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Article

What Motivates Companies to Take the Decision to Decarbonise?

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Abstract: Already more than 140 countries consider or have pledged to reach net-zero emission targets by 2050 or earlier and the share of global emissions falling into an emission pricing scheme has steeply increased over the past three years. Even where there are no direct implications for industry (yet), there is a series of subtle pressure points driving an increasing number of companies across the globe to work towards climate neutrality and pledging ambitious emission reduction goals. This article sheds light on the pressure points, the subtle triggers, the underlying considerations as well as the hoped-for benefits for industrial companies from achieving net-zero emissions. The observations and ideas presented in this paper are derived from quantitative data obtained via the Energy Efficiency Index of German Industry (EEI) and qualitative data. Not only societal, work force, supply chain and investor expectations play a large role, but also many strategic considerations which have the potential to make the company more resilient and profitable, particularly in time of crisis. Those companies that do not move towards decarbonisation, on the other hand, may face a costly late-mover disadvantage. This piece uncovers subtle interconnections, helping stakeholders from industry and beyond to grasp opportunities and challenges ahead.

Keywords: decarb-efficiency, decarbonisation, industrial energy saving, cost effectiveness, strategic decision-making, climate neutrality, net-zero, drivers, motivators, resilience

1. Introduction

1.1. Background

Even though the COVID-19 pandemic has put many aspects of life on hold across the world, this has not been the case for climate change. Whilst the emission level initially shrank in 2020, this positive effect of the pandemic was hardly measurable: The pandemic had an impact on what has been directly emitted, but not on the speed of the damage already in motion in terms of particles per million in the atmosphere [1]. Instead, another record high in emission levels was reported recently [2-3]. If large parts of the economy must be rebuilt after the pandemic 'anyway', this opportunity to iron out shortcomings of the pre-pandemic configuration should be used more than has been the case so far. This consideration not only relates to the outdated or missing infrastructure, insufficient security and resilience in energy supply, lacking digitalisation in learning, work-place, administration and processes, as well as the robustness of supply chains, but also to the chance to incorporate environmental and resilience considerations into the vast recovery programmes of, for instance, the European Union and the United States [4-5]. With this, tightened interim climate goals of EU and others [6] and warnings of climate scientists, social expectations are also rising in several dimensions despite the

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pandemic [7]. The most recent report of the Intergovernmental Panel on Climate Change (IPCC) puts it quite clearly: "Urgent action [is] required to deal with increasing risks" [8]. The war in Ukraine and the resulting drastic increase in energy prices, concerns about (energy supply) security, and disrupted global supply chains and markets add another dimension. On the one hand side, this unleashed, notably in Europe, rapid policy action to decrease dependency from fossil energy sources, including even more ambitious goals for energy efficiency and renewable energies, as well as for immediate demand reductions, on the other hand this policy action also promises measures to ease and support reaching these goals [9, 10].

Undoubtedly, a lot needs to be done. However, one of the main findings of the Energy Efficiency Watch Survey EEW4 [11] is, that the levels of energy efficiency improvements continue to be disappointing. This is partly because the question of "Why" to decarbonise remains unanswered for respective stakeholders and is not linked to issues of job and competitive impacts of energy efficiency. This is even more a shame, as those issues are considered to be of highest importance for a majority of stakeholders throughout the EU27, as the survey observes. It thus becomes clear, that the objective of decarbonisation and becoming more energy efficient largely depends on a public narrative, that underlines benefits and cost-saving-advantages in contrast to pure regulation forcing stakeholders to do so. Identifying *factors that potentially drive or motivate stakeholders* hence becomes *vital to plot this new narrative* [11].

1.2. What is known on drivers and motivators and what are limitations?

A bulk of existing literature examines the drivers, motivators and barriers to the adoption of more climate friendly or carbon-emission-reducing technologies and measures; however, they all differ in the way to do so. Sousa Jabbour et al. [12] review literature on the subject and conclude that the most cited factors include primarily political/regulatory and governance measures while technological and market factors are less frequently mentioned. A similar literature review study by Biresselioglu et al. [13] identify drivers (barriers and motivators) affecting European energy transition from different levels of decision-making. They find that motivators to decarbonise prevail at higher levels of decision-making (policymakers and international energy providers) and are more neglected at lower, individual levels. Other studies examine actual drivers by applying business surveys and empirical methods. In a study of 2007, Okereke [14] identifies motivations such as profit, credibility, fiduciary obligation, risk guidance and ethical considerations. Drivers, in contrast, are energy prices, market shifts, regulation and directives, investors pressure and technological change. A third category – barriers – refers to a lack of strong policy framework, uncertainty about governments' actions and uncertainty about the marketplace. Palsson and Kovács [15], Wong and Shahidi [16] and Boiral et al. [17] evaluate why companies from different sectors (transport, construction, manufacturing) and different countries (Sweden, Australia and Canada) reduce their production-related emissions and what the key determinants of those - internal and external – drivers are. They conclude that company strategy (internal) outweighs stakeholder pressure (external) [15], that more stringent standards and rewards (rather external) in combination with respective organisational culture (internal) outweigh fear of penalty (external) [16] and that firms committed to tackling climate change have better financial performance. Economic motivation is not key for a commitment to reduce greenhouse gas (GHG) emissions though, which is more influenced by environmental and social concerns (internal) [17].

