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Driving the electric bandwagon: The dynamics of incumbents' sustainable innovation

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Abstract

Given that entire industries face sustainability challenges, it is important to understand the dynamics that lead "firms-in-an-industry" to engage in sustainable product innovation. To provide more insight into the question of how innovation activities spread from individual firm action to an industry-wide engagement, this paper examines the automobile industry and the development of electric vehicles (EVs). The analysis covers automobile incumbents over a crucial decade for EV development in the industry, focusing on the different strategic motives that especially the so-called "first movers" used to justify their earlier engagement. We find that EVs became a core pillar of the incumbents' technology strategies through a combination of coercive, normative, and mimetic pressures. Yet, the strategic motives to engage in EVs stayed poles apart between different companies. The insights from our study are relevant for those interested in the diffusion of sustainable product innovation and in incumbent behaviour in sustainability transitions.

KEYWORDS

cars, electric vehicles, environmental policy, mobility, product innovation, systemic change

1 | INTRODUCTION

Why do companies in an industry collectively invest in sustainable technologies? Previous research has shown that firms engage in sustainable technologies as a response to environmental regulation, for instrumental reasons, or as a reflection of managers' green values (Dangelico & Pujari, 2010; Rennings, 2000; Sarasini & Jacob, 2014). Various studies also argue that sustainable innovation can lead to a competitive advantage (Blanco, Guillamón-Saorín, & Guiral, 2013; Chen, Lai, & Wen, 2006; Cramer, 2000). However, the majority of these studies tend to focus on product innovation that is autonomous (e.g., biodegradable plastics or green roofs), but rarely on systemic forms of innovation (e.g., the smart grid or new mobility services) that are dependent on technological as well as societal changes (cf. Pinkse, Bohnsack, & Kolk, 2014). Autonomous innovation and systemic innovation, however, are fundamentally different. Whereas autonomous innovation lies at the discretion of a focal company, the success of systemic innovation requires the industry as a whole to engage in a transition, otherwise chances for success of the individual company are limited (e.g., Planko, Chappin, Cramer, & Hekkert, 2019). Dominant theoretical explanations for firm behaviour regarding disruptive, autonomous innovation might therefore not hold for systemic innovation (e.g., Geels, 2018). A better understanding of how companies start to engage in systemic innovation is important, given that many of today's large technical systems (e.g., energy, transportation, railway) are unsustainable, but answers to why and how companies start to engage in this specific form of innovation are not straightforward.

On the one hand, so-called "firms-in-an-industry" (Geels, 2014, p. 262) have few incentives to act "first" on systemic innovation, and many more incentives to follow the general evolution of the industry. Because the investments of competitors and the decisions of local and global policymakers matter (Bohnsack, Kolk, & Pinkse, 2015; Pinkse et

al., 2014), companies can be expected to be cautious to not move too quickly and avoid costly investment failures (Rugman & Verbeke, 1998). On the other hand, competitive dynamics within firms-in-an-industry lead to incentives to deviate from the overall industry behaviour (Kang & Song, 2017). Studies on the frequency and intensity of adoption of sustainable innovation activities have shown that industry frontrunners often took the initiative and were then followed by others (Hockerts & Wüstenhagen, 2010; Kolk, 2010). For example, for cases such as hybrid technologies in the automotive industry or renewables in the electricity sector, copycat behaviour for more sustainable technologies only occurred after the first incumbents switched position. Here, the general evolution in an industry did not necessarily result from concerted, collective action or industry coordination. Such tendencies to "jump on the bandwagon" (Abrahamson & Rosenkopf, 1993) or "follow the leader" (Knickerbocker, 1973) have, however, only received limited attention in relation to systemic innovation. For a better understanding of the diffusion of systemic innovation, insights into how innovation activities develop from individual action to industry-wide engagement, and how first movers justify their strategic motives to engage in this type of innovation, will be valuable. This paper aims to contribute to answering these questions by presenting evidence from the case of the automobile industry and the development of electric vehicles (EVs) in the period from 2006 to 2016.[1] Based on the analysis of the contents of four newspapers and magazines as well as the annual and sustainability reports of the largest international automobile companies, it examines how momentum for EVs in the industry changed. It pays particular attention to explaining how the strategic motives of several large companies that "moved first" helped tilt the balance for those that were more hesitant in embracing EVs.

Sustainable mobility has long been a key issue in the automotive industry, following earlier concerns about climate change, increasing regulation, and the ongoing need to meet environmental demands, also from consumers who attach much importance to fuel efficiency and environmental friendliness (Kolk & Levy, 2004; KPMG, 2014; McKinsey & Company, 2013). As Zadek (2004, p. 126) put it when describing "the path to corporate responsibility," "automobile companies know that their future depends on their ability to develop environmentally safer forms of mobility." However, although the industry developed lower emission vehicles in response, a major mobility transition has not taken place yet (Bakker, Van Lente, & Engels, 2012; Bohnsack et al., 2015; Oltra & Saint Jean, 2009; Pinkse et al., 2014; Van Bree, Verbong, & Kramer, 2010). This most notably applies to EVs, which for a long time lacked economically viable business models (Bohnsack & Pinkse, 2017; Budde Christensen, Wells, & Cipcigan, 2012; Kley, Lerch, & Dallinger, 2011) despite several experiments (Bohnsack et al., 2014). Still, within the last decade, the industry changed from an outright sceptical view, following an earlier failed attempt by General Motors (GM) with the EV1, which was eventually scrapped in 2003, to a much broader adoption of purpose-built or adapted EVs. The automotive incumbents' changed position is well illustrated by two quotes from then-CEO of Renault-Nissan, Carlos Ghosn. In 2005, Ghosn had emphasized that even the more feasible petrol/electric (hybrid) cars represented a "terrible business prospect" (Ibison, 2005). In 2013, when Germany's largest automobile companies had announced a move to EVs, he instead stated to "welcome Germany joining the club" as "[t]he more companies that buy into electric, the better. […] All of this is helping to drive this tipping point" (Foy & Bryant, 2013).

The case of the EV, therefore, seems well suited to study the engagement of firms-in-an-industry in systemic innovation. Unlike autonomous innovation, such as the introduction of emission-reduction technologies or recyclable bags, the move towards EVs has been very capital intensive and risky for the automobile companies. Product innovation concerns are therefore likely to be closely intertwined with concerns about competitiveness, industry-wide behaviour, and regulation. Below, we will examine strategic motives used by the individual companies to justify their engagement in EVs and how these contributed to the changeover of positions within the industry as a whole (Section 4). To this end, the next section first discusses theoretical explanations for the drivers of converging versus diverging behaviour among firms-in-an-industry, before moving to the methods (Section 3).

2 | DRIVERS FOR SUSTAINABLE PRODUCT INNOVATION

2.1 | Drivers for converging behaviour

Why companies choose to invest in product innovation for sustainable technologies, that is, products that "strive to protect or enhance the natural environment by conserving energy and/or resources and reducing or eliminating use of toxic agents, pollution, and waste" (Ottman, Stafford, & Hartman, 2006, p. 24) has long been of interest to sustainability scholars. Whereas various frameworks and typologies have been suggested to delineate different forms of, for instance, eco-innovation (Sarasini, Hildenbrand, & Brunklaus, 2014) or sustainability-oriented innovation (Hansen, Grosse-Dunker, & Reichwald, 2009), most studies focus on sustainable product innovation as a generic concept (e.g., Chen, 2008; Chen et al., 2006; Dangelico & Pujari, 2010). Scholars have, however, shown that the drivers for sustainable product innovation depend on the "type" of innovation (e.g., Böttcher & Müller, 2015; Pinkse et al., 2014).

"Autonomous sustainable product innovation" is stand-alone and can be pursued independently by a company (Chesbrough & Teece, 1996)—developing it in-house and bringing it to the market autonomously. Examples include biodegradable plastics or bamboo phone covers. Motives for engaging in autonomous innovation often relate to competitive advantage, regulatory pressure, or reputation. "Systemic sustainable product innovation" cannot be pursued autonomously by a single firm; it is co-dependent on innovation outside a focal organization. The development and commercialization of systemic innovation need to be coordinated, for instance via an ecosystem strategy (Jacobides, Cennamo, & Gawer, 2018) or system-building

networks (Planko et al., 2019; Planko, Cramer, Chappin, & Hekkert, 2016) and often also depend on changes at a broader societal level, such as consumer behaviour or regulation. Examples include products and services related to energy and mobility, which require changes in infrastructure, rules, and norms. For systemic innovation, a transition to sustainability is more challenging and can easily destroy core competencies of incumbents. Hence, companies are careful not to move too quickly into investment and managers have to rely on their judgement of long-term prospects to engage in it (Cramer, Van der Heijden, & Jonker, 2006; Sarasini & Jacob, 2014). It is often argued that the push for systemic innovation needs to come from regulation and/or concerns for corporate social responsibility (Peters, Schneider, Griesshaber, & Hoffmann, 2012; Rennings, 2000). Nonetheless, companies that face the need to engage in systemic innovation also want to gain a competitive advantage and thus need to navigate the seas between competition, innovation, and ongoing transition dynamics.

