephone	60 min
		Technology supplier A	Sales Director	Telephone	40 min
		Technology supplier B	Global Product Line Manager	Face-to-face	60 min
	Infrastructure providers for liquefied gas	Gas producer and supplier E	Director Traffic	Telephone	40 min
		Gas producer and supplier E	Business Developer	Face-to-face	60 min
		Gas producer and supplier D	Senior Specialist	Face-to-face	60 min
		Gas producer and supplier B	CEO	Videocall	45 min
		Gas producer and supplier A	Product Manager LBG	Face-to-face	60 min
	Transport Buyers	FMCG company A	Transport Manager	Telephone	40 min
	Interest groups for liquefied gas	Industry association A	Project Leader	Face-to-face	90 min
		Industry association A	Project Coordinator Transport	Face-to-face	90 min

Appendix B. Interviews on electrified vehicles (2019–2021)

Year	Actor category	Company/organization	Role/title	Setup	Duration
2019	Vehicle manufacturers	Vehicle manufacturer A	Senior Manager	Telephone	45 min
		Vehicle manufacturer B	R&D Manager	Face-to-face	60 min
	Suppliers to vehicle manufacturers	Vehicle manufacturer A	Senior Project Manager	Videocall	75 min
		Vehicle manufacturer B	Senior Manager and R&D Manager	Videocall	50 min
		Vehicle manufacturer B	Project Manager	Videocall	70 min
		Technology supplier C	Sales Manager	Face-to-face	65 min
		Technology supplier D	Senior Manager	Telephone	30 min
		Transport consultancy A	Project Consultant	Face-to-face	40 min
	Infrastructure providers for electrified vehicles	Electricity producer and provider A	Program Manager	Face-to-face	70 min
		Electricity producer and provider B	Fleet Manager	Telephone	55 min
	Transport providers & vehicle operators	Industry association B	Regional Manager	Telephone	40 min
		International logistics company A	Quality & Environmental Manager	Videocall	70 min
		Hauler A	Quality, Safety & Environmental Manager	Face-to-face	65 min
	Transport Buyers	Waste management company A	Service Manager	Telephone	50 min
		FMCG company B	Transport Manager	Face-to-face	65 min
		FMCG company C	Sustainability Manager	Face-to-face	60 min
	Municipal policymakers	Food retailer A	Transport Manager	Videocall	50 min
		Municipality A	Strategist	Telephone	40 min
		Municipality A	Strategist	Face-to-face	70 min
	Actors from local demonstration projects	Science park A	Project Managers	Telephone	30 min
		Science park A	Project Managers	Videocall	30 min
		Science park A	Project Managers	Face-to-face	55 min
		University A	Researcher	Face-to-face	35 min
		University A	Researcher	Face-to-face	50 min
		University A	Researcher	Face-to-face	30 min
		University A	Researcher	Face-to-face	55 min
		University A	Researcher	Face-to-face	55 min
2020	Vehicle manufacturers	Vehicle manufacturer B	Senior Manager,	Videocall	65 min
	Infrastructure providers for electrified vehicles	Electricity producer and provider A	Program Manager	Videocall	55 min
	Transport providers & vehicle operators	International logistics company A	Quality & Environmental Manager	Videocall	60 min
		Hauler B	Senior Manager	Telephone	45 min
		Waste management company B	R&D Manager	Videocall	40 min
		Hauler A	Quality, Safety, & Environmental Manager	Videocall	180 min
	Municipal policymakers	Municipality A	Strategist	Videocall	180 min
	Industry experts	University B	Researcher	Videocall	180 min
	2021 Vehicle manufacturers	Vehicle manufacturer A	CTO	Telephone	35 min
		Vehicle manufacturer A	Former Project Manager	Videocall	55 min
		Vehicle manufacturer B	Senior Product Manager	Videocall	60 min

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