The literature thus mainly identifies two determining factors that lead to the decision of companies to become climate friendlier: drivers and motivators (barriers are rather hindering factors and thus not relevant for the research question to be addressed). Okereke [14] (p. 479) defines motivators as factors which "arise more or less directly from the raison d'être of business to maximise profit […;] motivational factors on their

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own are capable of inciting corporations to undertake carbon management actions." Drivers on the other hand are defined as "the factors that have the potential to 'force' corporations to take climate response action even when they would not have ordinarily wanted to do so". However, having identified two overarching determinants, it remains unclear what specific factors fall into these categories for the different sectors of an economy.

Other studies are focusing on motivations that lead to increased Corporate Sustainability (CS) [18] or how (low-cost) business models can profit from increased CS [19]. They identify normative motives such as ecological and social responsibility as the main motivators for increased CS, followed by reputation as well as cost- and risk- management. Shareholder, political and social pressure are ranked least important. Benefits from increasing CS can reach from creating implicit contracts that prevent harmful claims against a company and the ability to transfer risk to suppliers, to helping improve leadership by motivating management and employees. These studies are however limited to the matter of corporate sustainability in general, and thus are not explicitly linked to the current topic of decarbonisation.

1.3. Identifying factors that potentially drive or motivate stakeholders to plot a new narrative

Hence, building and extending on a conference paper presented at the European Council for an Energy Efficient Economy's digital summer study 2021 [20], this article aims at filling the abovementioned gaps by identifying specific factors leading manufacturing industries to decarbonise that can be pooled under the overarching determinants described as drivers and motivators.

The role of the industrial sector is understudied given its significance as it accounts for 28.0 % of final energy consumption, 18.4 % of energy-related emissions and 23.1 % of Germanys overall greenhouse gas emission (GHG) in 2019 [21-23]. Moreover, it essentially determines how future products and components for all other sectors are designed, sourced, and manufactured, as well as how they perform [24] (p.2). Thus, for the identification of factors that drive or motivate stakeholders to decarbonise, it makes sense to take a closer look at the manufacturing industry, specifically how manufacturers operate, decide and act.

Several research questions arise from these considerations and will serve as framework for this article: (1) Why do companies in the industrial/manufacturing sector pledge to decarbonise, (2) what is the range of factors that potentially influence their decision to do so? (3) And is it really environmental consciousness or something else that motivates them?

Doing so, the research ambition is to help gain a better understanding of how to communicate decarbonisation and the multiple benefits arising from it to companies and the respective stakeholders, so that they deliberately choose to adopt appropriate measures.

Understanding what the drivers and motivators, the external pressures as well as internal ambitions are, may facilitate the *plotting of a new narrative* triggering successful decarbonisation and the tailoring of fitting policies that appeal to these factors. Additionally, it may help the development of support schemes that expedite decarbonisation of the industrial sector – without harming the sector's competitiveness or even existence.

A strong and convincing narrative that both breaks the ice from the entrepreneurial perspective by triggering the intrinsic wish to decarbonise (internal ambition) and enables external stakeholders to undertake effective measures to trigger this wish in others (external pressures) is of utmost importance. Such a narrative is especially significant con-

sidering the noticeable but far too limited (and often also narrow) uptake of decarbonisation action, the increasing insecurities in energy and material supply, as well as energy and emission prices.

Identifying effective triggers is hence necessary to make use of the general principles of doing business – the strive to maximise profit. The latter is the difference between income (revenue) and expenditure (costs), with every internal or external action or decision having a positive or negative influence on it. For this reason, companies seek to reflect these variables in a profit function, which aims to identify the decision constellation where the difference between the revenue and cost functions (which reflect the variety of costs and associated revenues arising for each given set of decisions), and thereby the profit, is at its highest (positive) point [25] (pp. 23-26). Since the framework conditions are constantly changing due to internal or external decisions, this constellation leading to the maximum profit is a snapshot and requires a continuous optimisation of the profit function.

The state (or other actors) may intervene in this 'natural' striving for the maximisation of profit when an entrepreneurial action appears problematic or harmful to society by changing the framework conditions [25] (pp. 432-439). This change can either be achieved by the promise of increased/decreased revenue (shifting the revenue function) and/or of increased/decreased cost, risk or hardship (shifting the cost function). Ideally, such an intervention leads to congruence between the behaviour of the company necessary for an optimised profit function and the behaviour that is socially and ecologically desirable or necessary. If this succeeds, the adjustment of behaviour is an intrinsically desired reaction to changed framework conditions; if this fails, it can lead to measures being perceived and encountered as extrinsically 'motivated'. In the latter case, implementation may be reluctant, if it happens at all, resulting in poorer results and demanding more control efforts. To avoid unnecessary control efforts, the goal should therefore be to identify those factors that lead to self-motivated (intrinsically motivated) measures towards the socially desired action.

In this context, the question is: Which ingredient(s) can help shift companies' profit function towards the societally desired and agreed outcome corridor of averting climate disaster and achieving climate neutrality, in which both, business ambitions and the societal desires are met? The ingredient(s) leading to such shift and their individual shifting-intensity (how big of a shift one specific ingredient triggers) may differ significantly from company to company.