The focus of the literature on sustainable product innovation as a generic concept inherently means that rather limited attention has been paid to companies as "concrete actors doing the acting," also labelled as firms-in-an-industry for more systemic innovation (Geels, 2014, p. 262). For systemic innovation, a perspective of firms-in-an-industry is essential because companies in the same industry tend to face similar types of institutional pressures, such as government regulation, social norms, and common beliefs (Scott, 2001), and have an incentive to act collectively on such pressures (Aldrich & Fiol, 1994). It has been argued that, within an industry, there is converging behaviour of companies in their sustainability practices (Geels, 2014; Hoffman, 1999), due to an isomorphic impact of the concomitant sources of coercive, normative, and mimetic pressures (DiMaggio & Powell, 1983). Whereas coercive isomorphism includes government regulation, normative isomorphism implies change resulting from professional networks and norms, and mimetic isomorphism refers to imitation to catch up with competitors by, for example, adopting best practices or copying them. Interestingly, due to "follow-the-leader" behaviour (Abrahamson & Rosenkopf, 1993; Knickerbocker, 1973), convergence in product innovation can even occur when the motives of rivals' moves are unclear to a company, as it may want to prevent competitors from gaining undue advantage (Chen & MacMillan, 1992). When some companies adopt a technology, a critical mass builds up at a certain point where uncertainty is sufficiently reduced and/or the disadvantages of non-adoption become too large, thus creating pressures to invest and "jump on the bandwagon" (Aldrich & Fiol, 1994; Deephouse, 1996). This emphasizes the important role of those that deviate first from the herd and set the bandwagon in motion.

2.2 | Drivers for diverging behaviour

Although isomorphic pressures should lead to converging sustainable product innovation activities among firms-in-an-industry, there is also variation in their responses (Oliver, 1991; Seo & Creed, 2002). Literature has established that coercion breeds variation. Although coercive pressures lead firms to adopt a similar direction in their environmental strategies, there will also be variation within these strategies because firms can gain relatively more from differentiation (Milstein, Hart, & York, 2002). Companies respond in different ways, as they try to plot their path between the different pressures (Pache & Santos, 2010; Purdy & Gray, 2009). Besides, they do not only engage in sustainability innovation to achieve a license to operate in society and/or an industry, but also for more instrumental reasons (Aguilera, Rupp, Williams, & Ganapathi, 2007; Arnold & Hockerts, 2011). They compete with one another based on their sustainability innovation (McWilliams & Siegel, 2001) and thus also have disincentives to act collectively and move concomitantly towards a shared industry standard for sustainable product innovation (e.g., Hahn & Pinkse, 2014; Planko et al., 2019).

Generally, however, systemic innovation should not allow companies to reap strong first-mover advantages because uncertainties with regard to the market and technology are high, shifts in technology and consumer demand likely, and followers may be able to free-ride on costly infrastructure investments (Montgomery & Lieberman, 1988). Yet, incentives such as learning-based advantages and gaining technological leadership may still drive individual companies to act more proactively than others and not simply "wait-and-see". Against this background, considerable disagreement will remain within an industry as to whether, when, and how to move forward on a specific sustainable technology.

Divergence within industries has been at play, for example, with regard to the climate change issue in the 1990s, when a few frontrunners in the oil and automobile industries broke ranks in deciding to move faster on the issue than other companies within the same industries (Kolk & Levy, 2004). Similarly, although the chemical industry moved collectively into embracing the Responsible Care standard, there were also considerable differences between early and late adopters in how they subsequently implemented the standard (King & Lenox, 2000). Although isomorphism is relevant to the industry from a regulatory perspective, companies operate globally and participate in relevant networks across borders (Hansen, Lüdeke-Freund, Quan, & West, 2018), that is, there is still ample room for manoeuvre and managerial discretion. Studies on the impact of government support for sustainable technologies showed, for example, that it proved less important for the development of low-emission vehicles than support provided by companies themselves (e.g., Pinkse et al., 2014). Companies might expect subsidies to be uncertain and subject to political whims and sudden stops—some even have experience that they stopped (Kolk & Levy, 2004, p. 179) and thus do not build their strategies on them any longer.

How companies respond to institutional pressures is also likely to vary depending on firm-specific and contextual contingencies. Research has shown that the entry timing strategies of incumbents, such as those of automobile companies for EVs, differ depending on the single company's incentives and opportunities to innovate (Lee & Klassen, 2016; Wesseling, Niesten, Faber, & Hekkert, 2015). In addition, the opportunities and incentives that an individual

company perceives depend on managerial perceptions of future prospects and company-specific experiences with similar issues in the past (Cramer et al., 2006; Sarasini & Jacob, 2014). Hence, company-specific differences, particularly in perceptions of market potential, customer demand, and the future of the industry do matter. There will be inconsistencies between different firms-in-an-industry.

To summarize, then, although the literature suggests that there are strong institutional forces pushing firms-within-an-industry to make a concerted effort, company-specific attributes and strategies may also lead individual companies to go against the tide. Yet, the heterogeneity of incumbent behaviour remains an area with much potential for future work (Smink, Hekkert, & Negro, 2015; Van Mossel, Van Rijnsoever, & Hekkert, 2018). In particular, company-specific differences in reporting on the engagement in sustainable product innovation have been called "a fruitful area for further research" (Wesseling et al., 2015, p. 528). Against this background, this study sets out to investigate which strategic motives automobile companies used to justify their engagement in EVs and how this contributed to the changeover of positions within the industry as a whole.

3 | METHODS

The case of the EV is well suited to study the evolution of an industry's activities towards sustainable product innovation. Whereas EVs have a long and checkered history within the automobile industry, they have meanwhile achieved a level of diffusion that allows for a retrospective analysis of company-specific differences in terms of early versus late adopters and the move of the industry as a whole towards more sustainable mobility. What has been specific to the automobile industry in a sustainable technology context is the substantive influence of coercive isomorphism. Emission standards, fiscal incentives, and industrial policy have been key in pushing automobile companies in the direction of sustainability, generally, and sustainable product innovation, more specifically (Kolk & Tsang, 2017; Pinkse et al., 2014). Although most policies originated in specific national settings, there has been a convergence overall, as governments tend to take similar measures (Bohnsack et al., 2015). Moreover, despite different origins and histories of support regimes for lower emission vehicles, incentives are usually available for all models in a particular market, both to domestic and foreign companies that produce and/or sell there (See Appendix A for EV support in different countries). Therefore, the case of the EV offers the possibility to assess not only how the automobile industry as a whole adapted to coercive pressures, but also the motives that led single firms to deviate from the herd.

We defined those companies as firms-in-an-industry that can be seen as incumbents, that is, those firms that mainly have competencies related to the current technological regime (Smink et al., 2015; Van Mossel et al., 2018), and that are "established" and positioned in markets with "traditional" business models (Ciulli & Kolk, 2019). In our case, this included large automobile companies with competencies related to the combustion engine such as GM, Toyota, and Volkswagen (VW). It excluded, in turn, newcomers with specialized competencies related to EVs such as Tesla. This choice was anchored in our wish to investigate how incumbents, which are powerful actors to "unlock" sustainability transitions (Smith, Voß, & Grin, 2010), start to engage in sustainable product innovation. Whereas a company like Tesla can certainly be seen as a first mover in EVs, in our study, the definition of a first mover and a follower relates only to the firms "within" the group of incumbents.

