

Creating a net-zero future: the temporal interplay of innovation and governance for corporate decarbonization

Lukas Rickling¹, Ann-Kristin Zobel¹, Lukas Falcke², Qinli Lu³, Rhea Riemke¹

¹ University of St. Gallen, Institute of Management & Strategy (IfB)

lukas.rickling@unisg.ch
ann-kristin.zobel@unisg.ch
rhea.riemke@unisg.ch

² Vrije Universiteit Amsterdam, KIN Center for Digital Innovation

l.a.falcke@vu.nl

³ Imperial College London

qinli.lu@insead.edu

Introduction

Anthropogenic climate change is the most pressing grand challenge of this century (George et al. 2016). Mitigating climate change requires fast and deep decarbonization of the global economy to reach net-zero emissions by 2050 (IPCC 2022). Correspondingly, climate change is becoming increasingly important to organizations as they need to develop strategies for reducing carbon emissions (Nyberg & Wright 2022) within and across value chains (Stern and Valero 2021).

With rising stakeholder pressure (e.g. Murillo-Luna et al. 2008) and physical climate risks (Pankratz et al. 2023), many firms have initiated their journey to decarbonize now for desirable futures. Yet, as firms scale back in their net-zero ambitions (Carbon Tracker, 2023) and fail to deliver on their targets (Cenci et al. 2023), we require a better understanding of how firms can decarbonize effectively. Given its complexity and systemic nature, it is unlikely that there is one clear pathway to corporate decarbonization. Transitioning to net-zero involves multiple temporal issues, as firms need to combine short-term responses that reduce emissions as quickly as possible with long-term strategies that address hard-to-abate emissions (Slawinski & Bansal 2015), whereby solutions to the latter have yet to be developed. Combining literature in the fields of sustainability, governance, and innovation, we therefore adopt a configurational perspective (e.g. Fiss 2011, Furnari et al. 2021) to explore multiple possible decarbonization pathways.

Specifically, we include two dimensions of actions firms apply to address the temporal challenges of decarbonization. First, firms can leverage *corporate governance* to translate actions contributing to desirable futures into short-term economic impact (Keum 2021, Flammer & Bansal 2017). Second, for most firms, a deep commitment to and progress towards net-zero necessitates *innovation* in low-carbon technologies, processes, and business models (Stern & Valero 2021). While some progress can be made in the short-term by adopting incremental innovations, firms in hard-to-abate sectors require more radical and systemic innovations that are likely to reduce emissions only in the long-term (Pinkse et al. 2024, Slawinski & Bansal 2015) and that may depend on collaborative efforts with partners within and across value chains (Falcke et al., 2023, Zobel et al., 2024). Here, it is likely that firms that have just begun their decarbonization journey, thus potentially focused on actions with short-term emission impact, utilize governance mechanisms and corporate innovation differently than more advanced companies, which may need to explore the next generation of low-carbon technologies to secure longer-term progress. Yet, the interplay of these dimensions and their joint effects on decarbonization progress remain unclear. Since prior work points to important interdependencies between short-term oriented governance mechanisms and long-term oriented innovative effort (e.g. Flammer & Bansal 2017; Keum 2021), this is an important gap. We thus ask: *Which configurations of governance mechanisms and (collaborative) innovative efforts unlock progress on corporate decarbonization?*

Theoretical Background

Decarbonization through corporate governance

A well-established body of work has investigated how governance tools can incentivize sustainable development. Such tools can, for instance, take the form of shareholder activism, which is effective in eliciting corporate disclosure of climate change risks (Flammer et al. 2021); female representation on the board which has been associated with the setting of emission reduction targets (Nimer et al. 2024); or monetary incentives for executives coupled to the company's environmental performance (Flammer et al. 2019), or internal carbon prices (Zhu et al. 2022). Governance tools may help direct managers' attention toward actions for desirable futures which may not immediately result in enhanced financial performance (Flammer et al. 2019). When incentivized accordingly, managers may overcome their focus on short-term business results and adopt a more long-term and systemic perspective (Flammer & Bansal 2017), which

is necessary for achieving decarbonization (Pinkse et al. 2024). The effect of setting an internal carbon price may, for example, be twofold. First, the additional cost factor may sensitize managers to emission-intensive process steps that can be mitigated in the short-term. Second, the resulting levies can be used to secure funding for (long-term) emission reduction efforts. At the same time, however, economically quantifying carbon emissions through a one-dimensional price factor can distract from the complex long-term impact on society (Slawinski & Bansal 2015) and may thus encourage incremental innovation more than systemic innovation.