To ensure broad applicability of the findings and to identify differences between company types, it is essential to equip the analysis with a quantitative element that assesses weight and ranking order of key motivators across company sizes, industrial sectors, and energy intensities. This data was gathered by the Institute for Energy Efficiency in Production (EEP) in context of its spring 2020 data collection for the Energy Efficiency Index of German Industry (EEI) [26].

Findings will hence not only inform policymakers and the general public but also allow companies to reflect upon the points made in their internal deliberations on whether to decarbonise and how to shape their own decarbonisation strategy.

In order to provide an appropriate basis for the analysis, this article commences by constructing a framework, establishing and explaining the categories of motivators and drivers (Section 3.1-3.2). This framework is then applied to a qualitative case study focusing on the automotive industry (Section 3.3), specifically Bosch, and quantitatively tested across the manufacturing industry (Section 3.4). The quantitative part of the analysis relies on the results of the energy efficiency index of the German industry to examine what *actually* motivates German manufacturing companies to decarbonise, addressing differences in motivating factors depending on company size, sector, energy intensity, supply chain position and decision determinants. After a brief discussion (Section 4), this

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article concludes (Section 5) that motivators generally have the highest motivational relevance in the decision to reduce one's GHG emissions, while external drivers rank by and large below the motivators. Moreover, the results show that positive motivators lead to higher ambition levels than negative (external) drivers. Thus, policy measures that trigger an intrinsic reaction by strengthening the motivators would positively impact ambition levels and probably generate better outcomes than policies applying external pressure.

2. Methodology

As mentioned, the observations and ideas presented in this article are derived from a combination of quantitative and qualitative data. The study builds on observations made during professional interactions with manufacturing companies in Germany concerning energy efficiency and decarbonisation, as well as on media articles about this topic, particularly announcements of climate pledges. The arising assumptions on why companies choose to decarbonise and the range of factors that influence this decision were then tested in the framework of the Energy Efficiency Index of German Industry (EEI). The latter aims to assess the assumed and anecdotally observed drivers and motivators influencing corporate decisions towards decarbonisation.

In reaction to the lack of "targeted energy efficiency analysis" [27], the EEI was introduced in 2013 "as an index for industry as a whole and especially the manufacturing sector". It focuses on intentions, expectations, experiences, opinions, and observations of entrepreneurs from companies of all sizes, energy intensities and across 27 manufacturing sectors. The methodology of the EEI is modelled after the German monthly economic indicator, the ifo-Index [27].

A total of around 674,000 manufacturing companies in Germany created a revenue of nearly 3.43 trillion euros in 2019, employing around 11.61 million people; 198,000 of these companies belong to the most relevant subsectors that EEI focuses on [28].

The EEI data this paper is referring to is comprised of 864 observations gathered in May 2020, which was in-midst of the first wave of the COVID-19 pandemic in Germany, as well as half a year after the September 2019 United Nations Climate Action Summit and the announcement of the much-criticised German climate package [29-30].

Each of EEI's semi-annual data collections has a specific focus on selected current issues. The 1st data collection in 2020 looked predominantly at motivation, prioritisation and intended action of the German manufacturing industry in respect to decarbonisation and in light of the plan of a European Green Deal, aiming at climate neutrality by 2050, announced by the European Commission on 11 December 2019 [26,31].

Among the 18 questions posed to participants of EEI in total, companies were asked to indicate their sector (the one with the largest share of their revenue), revenue, energy consumption and number of employees. This enables cross-referencing and analysis of current-topic questions by these parameters. However, since revenue and energy consumption are often considered confidential, a significant number of respondents chose not to provide these figures or not to respond to some of the other questions asked. Therefore, the number of observations varies between the different EEI questions analysed below.

The data collection was carried out in mixed methods design, combining online (7 %) and telephone surveys (93 %). **Table 1** provides an overview of the sample by company size (as defined by the European Commission [32]). As explained by Buettner et al. [33] (pp. 3-4), we aim for an approximately even distribution across company sizes for EEI's samples instead of following the actual size distribution of manufacturing companies in Germany [28]. This allows us to make statements on all company sizes.

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Table 1. Sample composition by company size (n = 845)

Company size	Number of Employees	Revenue in million EUR	Total population (N)	Observations (n)	Percentage of Sample
Micro	0-9	≤ 2	124,904	186	22.0 %
Small	10-49	> 2 to ≤ 10	52,282	228	27.0 %
Medium	50-249	> 10 to ≤ 50	15,282	248	29.3 %
Large	>249	> 50	5,300	183	21.7 %
Total			197,768	845	100.0 %

Although difficult to achieve, desired was an even distribution across the 27 manufacturing sectors, representing 198,000 companies. Therefore, 'core industries'[1] were defined for the telephone survey, each of which should have at least 24 companies participating. Automotive industries and mechanical engineering are two of the eleven sectors of high importance for German industry. When taking a sectoral viewpoint in this paper, only sectors with at least 20 companies providing answers to the respective questions are considered [33].

The results of micro sectors (N < 10) are taken note of ('**') in case more than 50 % of the sector participated in this study; results of small sectors (10 ≤ N < 100) are taken note of ('*') if at least 15% of the sector participated [33].