To uncover the strategic motives of the incumbent automobile companies to (not) engage in EVs, we looked for data sources that allowed us to reconstruct their technology strategies and the arguments they used to explain their position on electric mobility. Consequently, we worked with archival data as it allowed us not only to extract the moves these companies made, but also direct statements by company representatives on the rationale behind them. Specifically, we used the contents of two industry trade magazines (*Automotive News* and *WardsAuto World*), a car magazine (*Autoweek*), a newspaper (*Financial Times*) as well annual and sustainability reports of the 13 largest international automobile companies from Europe, Japan, and the United States (see Table 1). In addition, online sources were used to obtain car sales data.[2] The period under study spans from 2006 until 2016.[3] 2006 was chosen as the starting year because it marked the beginning of the "revival of electric" (Bakker et al., 2012), meaning increased engagement in EVs after a period of non-activity, which eventually led to the first modern mass-produced EVs. The year 2015 was chosen as the final one because, by then, electrification had become an explicit part of most car manufacturers' technology strategy.

The data analysis proceeded in the following steps: First, we tried to establish, on a high level, which strategy a company had followed with regard to EVs. This was based on information such as the models they launched and the R&D investments they made. Appendix B provides a summary of the different technology strategies companies pursued. A comparison of these strategies provided a first indication which companies had moved first and which companies had followed the general industry development.[4] In addition, the evaluations of journalists and analysts helped us to contextualize whether companies' moves were perceived as innovative or merely as catching up with what others had done. In the next step, we focused more closely on the strategic motives that companies had expressed. Specifically, we extracted the direct, unfiltered statements of company representatives such as the CEO from interviews or sustainability reports in which they explained their rationale for engaging in EVs. A pattern that quickly became apparent was that statements either appealed to what we refer to as a "sustainability focus" or a "competitive advantage focus". The cross-comparison of statements helped us to establish whether a company had emphasized one of the motives more than the other when they started to engage in EVs.

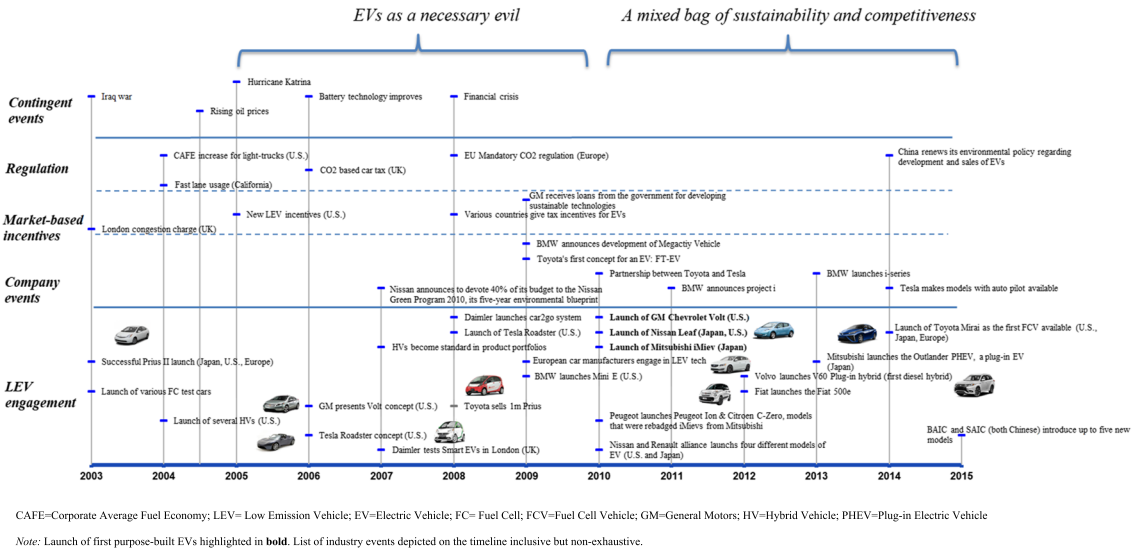
TABLE 1 Company reports analysed

Company	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
BMW	AR	AR, SR	AR, SR	AR	AR, SR	AR	AR, SR	AR, SR	AR, SR	AR, SR
Daimler	AR	AR	AR	AR	AR	AR	AR	AR, SR	AR, SR	AR, SR
Fiat	AR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR
Ford	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR	AR
Geely	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR
General Motors	AR	AR	AR	AR	AR	AR, SR	AR, SR	AR, SR	AR, SR	10-K
Honda		AR	AR	AR	AR	AR	AR	AR	AR, SR	AR, SR
Mitsubishi	AR	AR	AR	AR	AR	AR	AR	AR	AR, SR	AR, SR
Nissan-Renault		AR	AR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR
Peugeot/Citroën	AR	AR	AR	AR	AR	AR	AR, SR	AR	AR, SR	AR
Tesla					AR	AR	AR	AR	AR	AR
Toyota	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR
Volkswagen	AR	AR	AR	AR	AR	AR, SR	AR, SR	AR, SR	AR, SR	AR, SR
Volvo	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR, SR

Abbreviations: AR, annual financial report; SR, sustainability/corporate responsibility (i.e., nonfinancial) report, 10-K, 10-K form.

4 | THE DIFFUSION OF THE EV AS SUSTAINABLE PRODUCT INNOVATION IN THE AUTOMOBILE INDUSTRY

EVs were not new to the automobile industry. Already during the initial development of automobiles, around 1900, an electric motor was an option, but at the time, it lost the race against gasoline. Interest in electric driving re-emerged during the oil crises in the 1970s, but EVs were not able to escape the "technological lock-in" posed by other established car fuel types (Cowan & Hultén, 1996). Out of the group of incumbents, particularly GM invested in EVs in the 1980s and 1990s, before it stopped the venture for lack of commercial viability in 2003 (Pinkse et al., 2014). More generally, several automobile companies engaged in research and development activities on lower emission vehicles over the years, including EVs, as public pressure to address climate change had clearly gained momentum and became widely acknowledged in the industry (Kolk & Levy, 2004; Rothenberg & Levy, 2002). On occasion, these explorations also took place in collaboration with other companies inside and outside the industry. Yet, it was not until 2006 that the industry significantly increased its EV activities (Figure 1).



CAFE=Corporate Average Fuel Economy; LEV= Low Emission Vehicle; EV=Electric Vehicle; FC= Fuel Cell; FCV=Fuel Cell Vehicle; GM=General Motors; HV=Hybrid Vehicle; PHEV=Plug-in Electric Vehicle

Note: Launch of first purpose-built EVs highlighted in **bold**. List of industry events depicted on the timeline inclusive but non-exhaustive.

FIGURE 1 Timeline. Launch of first purpose-built EVs highlighted in bold. List of industry events depicted on the timeline inclusive but non-exhaustive. CAFE, corporate average fuel economy; LEV, low emission vehicle; EV, electric vehicle; FC, fuel cell; FCV, fuel cell vehicle; GM, General Motors; HV, hybrid vehicle; PHEV, plug-in electric vehicle

4.1 | Industry positions in the period 2006–2009: EVs as "a necessary evil"?

Although EVs experienced a revival from 2006 onwards, the wave of activities in the period 2006–2009 had an overwhelming focus on prototypes, concept, and test cars, and was accompanied by publicly expressed doubts about the future of EVs. Government policy in the form of emission standards, fiscal incentives, and industrial policy clearly put pressure on the automobile industry (Kolk & Tsang, 2017; Pinkse et al., 2014). In addition, in 2008, the launch of the Tesla Roadster received a lot of public attention and, arguably, put pressure on the incumbent car manufacturers to become more active. Also, Toyota's success with the hybrid Prius and its first fuel-cell concept cars increased momentum for alternatives to the gasoline-powered engine.

In response to such pressures, many incumbents built concept cars or prototypes (44 in total), used to present and/or experiment with electric technologies or designs, but these were often not intended for production. Furthermore, 14 test cars were examined under controlled, real-world conditions to learn from and improve the technology. Companies clearly wanted to be prepared if EVs were to gain momentum. Often, they profited from the green credentials that their frequently highly publicized initiatives obtained. For example, Chrysler, Renault, and BYD presented several concept cars, learned about technologies, and attracted positive publicity. Ford (Focus EV), BMW (Mini E), and Daimler (E-Smart) tested EVs in controlled environments, received feedback from test customers, and improved their reputation for being sustainable. Often, these cars were modified, conventional vehicles built in small series, or they were produced or modified through a third-party provider, that is, converted EVs (Bohnsack et al., 2014). This development suggests that the industry used them as a way of signalling to governments and society that it was taking responsibility by developing technologies that could live up to norms set in the future but did not consider these technologies mature enough to warrant a massive move into electric mobility.