Decarbonization through (collaborative) innovation

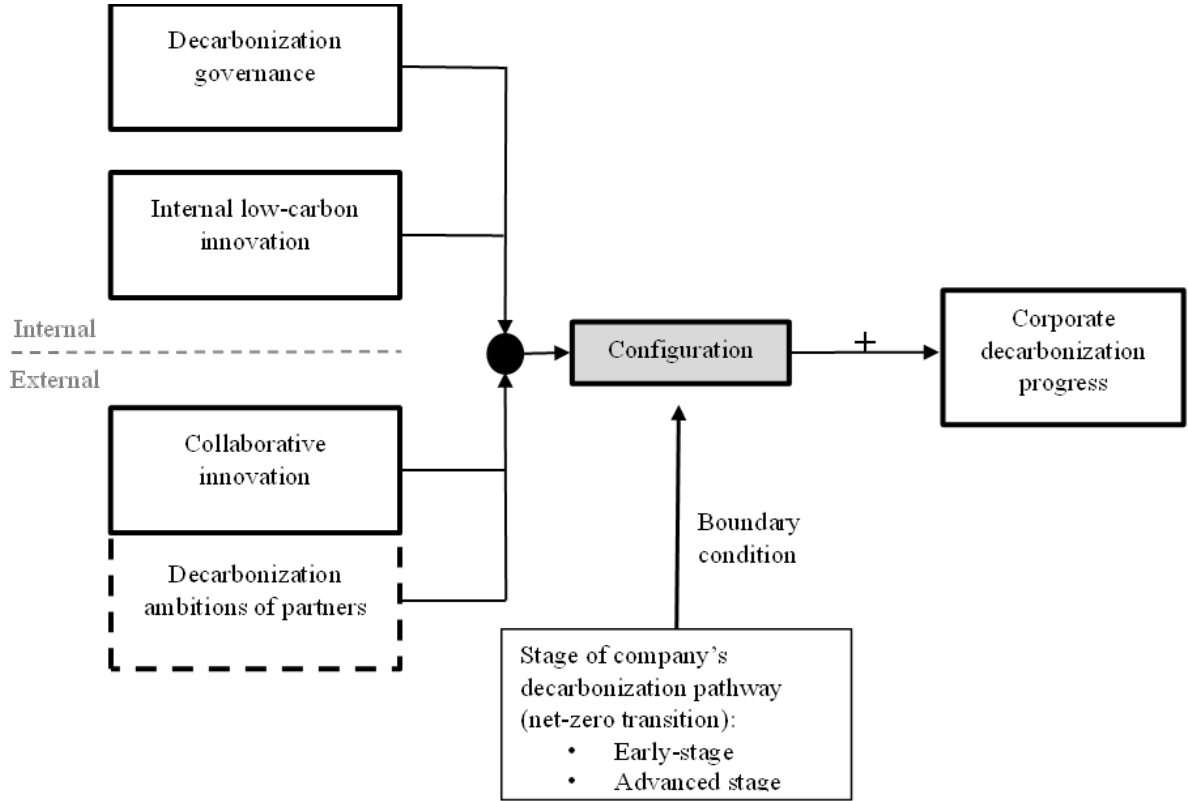
Scholars have already begun to investigate the importance of in-house innovation in addressing environmental problems – also called sustainable innovations (e.g. Demirel & Kesidou 2019). Yet, as sustainable innovations are often characterized by novelty and complexity, frequently demanding distant knowledge and capabilities, internal innovative efforts alone may be insufficient for achieving decarbonization (Barbieri et al. 2020). Furthermore, collaborations with various partner types can broaden the solution space for low-carbon innovation and thus contribute to a long-term perspective (Slawinski and Bansal 2015). As such, companies are increasingly turning to collaborative forms of innovation for sustainable development (McGahan et al. 2021). Specifically, two mechanisms may help to explain this positive relationship: 1) knowledge access and transfer, enabling firms to understand and measure their complex emission structure as well as to identify and integrate novel and unfamiliar technologies to reduce emissions (Zobel et al. 2024) social influence mechanisms, whereby partners who show high decarbonization ambitions may serve as a source of inspiration in decision-making or as a role-model for imitation to drive the focal firm's decarbonization efforts (Gerges-Yammine & ter Wal 2023).