The sectors themselves are coded according to the '*Klassifikation der Wirtschaftszweige 2008*', which is the German implementation of the *Nomenclature générale des activités économiques dans les Communautés Européennes*' (engl.: General Industrial Classification of Economic Activities within the European Communities), NACE, whose use is mandatory in the European Union and in compliance with the *United Nations' International standard industrial classification of all economic activities*, ISIC [33-36]. Three participants selected other sectors than those in focus and are hence excluded from further analysis, four further observations are considered manufacturing but were not able to self-assign to one of the sectors. These four are considered in the general, but not in the sector-specific analysis, reducing the sample size to 861.

In context of the questionnaire, companies are requested to indicate whether they respond on behalf of one specific site or their overall company. Of the 861 observations remaining, 659 refer to multiple sites (the whole company) and 199 to one specific site, 3 remain undeclared. What percentage of the total population (number of companies) of a sector participated is illustrated in **Table 2.** In very small sectors, such as the "crude petroleum and natural gas" sector (06), the percentage may appear to exceed 100 %. In this case, all 13 responses refer to one specific site; the same is the case for 6 out of 8 observations of the "mining of coal and lignite" sector (05), leading to the assumption that the majority (n(N) ≥ 50 %) of companies in both sectors participated and thus allowing for the inclusion of their results in the analysis.

Table 2. Sample composition by sector (n=864)

NACE Code	Sector	Total population (N)	Observations (n)	Percentage n (N)
05 **	Mining of coal and lignite	~	8	~
06 **	Extraction of crude petroleum and natural gas	5	13	260.0%
08	Other mining and quarrying	1,438	12	0.8%

[1] [1] 'Core industries' are the eleven sectors that have most economic weight in Germany (NACE code in brakets, sorted by Code): leather- (15), wood & cork- (16), paper- (17), chemical- (20) rubber & plastics- (22), non-metallic minerals- (23), basic metals- (24), fabricated metals- (25), electrical equipment- (27), machinery & equipment- (28) and motor vehicle (29) industries.

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10	Manufacture of food products	26,897	31	0.1%
11	Manufacture of beverages	2,435	19	0.8%
12	Manufacture of tobacco products	62	8	12.9%
13	Manufacture of textiles	4,637	18	0.4%
14	Manufacture of wearing apparel	3,306	14	0.4%
15	Manufacture of leather and related products	1,371	34	2.5%
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	12,944	39	0.3%
17	Manufacture of paper and paper products	1,558	53	3.4%
18	Printing and reproduction of recorded media	10,986	24	0.2%
19	Manufacture of coke and refined petroleum products	89	13	14.6%
20	Manufacture of chemicals and chemical products	3,280	48	1.5%
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	554	26	4.7%
22	Manufacture of rubber and plastic products	7,090	64	0.9%
23	Manufacture of other non-metallic mineral products	9,908	44	0.4%
24	Manufacture of basic metals	2,374	42	1.8%
25	Manufacture of fabricated metal products, except machinery and equipment	44,106	64	0.1%
26	Manufacture of computer, electronic and optical products	7,935	21	0.3%
27	Manufacture of electrical equipment	6,036	67	1.1%
28	Manufacture of machinery and equipment n.e.c.	15,964	72	0.5%
29	Manufacture of motor vehicles, trailers and semi-trailers	2,769	49	1.8%
30	Manufacture of other transport equipment	1,276	15	1.2%
31	Manufacture of furniture	10,826	29	0.3%
32	Other manufacturing	19,985	30	0.2%
99	Other		7	
	Total	197,831	864	0.4%

* small sector ($10 \leq N < 100$) with at least 15% of total population (N) participating; ** micro sector ($N < 10$) with at least 50% of N participating, ~ figures not disclosed in official statistic due to small sector size and associated confidentiality issues.

Assuming that both stance and envisaged action of a company in respect to decarbonisation activities differ depending on its energy intensity, the latter was computed for each company (if possible), and clustered into five intensity classes (not-, less-, moderately-, energy-intensive, very energy-intensive) [33].

The "energy intensity" variable is calculated as the ratio between the energy used and the revenue of a company. The "energy use" variable contains information on the overall energy demand of a company (converted) in MWh, while the variable "revenue" provides information on the revenue of a company during the previous financial year in million euros [33]. Executing this operation, the range of results is wide, counting 656 cases and extending from 0.0111 to over 10,000 Watthours consumed per euro of revenue (Wh/EUR) for this sample.

The distribution of observations across the five energy intensity classes is illustrated in **Table 3**. The lower the class of variable energy intensity, the higher the energy productivity level of a company – and reverse. Energy efficiency is an essential measure to increase energy productivity [33]. As only twenty of the energy intensity observations fall into the fifth class, there are just enough cases ($n \geq 20$) to include this class in the analysis

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conducted on the EEP 2020/1 survey data. In whatever analysis the figure drops beneath 20 observations only the lower four energy intensity classes remain.