The majority of incumbents had strong reservations about the EV readiness of the market, in general, and consumers, in particular, although some companies had "mixed feelings," exposing both negative and positive views. Toyota, for example, expressed being doubtful about the applicability of EVs, as the following quote illustrates: "We feel electric cars cannot replace normal vehicles. […] There will be a market for this vehicle, but a limited one" (Reed, 2009a). Concurrently, it did not want to exclude a possible future potential for EVs, which might explain the development of three concept cars (e.g., Toyota FT-EV) and two test cars (e.g., the Toyota Plug-In). And, although Daimler suggested that EVs might help address emission and gasoline supply issues in China, this company emphasized the barriers faced by EVs in general, stating that "[t]he chances appear better on the fuel cell than the battery electric side" (Kurylko, 2009). Furthermore, while considering EVs as a crucial technology, Volkswagen acknowledged that it would take a long time before they might enter the market on a larger scale.

Most incumbents, however, openly criticized the technology, especially the batteries. Honda noted that "battery-based electric vehicles aren't really practical at this point in time" (Greimel, 2008a): "It's questionable whether consumers will accept the annoyances of limited driving range and having to spend time charging them" (Automotive News, 2010). Hyundai mentioned practical and cost-related objections: "The usage of that kind of 100 percent electric vehicle will be very, very limited. […] We are talking about a huge amount of batteries sitting in the car. Who can afford that?" (Greimel, 2008b). Expectations regarding the moment at which EVs would leave the niche, if at all, also varied considerably. VW regarded EVs as having a distant timeline and believed that bringing EVs to the market would be "an engineering marathon. It's not going to be a sprint. […] Electric powertrains […] will be 'a supplement' to internal combustion engines. […] [B]y 2020 EVs will have a global share of 1.5 to 2 percent" (Guilford & Ciferri, 2009). Ford agreed that due to its characteristics, EVs would remain a niche product. As its vice president of research and advanced engineering stated: "I don't think it'll be a high volume. It'll be tailored for city driving and a limited range. Overall, I think it'll be significantly below 5 percent of the total new-car sales" (Automotive News, 2008).

Hence, despite exploratory activities by incumbents, overall scepticism and negative views prevailed. There was considerable uncertainty in the industry about EVs, and their legitimacy was rather low. What came to the fore towards the end of this period, though, was that despite all the scepticism, three companies deviated from this overall pattern.

4.2 | The emergence of a different position: EVs as first-mover advantage?

GM, Mitsubishi, and Nissan were the first incumbents to bring purpose-built EVs to the mainstream market with the Chevy Volt, iMiev, and Leaf, respectively. They announced to have dedicated production sites, although the volumes they expected differed largely.[5] Strikingly, these three companies expressed much more positive market expectations than their competitors. Looking closer at reasons used to explain their engagement, a mix of strategic motives could be noted, with nuances differing between the companies that also seemed to be influenced by the specific context in which they operated.

4.2.1 | General Motors

GM put much emphasis on the need for its EVs to be competitive in the mainstream market and argued that it was "determined to lead like no one else can" (GM, 2007, p. 24). As mentioned above, GM had a history of less successful engagement in the EV1, and its strategy was to develop an EV with a back-up internal combustion engine rather than one that relied on batteries alone, which disappointed (green) car enthusiasts. The company was pressured by the U.S. government to develop sustainable technologies in exchange for loans to solve its financial distress in the 2009 crisis. A move towards higher fuel effi-

ciency was also needed to be able to comply with U.S. corporate average fuel economy (CAFE) standards for its fleet and avoid having to pay penalties. Concurrently, its CEO noted the importance of the EV for GM: "As a 'halo' vehicle and an extremely important technology […], we think it's very important to have it" (Reed, 2009b). "We think it will help position us, recognize what we do and recognize the capacity that we have […]. We're not just doing it for image reasons, because it's awful[ly] expensive" (Automotive News, 2006). Its previous experience may have informed the perspective on the role of the EV overall: "The mass market EV has to be CAPABLE [emphasis in original] of being your primary vehicle. […] I think pure battery electric vehicles – they're not going to be niche vehicles, but they're not going to be a primary vehicle" (Treece, Child, & Guilford, 2010). Nevertheless, GM expressed to "believe in the ultimate electrification of the automobile. […] We believe that's where it's going" (LaReau, 2006).

4.2.2 | Mitsubishi

Mitsubishi also faced CAFE standards and a difficult financial situation, having suffered consecutive losses in the early 2000s. Moreover, it had failed to invest sufficiently in sustainable technologies, most notably lacking knowledge of hybrids. The company's commitment to a full EV helped it to leapfrog technology-wise, address fuel-economy concerns, and reorient itself as the iMiev represented one of the "new pillars for penetrating new markets" (Greimel, 2010), while at the same time displaying innovativeness and corporate responsibility. Acknowledging that EVs seemed most suitable for city use, Mitsubishi saw EVs as the ideal future technology, considering its environmental credentials: "When our electric vehicle debuts next summer and people see it running around the city, it will be highly valued. There's no noise, no smell, no emissions. When you think about the entire industry, it's not difficult to imagine 10 percent to 20 percent of cars being electric" (Greimel, 2008c). Mitsubishi claimed that the "electric vehicle is the embodiment of the ultimate eco-friendly vehicle" (Mitsubishi, 2007, p. 11) and later on stressed that the company wanted to "work to rapidly create a low-carbon society" (Mitsubishi, 2009, p. 2). Besides, Mitsubishi noted that their customers "have already had hybrids and are ready to make the next step" (Guilford, 2010).

4.2.3 | Nissan

Nissan also had a history of financial trouble—which its new COO (later CEO) Carlos Ghosn solved quickly after the start of the alliance with Renault in 1999—as well as a history of technological followership and concomitant brand position. These latter problems appeared to have inspired Ghosn's change of heart, as he stated at the shareholder meeting in early 2007: "Our most urgent R&D challenge today is to meet society's environmental expectations. That's why 40% of our budget for advanced engineering is devoted to the Nissan Green Program 2010, our five-year environmental blueprint. For our industry, environmental sustainability represents the biggest engineering challenge. Along with Renault we will pursue every possible avenue of environmental progress—from hybrids to fuel-cells to electric cars and clean diesels." The substantial EV investments they made had the Nissan Leaf as flagship because, as Nissan's North American Senior Vice President for Sales and Marketing put it: "I think this car can act as a real halo for the Nissan brand. […] It can have a transformative effect on the Nissan brand and how people perceive us" (Chappell, 2010b). Ghosn explained that "Nissan was a 'me too' company. But in electric, we're pioneers." Similar to Mitsubishi, Nissan envisioned a large future market for EVs: "Electric vehicles could take 10 percent of the global market by 2020, or roughly 6 million units in annual sales. […] We see it as mass market" (Greimel, 2009). The company pointed at "a segment of eco-friendly consumers who are interested in going to the next level. They own a hybrid vehicle. But if the next step is available, they want to take it" (Chappell, 2010a).

When considering the strategic motives of the three companies, it is striking that—compared with GM—both Mitsubishi and Nissan positioned their EVs far more explicitly as eco-friendly cars that would pave the way for a sustainable future and as their responsibility towards society. However, although the large-scale EV projects tended to be positioned as a way of being responsible towards society, all companies also emphasized competitive advantages. After the financial crisis 2009 had hit the car industry hard, they were in need of flagship innovation projects. Regulators pressured GM to invest in sustainable product innovation in exchange for loans, and Nissan was, as the number three among Japanese automobile companies, observed to suffer from severe "Prius envy." Still, although both a sustainability and a competitive advantage focus became apparent in their strategic motives, the individual companies differed in their emphasis of one over the other. This difference in emphasis becomes even more salient when the strategies of all large companies in the industry are considered. Table 2 illustrates automobile companies' somewhat different assessments on a continuum between sustainability and competitive advantage focus on the horizontal axis, while distinguishing first movers and followers on the vertical axis.