Methods

Qualitative Comparative Analysis

We argue that we need to better understand whether governance- and innovation-related efforts compete or complement each other in the pursuit of decarbonization. Next to the importance of investigating the combination of multiple dimensions (i.e., conjunction), and the possibility of multiple pathways (i.e., equifinality), understanding corporate decarbonization is also characterized by causal asymmetry as some dimensions (e.g., innovation) could play a facilitating or limiting role. In the following, we therefore conduct a Qualitative Comparative Analysis (QCA), investigating how different combinations of governance- and innovation-related dimensions enable corporate decarbonization for firms who are in the early-stage vs. advanced stages of their transition (see Figure 1).

Figure 1. A configurational framework of corporate decarbonization progress



QCA draws from Boolean algebra and set theory to enable a systemic comparison of cases (e.g. Fiss et al. 2011). It allows us to investigate how the conjunction of multiple dimensions consistently leads to an outcome of interest (i.e. decarbonization). We follow the crisp-set approach where both the conditions and the outcome of interest can only take the values of 1 – indicating full membership in a given set– or 0 – indicating full non-membership in a given set.

Combining long-term and short-term perspectives of decarbonization in our *outcome set*, we measure decarbonization progress in terms of the (long-term) ambition of corporate decarbonization targets and the extent to which these are completed (in the short-term) (see also Ioannou et al. 2016). Based on the theoretical background, we include the following 5 conditions in our analysis of the outcome set “high corporate decarbonization progress”: decarbonization governance, internal low-carbon innovation, collaborative innovation, decarbonization ambitions of partners, and early vs. advanced-stage decarbonization (see table 1).

Table 1: calibration of dimensions

Dimension	Calibration	Data source
High corporate decarbonization progress	>50% progress on a target with >50% targeted emission reduction by 2030-2040	CDP
Advanced stage decarbonization	>25% share of renewables in electricity generation portfolio	CDP, Sustainability reports
Decarbonization governance mechanisms in place	Both incentive mechanisms for top-management and internal carbon price in place	CDP
Internal low-carbon R&D innovation projects running	>1 purely internal low-carbon R&D project running	CDP
High number of collaborative partnerships	5 or more innovative partnerships in the last 3 years	Factiva
Partners with ambitious targets	2 or more partners with ambitious decarbonization targets	SBTi

Sample and Data

Our empirical context for this short paper is the U.S. energy sector. As the data for our outcome set is derived from the Carbon Disclosure Project's (CDP) dataset, our sample is limited to U.S. energy companies voluntarily reporting their target progress to the CDP in 2022. By filtering for U.S. companies in the sectors “Energy utility networks” and “Thermal power generation”, we built a preliminary sample of 26 companies. To construct our dimensions and outcome set for the QCA, we compiled a dataset based on the following sources: 1) The CDP 2022 dataset 2) Factiva; and 3) the Science Based Target initiative (SBTi) (see also table 1).

Results and Discussion

The QCA yields three configurations of conditions that are consistently associated with high decarbonization progress (see table 2). We use black bold circles to indicate the presence and crossed circles to indicate the absence of a condition. Bigger (smaller) circles represent a stronger (weaker) link between the respective condition and the outcome. Empty fields in the table indicate that the condition can be either absent or present (i.e. “don’t care”).