Table 3. Sample composition by energy intensity (n = 656)

Energy Intensity Class	Energy Intensity Interval	Observations	Percentage
not energy intensive	0 to < 10 Wh/EUR	151	23.0 %
less energy intensive	10 to < 100 Wh/EUR	243	37.0 %
moderately energy intensive	100 to < 1,000 Wh/EUR	198	30.2 %
energy intensive	1,000 to < 10,000 Wh/EUR	44	6.7 %
very energy intensive	≥ 10,000 Wh/EUR	20	3.1 %
Total		656	100.0 %

3. Results

3.1. Why decarbonise: What factors influence the decision to decarbonise?

The number of companies pledging to comply with the Paris climate goals is steadily increasing, as are those that announce climate, carbon neutrality or net-zero goals for diverse target years. What set of triggers leads these companies to take the decision to decarbonise in the first place? As pointed out by Buettner et al [33] (p.17), "the understanding [..] which factors, besides regulation and carbon tax, play a role in the decision to decarbonise, is essential to tailor schemes and services appealing to these trigger points. Of similar relevance is the (relative) weighting of the individual factors."

To address this question, this article aims to identify drivers and motivators that potentially influence such decisions. As explained in the literature review, drivers can be understood as mainly external pressure points that indirectly trigger, sometimes even force companies to take action. Motivators on the other hand are rather defined as internal considerations which can reach from purely business orientated profit maximising/business survival issues to more abstract value-based determinants that are not as trivial to identify. Experiencing pressure (may it result from a driver or motivator) on a specific point can positively or negatively affect an underlying need, core value or ethic of either the person in charge or what the person in charge is measured by. However, since the publication of the relevant literature by scholars such as Okereke [14] on drivers and motivators, more than a decade has passed in which economic conditions, environmental considerations, as well as business culture have changed, necessitating a re-examination.

Recent announcements to become climate neutral (or carbon neutral) may initially be perceived as if environmental consciousness was the dominating motivation, but actually serve other underlying needs, intentions, values or strategies or result out of external pressure. Thus, establishing what these underlying factors are nowadays will help to (a) understand how companies which have not yet come forward with decarbonisation plans can be triggered to do so, and (b) inform supporting bodies on how and where they can help best.

In summary, understanding the underlying needs, values and considerations, as well as external pressures allows to tailor subsequent activities to trigger an effective reaction that is satisfying the needs of the company, as well as to reach the societally desired outcomes, ideally in a win-win manner. Unleashing such 'change through anticipative steering' (#CTAS) [37] hence builds on identifying pressure points (drivers) and subtle triggers (motivators).

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3.2. What are the pressure points, the negative (external) drivers?

Having discussed the relevance of understanding the underlying pressure point(s) for triggering effective reactions, this section will present and explain the nine most significant negative (external) drivers:

(a) Being **able to sell one's products** is perhaps the core need of any company. Whilst the question of how these products came into existence was rarely focused on in the past, **public and regulatory scrutiny** direct more and more attention to this aspect now and hence urge manufacturers to follow suit. While the spotlight was predominantly on sweatshops and child labour [38] in the late 20th century, fair trade aspects [39] have moved into focus in the early 21st century. In recent years, however, the focus has gradually shifted towards environmental aspects, such as local pollution caused in harvesting natural resources, for example lithium [40] (crucially important for batteries and e-mobility), deforestation of rainforest to create space for soy [41], or rapeseed being planted for biofuels instead of eatable crops [42].

(b) Not only do these direct causalities constitute pressure points that are potentially very **harmful to a company's reputation** and success - increasingly, also **indirect factors** are **becoming a cause of concern**. The multi-facetted German brand SIEMENS was hit by a PR-disaster in early 2020 in context of its activities as supplier of railway signals. Whilst in other circumstances this would have been good news considering railways are seen as a comparably environmentally friendly mode of transport, SIEMENS faced calls for boycott as these signals were to manoeuvre trains to a new coal mine in Australia that was much debated from an environmental perspective [43-44].

(c) The EU commission's proposal for a new **supply chain regulation** makes the manufacturer legally and financially responsible for what happens (or not) in its supply-chain, wherever it begins, adding a significant need for caution on top of the PR (and sales) perspective [45]. This proposed EU directive is reaching further than the German one, that comes into force in 2023 already [45-46]. However, respecting these requirements is not an easy undertaking considering how fragmented and multi-layered supply chains have become in the past decades. This applies similarly to the measures envisaged by the EU's sustainable products initiative, for which "product-specific information requirements will ensure consumers know the environmental impacts of their purchases" thanks to "Digital Product Passports" facilitating repairs, recycling and the tracking of relevant substances along the supply chain [47]. A pragmatic approach, which implies only checking the directly preceding and succeeding supply chain actors and contractually binding these to the same regulatory standards, may work as long as these companies are themselves falling under the regulation (geographically).

(d) Unsurprisingly, all these points also have an impact on the **attractiveness of a company as an employer**. Whilst unemployment rose in general due to the COVID-19 pandemic, many thousand positions remain vacant in German manufacturing. From an academic viewpoint, open positions exceeding applicants is called 'employee's market'. This gives applicants and employees a stronger position as they constitute a 'scarce good' during periods and in sectors with a shortage of skilled personnel [48]. In an environment where skilled applicants can choose with whom to sign a contract, the preferences and expectations of new recruits and the existing workforce matter more than usual to a company if it wants to attract new personnel and retain existing employees. According to a McKinsey study, the sustainability (ethos) of a future employer has a higher importance to – in most cases – young graduates than starting salary or job security, similarly, a YouGov online poll found that, of existing workforce, 68 % consider sustainability efforts of their employer as important [49-50].