As Table 2 indicates, the companies in the industry that most clearly stressed that their engagement in EVs was part of their responsibility towards society included Nissan, Mitsubishi, and BMW. At the other end of the spectrum, we find those that expressed to be focused on gaining a competitive advantage, particularly GM, Fiat, and Honda. Overall, we can conclude that first movers generally put greater emphasis on the higher cause of sustainable development as driving their efforts, and followers on competitive dynamics. Yet, individual companies also deviated from this pattern. In addition to GM as a first mover that emphasized the competitive advantages of EV engagement, an interesting case is BMW. BMW strongly emphasized sustainability as a "higher cause" to motivate its actions and clearly pushed the development of EVs in the period under study. Specifically, it announced that its "long-term aim is to produce emissions-free mobility" (BMW, 2010, p. 35) and that "premium has to become sustainable in the long-run" (FAZ, 2009, p. 14). With its project-i, BMW aimed to develop a purpose-built electric megacity vehicle "that can lastingly change mobility behaviour." Although it only brought the i-series to the market in 2013, and thus represents a follower in our classification BMW emphasized its sustainability vision over competitive concerns.

TABLE 2 Sustainability versus competitive advantage focus of incumbent first movers and followers

	Mitsubishi	Nissan	General Motors
First mover	Our top priority is to press ahead with the development of the iMiev (Mitsubishi innovative Electric Vehicle). **This next-generation electric vehicle is the embodiment of the ultimate eco-friendly vehicle** (Mitsubishi, 2007, p. 11) The Mitsubishi Motors Group's vision for addressing environmental issues is "**Leading the EV era, towards a sustainable future**." To realize this vision, we have started mass production of the new-generation electric vehicle iMiev and have begun rollout of the iMiev in Japan, looking to expand rollout globally (Mitsubishi, 2009, p. 2) Mitsubishi Motors is striving to **become a unique provider of eco-cars, contributing to the environment** (Mitsubishi, 2013 AR, p. 14) Today, we see electric vehicles as the pinnacle technology that will play a crucial role in the automobile's next 100 years […] we **work to rapidly create a low-carbon society**. (Mitsubishi, 2009,p. 2)	Nissan intends to be the global leader in zero-emission mobility. Our ultimate goal is to create a **society that is environmentally responsible and also enriches people's lives**. (Nissan, 2010, p. 15) The key contents of our plan focus on **developing leadership and profitability in growth markets** worldwide, actively cultivating sustainable mobility through electric vehicles and technologies that reduce emissions, and advancing mobility for all. (Nissan, 2011, p. 3) As an automaker, it is **our responsibility to help realize a sustainable mobility society through our zero-emission efforts**. (Nissan, 2013 p. 13)	We're on a five-lane highway to develop more environmentally friendly and energy-efficient cars and trucks. From gas friendly to gas free, from biofuels to electric, GM is determined to **lead like no one else can**. (GM, 2007, p. 24) GM launched the Chevrolet Volt electric vehicle with extended-range capability in November 2010. The vehicle underscores GM's **commitment to technology leadership, while positively shaping perceptions about electric vehicles**. (GM, 2010, p. 4) We are **committed to leadership** in vehicle design, quality, reliability, telematics and infotainment and safety, as well as to developing key energy efficiency, energy diversity and **advanced propulsion technologies, including electric vehicles.** GM, 2012, p. 19)

(Continues)

TABLE 2 (Continued)

Follower	**BMW** We are not only working on electrically driven cars, but also on **concepts designed to significantly reduce the environmental impact of the car all the way along the value-added chain**. (BMW 2009 p.35) Our long-term aim is to **produce emissions-free mobility** with vehicles powered by electricity and hydrogen. (BMW, 2010, p. 34) BMW i stands for visionary electric vehicles, revolutionary lightweight construction, inspiring design and innovative mobility services. It also stands for **a new understanding of the term "premium" that is strongly defined by sustainability.** (BMW, 2012, p. 38)	**Ford** Ford Motor Company is embarking on an aggressive plan to bring pure battery-electric vehicles, next-generation hybrids and a plug-in hybrid **to market quickly and more affordably** over the next four years. It's the next step in our commitment to deliver fuel economy solutions for millions (Ford, 2008, p. 4) Our **commitment and approach to sustainability is unique in the industry**. We **prefer to provide our customers the power of choice**. All Ford front-wheel drive and all-wheel drive global platforms are engineered to accept a full technology range of gasoline, diesel, hybrid, plug-in hybrid or electric vehicle propulsion systems. (Ford, 2012, p. 16)	**Daimler** In order to **reduce CO2 emissions even further** and to be able to offer vehicles that are compatible with future requirements over the long term, we are also **working on alternative drive systems** such as fuel cells, battery and electric vehicles and lightweight construction methods (Daimler, 2007, p. 56) In order to **achieve locally emission-free mobility** with electric vehicles, Daimler is relying on battery-electric and fuel-cell drive systems, and **continues to systematically develop them both.** (Daimler, 2011, p. 49)	**Honda** Environmental technologies are **increasingly vital to competitiveness in the automotive sector** now that growing global awareness of environmental issues is leading consumers to demand cars with better fuel economy. Honda is developing eco-friendly automotive technologies on a number of fronts, including hybrid vehicles and a fuel cell electric vehicle (Honda, 2012, p. 8) **Volvo** Hybrid and electric cars are unlikely to satisfy this demand in the short term and this has raised interest in optimising and **downsizing the internal combustion engine, possibly in line with electrification**. (Volvo, 2013, AR p. 14)	**Fiat** In many cases, **technological and cost barriers limit the mass-market potential** of sustainable natural gas and in particular electric vehicles. (Fiat, 2013, AR, p.38) **VW** Vehicles with **combustion engines will continue to dominate our roads in the coming 20 years**. But all experts agree: the electric car will shape the future (VW, 2008, p. 58) Batteries need to be made more powerful, safer and cheaper, a **charging infrastructure has to be developed and the energy required to "refuel" must be generated from renewable sources**. (VW, 2011, p. 55)

Note. Some parts are put in bold by the authors to highlight the core themes of the quotes. Given the large number of sources for the findings presented in this table, we do not provide detailed references for all statements. Full referencing is available from the authors upon request.

4.3 | Industry perceptions from 2010 onwards: A mixed bag of sustainability and competitiveness?

The first movers' actions appeared to develop momentum for EVs, creating a critical mass, or at least sufficient resonance more widely for other companies to engage and take a more positive attitude. Legitimacy for the EV thus gradually increased, as reflected in several new models that were launched in the three years following 2010 (see Table 3 for incumbents' EV engagement and Table 4 for worldwide sales). It should be noted, however, that except for the three first movers and BMW, the other companies paid most attention to modifying conventional cars to EVs.

Although a growing group of followers emphasized EVs as an act of corporate social responsibility, many companies kept their reservations, stressing the difficulty for EVs to compete with other car technologies. Honda (2012, p. 8) argued, for example, that "[e]nvironmental technologies are increasingly vital to competitiveness in the automotive sector." Likewise, Geely (2013, p. 15), which acquired Volvo in the period covered by this study, announced that "[t]he Group will also leverage on Volvo Car's leading technology on hybrid electric vehicles to achieve a gradual transition from hybrid to pure electric technology." Ford also offered a more positive perspective than before, stating that its "electrification strategy foresees a future that includes different types of electrified vehicles, depending on customers' needs. There will not be a one-size-fits-all approach, but a

TABLE 3 Incumbents' EV engagement in the U.S. market

Company	First model	Year	Location of first launch	Purpose-built vs. converted	Other models
GM	Chevy Volt	2010	US	Purpose-built	
Nissan-Renault	Leaf	2010	Japan & United States	Purpose-built	ZOE, Twizy
Mitsubishi	i-MIEV	2010	Japan	Purpose-built	
Daimler	Smart EV	2011	Germany	Converted	
Ford	Focus EV	2011	US	Converted	
Toyota	Prius-Plug-in	2012	Japan & US	Converted/Purpose-built	
Honda	Honda Fit EV	2012	Japan (2010)	Converted	
BMW	i3	2013	Germany	Purpose-built	i8
Fiat	e500	2013	US	Converted	
Geely	Volvo V60-PlugIn	2013	Sweden (2012)	Converted	XC90 Plug-In
VW	e-Up	2013	Germany	Converted	e-Golf

Note: Year refers to start of EV sales. Whether a car is purpose-built is at times debatable. For example, the Chevrolet Volt is based on the platform of the Chevrolet Cruze but could also be considered purpose-built; the Prius Plug-in is a purpose-built hybrid that has been extended, but it is not a purpose-built EV. By contrast, the Ford Focus Electric is clearly converted-only, with the car's technology being a compromise.
Abbreviation: EV, electric vehicle.
Sources: http://energy.gov/downloads/electric-and-hybrid-electric-vehicle-sales-december-2010-june-2013, and http://ev-sales.blogspot.nl/2014_01_01_archive.html (both accessed 19 May 2014)