Table 2. Configurations of governance and innovation dimensions associated with high decarbonization progress

	<i>High corporate decarbonization progress</i>		
	Configuration 1	Configuration 2	Configuration 3
Advanced stage decarbonization (High share of renewables)	⊗	⊗	●
Decarbonization governance mechanisms in place	●		●
Internal low-carbon R&D innovation projects running	⊗	●	●
High number of collaborative partnerships		●	●
Partners with ambitious targets		●	
Consistency	0.857	1	1
Raw Coverage	0.4	0.2	0.133
Unique Coverage	0.4	0.2	0.133
Overall solution consistency		0.916	
Overall solution coverage		0.733	

Configuration 1: Governance to harness low-hanging decarbonization fruits for early-stage firms

The first configuration implies that for firms in the early stages of their net-zero transition, a focus on internal decarbonization governance rather than (internal) low-carbon innovation projects is an effective means for decarbonization. When there is no internal low-carbon innovation (i.e., absence of condition), collaborative innovation and ambitious partners are less relevant (i.e., neither absent or present). To illustrate and better explain this governance-focused decarbonization strategy, we use the case of the energy utility Vistra Corp. Vistra Corp.'s generation portfolio consists of less than 2% renewable power plants. Given the small share of renewables in their portfolio, they might focus their internal resources on adopting readily available low-carbon technologies rather than on pursuing low-carbon R&D projects. Correspondingly, they installed comparatively strong decarbonization governance mechanisms to likely harness “low-hanging fruits” such as the reduction of air travel and the implementation and operation of established renewable energy generation capacity. In fact, Vistra Corp. has set internal targets for both these low-carbon initiatives, which yield immediate short-term effects for decarbonization progress.

Configuration 2: Tapping into the knowledge of ambitious partners to advance early-stage decarbonization

Another path for early-stage transitioners is to leverage the benefits of innovation and combine internal R&D with collaborative innovation, entailing relationships with partners that have ambitious decarbonization targets. This may suggest that these firms do not only benefit from collaborative innovation because of knowledge access but also because of social influence mechanisms, such as social comparison and peer pressure. Having decarbonization governance in place is not required. Jointly, configurations 1 and 2 suggest that during the early-stages of the transition, the individual impact of corporate governance mechanisms or innovation-centric endeavours can independently contribute to setting the company on the path towards decarbonization. Duke Energy helps to illustrate: While also owning a relatively small share of renewable energy plants, in contrast to Vistra Corp, Duke Energy's decarbonization strategy is more innovation focused. In fact, Duke Energy is investing into implementing renewable energy plants

but also into research in complementary, more long-term-oriented, smart grid and storage technologies, both internally and in cooperation with ambitious partners (i.e., Kroger Co. and Siemens Energy respectively).

Configuration 3: Holistic collaborative innovation and governance strategy for advanced decarbonization

The third configuration outlines a strategy for companies which are already more advanced in their net-zero transition. Contrasting the two “focused” strategies for early-stage transitioners, both decarbonization governance and internal combined with collaborative innovation must be present, likely to tap into external knowledge sources and direct funds and incentives to scale successful innovation. Thus, it is noteworthy that firms must reconsider their innovation or governance focus and complement it with other mechanisms to maintain momentum and ensure effectiveness as they progress in their transformation. As the focal company is already advanced in the net-zero transition, the presence of ambitious partners (and the associated social influence mechanism) does not matter. Importantly, in this configuration as well as configuration 2, internal R&D needs to be combined with collaborative innovation to make substantial decarbonization progress. An illustrative example in this case is Sempra Energy. With a strong decarbonization governance installed and comparatively large network of partners, Sempra is able to engage in more advanced and long-term innovative technologies to drive decarbonization progress in the later stages of their transition. For instance, Sempra internally researches green hydrogen technologies and collaboratively explores seminal micro-grid projects, next to further growing the share of renewable energy plants.

Future development and expected contributions

Focusing on temporal aspects of corporate decarbonization, we combine a governance with an innovation perspective to explore which combinations are best suited for decarbonization progress for companies at different points in the net-zero trajectory. Our results suggest that decarbonization requires both: governance and innovation, but that the effectiveness of the interplay of the two mechanisms is dependent on the company’s net-zero transition stage. In that context, we uncover the crucial role of collaborative innovation for facilitating corporate decarbonization in the short- and long-term. Our empirical insights show that companies benefit from collaborative innovation and resulting broader low-carbon solution scope (Slawinski and Bansal 2015) both in the early, short-term driven, stages as well as in more advanced, long-term driven, stages of their net-zero transition. Companies which exploit commercially viable, short-term, low-carbon solutions through a focus on decarbonization governance in the early stages, may still make substantial progress later on if they adopt a complementary collaborative innovation approach to explore more systemic and long-term solutions.

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