(e) From a **re-financing perspective**, pressure is also on the rise, particularly for companies in shareholder-ownership. Around the 2019 UN Climate Summit in New York, investors clarified their position in relation to divestment and complying with the

goals set out in the Paris Climate Agreement [51]. Similarly, in his 2021 "Letter to Shareholders", Larry Finkman – chairman of Blackrock – announced the commitment to climate issues including temperature alignment goals in Blackrock's investment portfolios [52]. This position is not ideologically driven – it follows the general notion that (long-term) investors have a responsibility for the assets they have been trusted with, meaning they cannot justify investing these into **business models** that have a known **expiry date** (i.e., coal power plants in countries that have announced to phase out coal). The thinking behind is that investments with an outdated or no-longer working business model will lose in value or become a so-called stranded investments (which means their value drops towards zero) – and therefore are toxic to (continue to) knowingly invest in.

(f) Initial investments aside, shareholders do have a say on the strategy and approaches taken by companies. Once the share of investors following the aforementioned ethos or ideologically supporting climate action reaches the **majority of shares**, strategy changes and climate goals can be put in place against the will of the company leadership. A recent example is the US oil company EXXON, where a coalition of activist investors was successful in electing at least two climate-friendly directors to the board of the energy behemoth [53].

(g) Further, in late 2020, investors have sent a letter to Europe's largest companies warning them to disclose **climate related risks**, as these can significantly impact a company's success [54]. In 2019, for instance, BASF faced significant problems regarding their production since the water level of the Rhine River was too low to allow goods to be transported via barges [55]. This situation at present, in the summer of 2022, is even more severe causing difficulties in the supply (and the associated transport cost) of raw materials and fuels, the low water levels, are not sufficient to cool nuclear and coal power stations and operate hydro power hence leading to reduced energy generation and subsequently energy cost increases or involuntary shutdowns [56, 57]. Similarly, in the food industry, droughts can have a severe impact on (the price of) crops needed for products. Moreover, for companies requiring significant amounts of water, i.e., for paint shops and battery plants, water usage curfews may negatively impact their output.

(h) With globalisation, focusing on core strengths and specialisation, many companies have outsourced parts of their production, leading – in some sectors – to a **low vertical range of manufacture** among the so-called Original Equipment Manufacturers (OEMs). This means that components are – at large – only assembled, painted, tested and wrapped for delivery to the end customer. Consequently, only very **little of the emission footprint** of the product actually lies **within the direct control** of OEMs. In the automotive industry, for example, the direct emission footprint of a car manufacturer for a car sold to the customer, can be as low as 5 % of the total carbon footprint (of which the painting process causes the majority) [58-60]. Whilst outsourcing and specialisation has in general been advantageous (in terms of economies of scale, focusing on core strengths and comparative cost advantages), it can now become a burden when a company aims to identify its Scope 3 emissions[2] or its product carbon footprint[3]. Even more so if it wants to reduce these footprints. This is a severe issue as, according to McKinsey, "only 2 percent of companies have visibility into their supply base beyond the second tier" [63] and according to the 2nd iteration of the Energy Efficiency Index of German Industry in 2021, 75 % of participating companies plan to decarbonise their Scope 3 emissions, 70 % even strive to be able to offer products with a net-zero footprint, leading to already 38 % of companies already adding emission-footprint related requirements to their contracts with suppliers to achieve this goal. Among the companies aiming for a

[2] [2] Scope 3 emissions are indirect emissions of the up- and downstream supply chains (excluding indirect emissions arising from the generation of energy purchased, which are Scope 2) [61], as well as for instance commute, waste and business travel.

[3] [3] The Product Carbon Footprint (PCF) "represents the sum of all carbon dioxide emissions (measured in CO_2) and greenhouse gas emissions (measured in CO_2-equivalents, CO_2-eq) caused directly and indirectly by [..] a product [..] over a defined period of time or over its life cycle." [62].

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net-zero product carbon footprint (PCF) it is nearly every second one that does impose such requirements (45 %), twice as many as among companies that do not aim for a net zero PCF (21 %). [64].

(i) Therefore, not only **rising energy prices** [65], but also **increasing emission charges** [66] present an economic incentive for companies to take action to reduce cost risks and regain competitiveness through energy efficiency and decarbonisation measures. This is especially the case when lower emission intensity or even net zero PCF is desired by either the company itself, its downstream supply chain/clients or legislators.

(j) Other, non-climate related pressure points such as the **futureproofing** of the business model and product portfolio, as well as a general **supply chain security** have become an increasing cause of concern:

At times broken lines of supply during the pandemic and cases such as the cargo ship *Ever Given* being stuck and blocking off the Suez Canal [67-68] had serious **ripple effects** on the global flow of goods. The war in Ukraine, the effects of the Shanghai lockdown [69] and ongoing supply shortages in several industries [70] underlines that the turmoil caused by the initial wave of the pandemic and the *Ever Given* were not just unfortunate one-off turbulences but are something a business should better be prepared for (for instance by diversifying supply, increasing the 'buffer-storage' of required goods and materials, and buying local). This preparedness extends both to price and general availability of energy, goods and resources. The less of these are needed (due to efficiency gains, local sourcing, and circularity efforts), the lower the exposure in absolute terms.