TABLE 4 Worldwide sales of the Top 20 (PH) EV models in 2015

Rank in 2015	Model	Volume in 2015	Purpose-built*	Type
1	Tesla Model S	50.366	Yes	EV
2	Nissan Leaf	43.870	Yes	EV
3	Mitsubishi Outlander PHEV	43.259	No	PHEV
4	BYD Qin	31.898	No	PHEV
5	BMW i3	24.083	No	EV
6	Kandi K11 Panda EV	20.390	Yes	EV
7	Renault Zoe	18.846	Yes	EV
8	BYD Tang	18.375	No	PHEV
9	Chevrolet Volt	17.508	Yes	PHEV
10	Volkswagen GTE	17.282	No	PHEV
11	BAIC E-Series EV	16.488	No	EV
12	Zotye Z100/Cloud EV	15.467	No	EV
13	Volkswagen e-Golf	15.356	No	EV
14	Audi A3 e-Tron	11.962	No	PHEV
15	Roewe 550 PHEV	10.711	No	PHEV
16	JAC J3 EV	10.420	No	EV
17	Ford Fusion Energi	9.894	No	PHEV
18	Ford C-Max Energi	9.643	No	PHEV
19	Kandi K10 EV	7.665	Yes	EV
20	Kia Soul EV	7.510	No	EV
Total		400.993		

**Note*: See footnote under Table 3
Source: Derived from the EV-Sales Blog which provides the most comprehensive information on EV sales, http://ev-sales.blogspot.nl/2014/01/world-top-20-december-2013-special.html, last accessed 19 May 2014 and https://ev-sales.blogspot.pt/2016/01/world-top-20-december-2015-special.html, last accessed 4 May 2016. The figures for 11 and 15 were indicated to be estimates.

diverse and smart range of applications of different types of electrified vehicle technologies."[6] Yet, Ford was careful in picking winning technologies a priori and argued: "We prefer to provide our customers the power of choice" (Ford, 2012, p. 16). Accordingly, the company claimed that "[a]ll Ford front-wheel drive and all-wheel drive global platforms are engineered to accept a full technology range of gasoline,

diesel, hybrid, plug-in hybrid or electric vehicle propulsion systems" (Ford, 2012, p. 16).

Hence, despite positive developments in the direction of the wider diffusion of EVs, many companies remained sceptical and were undecided as to which technology would be most suitable for a move towards sustainable mobility. For example, GM (2013 SR, p. 11),[7] while having pioneered the range-extender technology, mentioned being concerned about the future of EV technology, largely because of limited demand: "consumer acceptance of advanced technology vehicles, such as plug-in electric vehicles, has not been growing as quickly as many in our industry predicted." It also noted advances in fuel-saving technologies more broadly: "Furthermore, we're achieving truly remarkable progress in vehicle and internal combustion engine efficiencies." Volkswagen (2013, p. 142) pointed to the limitations for EVs in the current situation: "In the area of battery chemistry, developing high-performance batteries and building up technological expertise are both vital to increasing the range and hence the attractiveness of electric vehicles. Another challenge is integrating electric cars into the existing infrastructure." Fiat (2013, p. 38) mentioned that "technological and cost barriers limit the mass-market potential of [...] electric vehicles."

In line with the companies' modest expectations, the market share of EVs in 2013 was still negligible. The markets with the highest market share were Norway (6.1%), the Netherlands (5.6%), and the United States (1.3%; Mock & Yang, 2014, p. 3). Although it might be suggested that generous policies led to these figures, it should be noted that in countries with similar incentives (see Appendix A), market shares were considerably lower (e.g., Denmark [0.3%] or the United Kingdom [0.2%]). What had started as the "revival of electric" (Bakker et al., 2012) now seemed to be stuck in limbo between becoming an industry standard or fading away as an electric episode, like it had happened before. An announcement by Fiat's CEO Marchionne echoes this. At a conference, he stated that "I hope you don't buy [the 500e] because every time I sell one it costs me $14,000."[8] Because the 500e is a converted vehicle, this might also speak for the possible success of purpose-built EVs. A certain number of companies, particularly those based in Japan, also prepared for a future with fuel-cell vehicles and adjusted their portfolio in case this technology would take off there. For instance, Toyota pushed the development of the Mirai as the first fuel-cell vehicle available for the passenger market. Honda and Nissan, in turn, "announced an agreement to work together with other Japanese automotive manufacturers to support hydrogen station infrastructure development" (Honda 2015, SR; Nissan 2015, SR, p. 29).

And yet, although the future of EVs was uncertain, the revival had created momentum for the electrification of cars. Notably, companies started to embed their technology strategy for EVs into their efforts to respond to a larger transformation of the automotive industry and individual mobility. Especially in European markets, they began to develop new business models, such as mobility-as-a-service, to reduce the need for individuals to own cars. Pioneered by Daimler with the car2go system in 2008, BMW, Fiat, and Toyota mentioned experiments in carsharing for EVs in their sustainability reports in 2014, and also, GM, Ford, and Peugeot had developed urban mobility carsharing systems by 2015. Another trend affecting EVs was the emergence of autonomous driving. Tesla was at the vanguard of this innovation, making models with autopilot modes available in 2014. By 2016, all major car companies headquartered in Europe or the United States had plans to test or include autonomous driving in their EV offerings, especially for those aimed at Western markets.Furthermore, China renewed its environmental policy, which promoted the development and sale of EVs, even though the innovation centred on improving car performance to boost individual passenger car sales. Along these lines, the Chinese EV makers' global share rose from 31% in 2015 to 43% in 2016, largely based on the growth of the Chinese market, which turned China into the fastest growing market globally and the largest volume market. In addition to Chinese companies such as BAIC and SAIC, which introduced up to five new models in both 2014 and 2015, Western companies like Renault-Nissan also started to collaborate with Chinese companies (in this case BYD) in order to have a stake in a new developing market with great potential.

5 | DISCUSSION

This study aimed to shed light on how sustainable product innovation activities evolve from individual firm action to an industry-wide activity. Based on the case of the EV, it focused on the strategic motives that individual companies used to justify their engagement in sustainable product innovation and how this contributed to the changeover of positions within the industry as a whole. Our analysis showed that, within a relatively short period of time, a group of large automobile companies collectively moved to the production of EVs through a combination of coercive, normative, and mimetic pressures (DiMaggio & Powell, 1983). Governments' coercion gave the initial push, triggering the collective engagement in EVs, but it was the normative and mimetic pressure created by three first movers—Nissan, GM, and Mitsubishi—that provided a further thrust to the industry to provide EVs as a way to fulfil societal obligations. Legitimacy in the industry thus gradually increased, as reflected in the launch of several new EVs in the 3 years following 2010. Most incumbents jumped on the bandwagon and showed herd behaviour; the only incumbents that did not engage in EV development were Mazda, Hyundai, and Suzuki.

This rather swift convergence seems like quite a sea change given that, in the initial years of the period under study, the companies in the industry had diverging perceptions with regard to the prospects of EVs and to engaging in EV production at all. Emphasizing convergence, therefore, does not provide a full account of how EVs came to be adopted as a sustainability practice in the automobile industry. Industry positions converged considerably, but not fully. Subsequent to the engagement of the three large incumbents, followers mainly started to convert conventional vehicles into EVs to keep up with developments and be prepared in case EVs would become mainstream. With the exception of BMW, they largely failed to see an immediate future for EVs due to cost, infrastructure, and technological barriers. Therefore, although the engagement in EVs generally became widespread over

the past decade, the terms of engagement stayed poles apart between companies.

First movers generally positioned their engagement in EVs as part of their corporate social responsibility and sustainable innovation efforts, whereas followers leaned more towards seeing EVs as a means to an end, with the end being competitive advantage, or at least not incurring competitive disadvantages by missing the boat. This, however, is not to say that first movers did not focus on economic motives and acted for merely altruistic reasons. For example, Nissan and Mitsubishi were, due to their history, both in need of flagship innovation projects. GM, on the other hand, was a first mover that faced more immediate pressures to comply with regulatory standards for its fleet. Their early engagement in EVs was supported by company-internal circumstances such as financial distress and the need to brush up their technological image and, to some degree, external circumstances such as policy support. Arguably, the actions of these companies paved the way for others to see a sustainability and a competitive advantage focus no longer as mutually exclusive. The strategic motives that fast-follower BMW (2012, p. 38) expressed nicely reflect this blending of foci, emphasizing that the EV "also stands for a new understanding of the term "premium" that is strongly defined by sustainability."