In brief, there are ten negative (external) pressure point, which are of relevance in the decision-making process on whether to decarbonise. Namely, these pressure points are (a) the ability to sell one's product, (b) company reputation, (c) supply chain regulation, (d) attractiveness as an employer, (e) re-financing perspective, (f) shareholder pressure, (g) climate-related risks, (h) direct control over one's carbon footprint, along with (i) energy- and emission cost risks and (j) supply chain security. However, the precise impact of each of these negative (external) drivers depends on the political, economic and societal circumstances and setting of a company.

3.3. What are the assumed motivations, strategic considerations and benefits?

After having established the points pressure is applied to – the (negative) external drivers – in the previous section (3.2.), this section switches perspective and analyses possible motivations, (strategic) considerations and assumed benefits of an early mover that announced ambitious and short-term goals before it became a trend to do so.

The announcement of Bosch on 9 May 2019 to become carbon neutral by 2020 [71] appeared to come out of the blue – ahead of the European Parliament elections (23-26 May 2019) with a land slide gain in support for the Greens, the UN's New York climate summit (23 September 2019) with climate pledges and packages from many stakeholders, as well as the peak of attention for Fridays for Future so far and the European Green Deal (11 December 2019) [31]. According to the press announcement, this commitment secured Bosch the "earliest carbon neutrality of any global industrial enterprise" [71].

With "Bosch's carbon-neutral initiative [which at that time was] unprecedented in scope and timeframe" [71], the company – that is owned by the charitable Robert Bosch Foundation, and hence bound to its values – succeeded in **displaying leadership** in an issue of increasing global and societal relevance after climate scientists called for urgent action (08 October 2018) [72].

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3.3.1 Taking initiative and leadership in climate action has several effects

While such an action does come with risks, as is the case for most early adopters, it also awards the **first mover advantage**, the 'pole-position' in all benefits associated. It allows one to shape the narrative and to have the near exclusive benefit of the arising publicity, with the possibility of associating such a move with the company's name or one of its products if it proves to be an innovative pioneer (in context of this article: a decarbonisation frontrunner). In this way, Sony's Walkman became the generic name for mobile cassette players, "to google" a common expression for searching for something in an internet search engine, a Hoover a synonym for a vacuum cleaner or a Xerox for a photocopier [73,74]. These are just a few examples of many. However, it is not necessarily enough to be the first, but to set a new standard, i.e., to be the first to do it so well - or in such an innovative way. Apple, for example, was not the first to offer smartphones with touchscreens, but set the standard with its incomparable "simplicity", which has become synonymous with the brand [75]. This is where successful communication at an early stage is crucial:

What is known as **near-exclusive PR** describes the situation where the first mover will have a period of unparted attention, and anyone who follows second and third only receives lower levels of attention (if sticking to the same media formats).

When taking a far-reaching step as a first or early adopter, one achieves several things: firstly, being **on top of the game** and daring to address challenges head-on; secondly, giving the impression of striving for **innovative approaches** and **future-proofing** the business. Especially the latter point relates to the fact that the innovativeness of one company **imposes significant pressure on all immediate competitors**. For Bosch, being a globally active supplier to (in large parts) the automotive industry, future-proofing appears to be of high strategic importance in the midst of a disrupted automotive sector. No manufacturer wants to share the fate of Nokia, which lost its spot as world market leader for mobile phones and vanished from the market within only a few years when it missed the shift towards touchscreen-operated smart phones [76].

As mentioned before, there is scarcity of skilled personnel; according to the Ifo-Institute, every second company is affected with the outlook of further worsening [77]. In light of the McKinsey study and the YouGov poll referred to earlier [49], it appears crucial to appear climate conscious, innovative, socially responsible and future-proof to **attract skilled personnel or graduates** [50] – and being able to do this earlier than competitors make this aspect also a motivator

Apart from sector disruptions, peer- and recruiting pressure, pressure imposed by customers can play a large role. Besides end-customers, these are large original equipment manufacturers and brands that have a tremendous market power. This power allows them to basically determine the standards and specifications for parts that are later used to assemble the end-product. It is needless to say that – unless it is a very specific niche-product – such market power also comes along with significant price pressure (for instance milk prices secured by large supermarket chains). Such **supply-chain pressure** is increasingly applied by car manufacturers on their supply chain in respect of the environmental performance of pre-products: Daimler, Volkswagen and others push the decarbonisation agenda and suppliers, such as Bosch and Continental have to fall in line if they are not already acting proactively [78]. The associated motivation is to be 'ahead of the game' so that when such pressures are being imposed one's company is not hit unprepared, illustrating how thin the line between drivers and motivator is.

The supply chain aspect, in combination with client expectations [and regulatory requirements] makes the situation particularly complex in, for instance, the automotive industry.

3.3.2 Example: The impact of interdependencies on decarbonisation in the automotive sector

Following the Diesel scandal, many manufacturers and suppliers both pledged climate goals and a shift of their model range more and more towards non-combustion engine driven vehicles. The vulnerable point of combustion engine driven vehicles is that they (mostly) run on fossil fuels and emit – especially diesel engines – harmful particulates and fine dust. Conversely, for electric vehicles the weak point is the limited distance that can be traversed with one charge, in combination with the much longer 'refilling' time and the availability of charging stations. The larger the battery the longer the range – assuming an already optimized drive train and consumers.