In other words, by creating normative and mimetic pressures, first movers' actions drove the bandwagon, opening the door for perceiving sustainable product innovation as a source of a long-term competitive advantage. Figure 2 summarizes the points made thus far. It also serves to highlight the important role of first movers' actions in closing the chasm between coercive pressures, which are usually triggered by events and actions outside the firms-in-an-industry, and mimetic and normative pressures, which subsequently arise from the competitive dynamics among the firms-in-an-industry.

Interestingly, this dynamic resembles the one between niche players and incumbents that the sustainable entrepreneurship domain has put forward. In their study on the interaction between sustainability entrepreneurs and incumbents, Hockerts and Wüstenhagen (2010) argue that sustainable entrepreneurs first push a sustainability focus. Incumbents then follow into the sustainability niche but introduce a cost focus and make sustainable innovation ready for the masses. Our analysis highlights that within the group of incumbents, a similar dynamic takes place as well: First movers create the possibility to position the engagement in sustainable product innovation as both motivated by competitive advantage and sustainability. Our analysis of the EV case also shows that the ultimate transformation of markets does not simply "occur" as a result of such first-mover and follower dynamics. For autonomous innovation, followers' tendency to jump on the bandwagon may quickly result in the replacement of industry standards and dominant technologies (e.g., Geels, 2018). For systemic innovation, however, co-dependencies to changes in infrastructure, user behaviour, and other technologies may lead to continuous uncertainty. The constant hesitation expressed by GM in the years following 2010 is living proof of this struggle between wanting to "green" the product portfolio, on the one hand, and pursuing it even when customer response stays lukewarm, on the other.

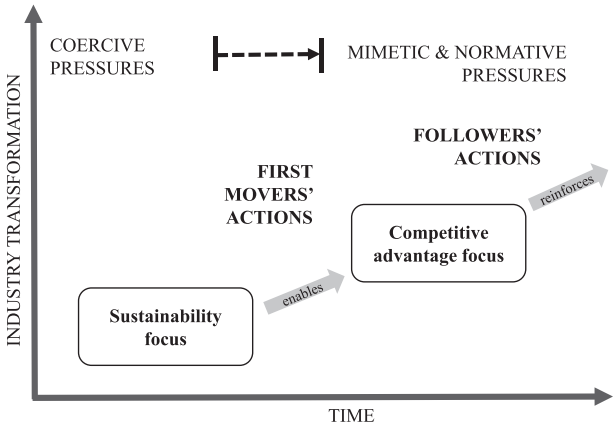


FIGURE 2 First movers' central role in pushing industry transformation toward sustainable product innovation

What appears to be one of the main peculiarities of sustainable product innovation in the automobile industry is that whatever technology will become the main foundation of sustainable mobility in the future, it will involve a highly capital-intensive change that may prove to be disruptive to existing competitive positions (Pinkse et al., 2014). Any move towards higher engagement in sustainable technology hits the competitive core of the automobile industry. The question whether it will pay off to become more responsive to societal concerns is therefore an inevitable one (McWilliams & Siegel, 2001). Even those companies that legitimize their EV engagements in terms of having a responsibility towards society will also be preoccupied with the competitive dimension of EV technology. The financial stakes are simply too high to invest in EVs only to please governments and other organizations criticizing the industry for damaging the environment. A sustainability and competitive advantage focus thus need to come together to enable systemic forms of sustainable product innovation.

The analysis presented in this paper is not without limitations. The study relied on an analysis of publicly available data including trade journals, magazines, newspapers, annual reports, and online sources. Although these sources allowed for a comprehensive reconstruction of the developments over the course of 10 years, the information may have been subject to reporting bias (Yin, 2009). Some events may have received more attention than others in the public domain, and incumbents' motives were presented in a specific light by journalists. We tried to address this potential problem by working as much as possible with direct statements from the companies and triangulating between different sources. Moreover, although the automotive industry and its activities with regard to the EV are a well-suited case to look at the establishment of sustainable product innovation that requires systemic changes, due to its vast scale, high sunk costs, and complexity in terms of organization, production, sourcing, products, and technology, some of the dynamics observed in this paper could be idiosyncratic to this sector. It would be interesting, therefore, to replicate this study in a different industry, such as utilities or the oil and gas sector, and examine incumbents' engagement in renewables. More research on the automotive industry, and

incumbents in particular, is also needed considering recent technological developments such as autonomous driving and social innovation related to carsharing (Ciulli & Kolk, 2019). It would be interesting to study how these developments interact with the development of EVs and the diffusion of systemic innovation.

Lastly, future research might also pay more attention to the influence of geographically bound government policies on car manufacturers' innovation strategies (cf. Bohnsack et al., 2015). Whereas our analysis already indicated that coercive pressures such as the CAFE standards in the United States might have triggered first movers' actions, it would also be interesting to consider how different national market regimes influence industry-wide action. For instance, the Chinese market is a huge market globally and the largest volume market for EVs and has often been used by car manufacturers to justify their continuous engagement in EVs despite moderate demand in their home markets. In general, further insights into the particularities of entry timing strategies for sustainable product innovation that requires systemic changes would be highly relevant to inform the governance of sustainability transitions. Policymakers, for instance, can benefit from a better understanding of the strategic motives, in addition to regulatory pressures, that lead incumbents to engage in sustainable product innovation.

6 | CONCLUSION

Through an in-depth analysis of the case of the EV, this paper contributed to the understanding of the diffusion process for sustainable product innovation that co-depends on systemic changes in the industry. This is important, not least because many explanations on innovation diffusion are based on studies that take autonomous innovation as a vantage point. Bringing autonomous innovation to the market, however, is fundamentally different from the long-term, co-evolutionary change processes that characterize systemic innovation. The paper thus responded to calls from scholars to move beyond the use of innovation frameworks that consider the single firm rather than firms-in-an-industry (Geels, 2018). The analysis of the EV case has highlighted the important role of first-moving companies, with a divergent behaviour that can drive a bandwagon of convergent behaviour to eventually help move the industry as a whole towards sustainable product innovation. Focusing on the interplay of sustainability visions and economic rationales as strategic motives for engagement, we found that opportunistic reasons such as the need for flagship innovation projects may trigger firms in an industry to move first. By doing so, however, they enable a combined sustainability and competitive advantage focus for the industry as a whole, which may support, at least to some extent, the much larger transition that will be needed.

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ENDNOTES

[1] It should be pointed out that, although EVs are considered more sustainable than other types of cars, especially those with a traditional internal combustion engine, and thus as epitomizing companies' corporate social responsibility, the degree to which this might be the case depends on the type of energy used (Bohnsack, Pinkse, & Kolk, 2014; Romm, 2006). Given their potential to improve energy efficiency and air quality and reduce environmental degradation, we follow the widely shared perception of EVs as a form of sustainable mobility.

[2] It must be noted that some of the sales data are estimates from the internet; this has been indicated in the findings. We preferred using somewhat less accurate data instead of having no data at all, as the figures approximate the scale of the various EV engagements of individual automobile companies.

[3] Because a part of the analysis was based on a larger study for which data were collected until 2010, the sources from *Automotive News*, *WardsAuto World*, *Autoweek*, and the *Financial Times* were only available for the 2006–2010 period. The other data sources spanned the whole period of 2006–2015.

[4] In this study, we tie the definition of a first mover to the timing of public announcements to commit to the EV and the market launch of a first, purpose-built model for the mainstream market. Because many companies made significant investments in technology research on electric driving, we focused on the commitment to purpose-built EVs as a core part of a company's future product portfolio to differentiate a first mover from a follower.

[5] For instance, the Mitsubishi iMiev, first available in 2009, started with 1,400 cars and was planned to eventually grow to 55,000. The initial numbers for the GM Volt and Nissan Leaf, both introduced 1 year later, were higher, with 10,000 and 13,000, respectively, and so were the projections (100,000 and 500,000, respectively).

[6] http://corporate.ford.com/microsites/sustainability-report-2012-13/environment-products-electrification-strategy, last accessed 22 July 2014.

[7] Company references refer to the analysed annual reports as displayed in Table 2. In the case of a reference from a sustainability report, the abbreviation SR is added to the year of the report.

[8] http://www.reuters.com/article/2014/05/21/chrsyelr-ceo-evs-idUSL1N0O71MS20140521, last accessed 24 July 2014.

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APPENDIX A

Main fiscal incentives related to EVs in different countries

Country	One-time subsidies*	Fiscal incentives	Specification
China	up to 60,000 RMB (7,200 EUR)	EVs exempted from annual taxes	—
Denmark	N/A	EVs exempted from registration fee; annual circulation tax exemption	For cars up to 2,000 kg
France	up to 7,000 EUR	EVs exempted from registration tax; company car tax exempted	Up to 20% of the price of the car (bonus-malus system)
Germany	N/A	EVs exempted from circulation tax; deduction of tax for company cars	—
Japan	up to 850,000 JPY (6,300 EUR)	EVs exempted from acquisition tax; annual tax 50% exemption	For the purchase of a new car
Netherlands	N/A	EVs exempted from circulation tax and company cars from income tax	—
Norway	N/A	EVs exempted from 25% VATCirculation tax only 350 EUR	—
Sweden	up to 40,000 SEK (4,500 EUR)	EVs exempted from road tax; company car tax reduction 40%	—
United Kingdom	up to 5,000 GBP (5,800 EUR)	EVs exempted from excise duty, tax on company cars exempted	Rebate of up to 25% of the price of the car; no circulation tax
United States	up to 7,5000 USD (5,400 EUR)	—	Based on battery capacity

**Note.* Specific amounts depend on purchasing price and CO_2 emissions.
Sources: ACEA (http://www.acea.be/images/uploads/files/20100420_EV_tax_overview.pdf), New York Times (http://wheels.blogs.nytimes.com/2010/06/02/china-to-start-pilot-program-providing-subsidies-for-electric-cars-and-hybrids/), U.S. Department of Energy (http://www.afdc.energy.gov/afdc/laws/laws/US/tech/3270), JAMA (http://jama.org/pdf/FactSheet10-2009-09-24.pdf), accessed 3 August 2011; Mock & Yang, 2014.

APPENDIX B

Company	Overview of EV Strategy 2006–2015
BMW	Started off with the MINI E in 2009 BMW. In 2013, they launched the i-series cars, a far-reaching initiative developing completely new vehicle concepts. In the long term, BMW's aim is to produce emission-free mobility with vehicles powered by electricity and hydrogen. BMW believes that online applications and networks will be important in bringing changes to future mobility.
Daimler	Daimler developed the electric Smart and established Car2Go, a car sharing scheme in which EVs could be used. Since 2010 Daimler also developed the electric A-and B-class. Daimler's ambition is to develop EVs over the whole spectrum. Daimler's smart brand that includes smartfortwo, smartforfour, and the smart convertible models to be launched in 2016, is intended to enhance the company's position in the field of electric mobility. A strategic partnership with a Chinese company to launch a fully electric vehicle (DENZA)is part of their strategy. Daimler is also heavily involved in the use of digital technologies for innovative mobility concepts like car2go, CharterWay, Bus Rapid Transit (BRT) and the "moovel" mobility platform.
Fiat	Launched the first EV in 2012 (Fiat 500e). Fiat believes that natural gas is the most effective and affordable solution to reducing CO2 emissions, but the company is also working on research & development of electric vehicles. Fiat has a cautionary stand on the feasibility of launching aggressively on such technologies while still maintaining competitiveness. Instead, it outlines a commitment to reduce emissions by developing increasingly efficient technologies for conventional engines, expanding the use of alternative fuels (such as natural gas and biofuels), and developing alternative propulsion systems (such as hybrid or electric solutions). It launched its first EV Fiat500e in 2012 and introduced the Chrysler Pacifica Hybrid at the beginning of 2016.
Ford	Ford focuses on making all of their models available with ICE, hybrid, and electric motors. In this way they believe that they can satisfy most needs. The goal is to gradually reduce the production of ICEs. Ford has a broad strategy of developing and maintaining its business on the wider vehicle spectrum including electrified products. It launched a new version of its Focus EV among its new electrified products. By 2020, it plans to invest $4.5 billion in electrified vehicle solutions.
General Motors	General Motors commenced its move toward EVs again in 2007 by signing contracts with two battery technology companies. The Chevrolet Volt was made available in the US in 2010. GM believes that electrically driven vehicles are the best long-term solution for providing sustainable personal transport. GM is investing heavily on multiple technologies offering increasing levels of vehicle electrification including eAssist, plug-in hybrid, full hybrid, extended range and battery electric vehicles. Chevrolet Volt and Cadillac ELR are among its extended range of offerings, while the all-electric Bolt EV is planned to go into production in late 2016. As part of its long-term strategy to reduce petroleum consumption and greenhouse gas emissions, it plans to continue developing hydrogen fuel cell technology like the Chevrolet Equinox fuel cell electric vehicle.
Honda	Honda invests in fuel efficient technologies but has no outspoken EV strategy. As Honda's first EV, the Fit EV was to be released in Japan and US in 2013. Since 2007, however, they have produced electric motorcycles. Honda promotes a wide variety of environmental friendly technologies, including gasoline engines with lower fuel consumption, hybrid vehicles, plug-in hybrid vehicles and electric vehicles. To address emission and energy issues, it is developing the Honda Smart Home System (HSHS). To seize new business opportunities, it is advancing the development of electric vehicles (EV) and fuel cell vehicles (FCV) and securing partnership with other companies for the preparation of hydrogen infrastructure.
Mitsubishi	In 2006, Mitsubishi already stated that they aimed at bringing an affordable EV to the market by 2010. The iMiev was their first EV in 2010. In 2009 Mitsubishi stated that it believed EVs would become the future. By 2020 Mitsubishi aims to reach a 20% of higher total production ratio of EVs. Mitsubishi has also stated, in 2013, its plan to work on infrastructure in order to accelerate the growth in the EV market. Mitsubishi promotes sustainability initiatives in each of its business activities by promoting the widespread use of electric vehicles. In 2013, it launched the Outlander PHEV, a plug-in hybrid electric vehicle. Together with strategic business partners, Mitsubishi intends to promote lithium-ion battery business for eco-friendly vehicles and electricity storage systems that emit minimal level of CO2.
Nissan	Since 2007, the Alliance between Nissan and Renault, has made large investments in R&D into EVs. Nissan aims at becoming a global leader in zero-emission vehicles together with Renault. In 2010, the first EV was launched in the U.S. and Japan. In their first generation, the alliance produced four different models. The aim was to have 1.5 million EVs on the road by 2016. Nissan is a foremost advocate for the development of recharging networks. In the long term, it aims to increase the adoption of zero-emission vehicles—battery electric and fuel-cell electric (EVs and FCEVs), and to promote the use of renewable energy to power these technologies.
Peugeot	The company has launched the Peugeot Ion and Citroën C-Zero EVs in 2010, models that were rebadged iMievs from Mitsubishi. Mitsubishi wants to reduce emissions, but they are not only focusing on EVs, but also optimizing ICEs and hybrids. The company has maintained its R&D spending to commit itself to CO2 reduction and environmental issues by reducing vehicle weight, optimizing engine performance and electrifying the drivetrain.
Toyota	In 2009, the FT-EV was Toyota's first concept for an EV. In 2010, Toyota established a partnership with Tesla involving the development of EVs. The plan was to introduce 10 new hybrid models by 2015 and also develop plug-in EVs, EVs and fuel-cell EVs to meet the need of the market. Toyota believes hybrids will be the future generation of cars. Toyota has under the "New Vehicle Zero CO2 Challenge," decided to challenge itself to reduce vehicle CO2 emissions by 90% in comparison with 2010 levels, by 2050.
Volkswagen	In 2006, VW stated that they expect an electric drive system within two decades drawing energy either from fuel-cells or batteries. In 2011, the eUp! Was announced, but VW is still careful in their optimism and believes that e-mobility still faces challenges, notably those related to charging system and infrastructure. Therefore, VW believes that hybrids will be very important the coming years when it comes to electrification. VW has a goal of reducing energy and water consumption, waste and emissions per unit produced across the Group by 25% and be the market leader in electric mobility by 2018. The company's e-mobility strategy is tailored to the Chinese market and provides for both joint ventures to successively produce plug-in hybrids and electric vehicles locally.
Volvo	Volvo produced the V60 Plug-in hybrid, which reached customers in 2012, being the world's first diesel hybrid. Volvo has not stated a specific EV strategy but is committed to a better environment and society.