However, batteries require comparatively large quantities of lithium, the mining of which can also be quite harmful to the environment [40]. The environmental damage done by the mining activities to acquire Lithium (or other rare earths and raw materials) is unquestionably an issue, irrespective of the decarbonisation efforts on one own's direct carbon footprint (this is on-site emissions, Scope 1) and choice of energy sources (these are indirect emissions associated with energy purchased, Scope 2), which are exclusively under one's control [61], thus leading to public criticism [79].

A viable solution to address this was the announcement by, for instance, Volkswagen that their first mass market electric vehicle ID.3 will have a footprint of **(net) zero carbon at the point of handover** [80]. To understand the scope and implications of this announcement, it is necessary to understand the nowadays low production depth and the subsequently vast range of suppliers and sub-suppliers. This means, that except for design, testing, assembly, and painting, few production steps take place at site of the vehicle manufacturer. In aggregate, this may be around 15 % of the vehicle's total production footprint (two thirds of these energy-related scope 2 emissions, one third process related scope 1 emissions [60]). Since, in turn, around 85 % of the footprint are emitted by the supply chain [58] (p.6), manufacturers have a strong interest not to carry the 'net zero' costs (alone). Whilst they may initially achieve such net-zero footprint through compensation, there is a strong financial incentive for manufacturers to pass the responsibility down to the supply chain as much as possible (as it is in fact done by Volkswagen via contractual requirements and certified climate protection projects [80]). The same applies to the suppliers, and subsequently their suppliers until the beginning of the chain.

While large suppliers – such as Bosch – have taken the step to decarbonise their operations proactively, many others, smaller companies, and competitors have not done so – not yet. This is an issue we will get back to. Smaller suppliers are faced with the triple issue that (a) they may not have the capacity, knowledge, and assets to take the decarbonisation decision easily, (b) they cannot be certain that their product range will survive the disruption of the sector and (c) they cannot take action as long as it remains undefined what changes to the product range (and hence production machinery and associated processes) are desired by their clients resulting from this disruption [78,81].

Therefore, as pointed out by Buettner et al [33] (pp.16-17), particularly small companies and energy intensive companies, which have a large footprint due to their processes, need assistance.

The European Emission Trading System ETS only applies to what happens within the European Union (in some particularly emission-intensive sectors and energy generation) and, furthermore, has exemptions in place for some sectors to avoid them from leaving Europe due to their emission intensity which would also cause 'carbon leakage', meaning the emissions remain but happen elsewhere [82]. The German national emission price on the embodied carbon emissions of other primary energy sources, which are not covered by ETS already, only applies to companies' manufacturing sites in Germany. A European Carbon Border Tax/Adjustment may never come, due to the concerns of the World Trade Association and other countries [83].

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However, the question remains why suppliers from outside Germany, respectively outside the European Union, may still have to undertake steps towards emission reductions?

1. According to World Bank, the number of countries and regions working on or having implemented a carbon pricing scheme has risen to 22,3 % of global GHG emissions in 2020. This is about 8 % more than in 2019 [84] and the world's largest emitter, China, has also announced that it considers introducing some sort of carbon pricing [85], which it has launched in the meantime. Whether we are on a way to a global price for carbon, as called for by US climate envoy John Kerry [86] , or whether there will be a carbon border tax scheme between countries with such a scheme and those without is a different question, but not of relevance here. Similarly, having a scheme in place does not automatically lead to having a noticeable effect as it was the case with the EU ETS until a reform of the scheme in 2017 [87]. In September 2022, the global carbon pricing initiatives represent 23.11°% of global GHG emissions [84].
2. Particularly for companies in countries or regions, where societal and legal expectations for tackling climate change and reducing emissions are high, it may be quite disadvantageous and costly not to conform. In particular, the company's image might be harmed and there may be boycotts if it does not apply high standards even outside its stricter home region. The example of Siemens's railway signals alludes to this dynamic. The German supply chain law and the European supply chain regulation in development further tighten the options to deviate [45,46,88].
3. There are a number of precedents that underline that a tough standard in one market of a critical size can lead to a general adoption of that standard even if it is not required elsewhere. This is the case as pursuing different standards at the same time would (a) contradict the principles of the economies of scale in terms of costs of production, acquiring parts, etc. and (b) it may only work for a limited period of time to sell a product of a lesser standard. Nevertheless, the validity of the latter point largely depends on the product in question. A prominent example has been the strict environmental standards on combustion engines imposed by the State of California (ca. 80 million people) that then became the quasi-standard for the United States as a whole (ca. 330 million people) [89]. Later, this phenomenon became known as the "California effect" [90].
4. Due to globalised supply chains, however, requirements of the client (car manufacturers in this example) may be the ultimate reason to act – irrespective of the country one is manufacturing in. Unless being supplier of a very specialised or of a niche product, the client company determines what it purchases and to what terms. The supplier will have to comply if it does not want to be replaced by a 'more willing' competitor. The longer a supplier waits to take action, the harder it may become to pass costs of the transition on via its product price.

Thus, irrespective of whether OEMs or regulators define a quasi (global) standard only legally binding in some geographies, there is little chance for suppliers (that wish to remain suppliers) not to pursue decarbonisation. This holds true even in cases where carbon pricing or adjustment schemes may not (directly) affect one's manufacturing if the company at the top end of the chain decides on (net) carbon or climate neutrality of their product at the point of handover.

A question that should be monitored is to what extent the supply industry is supported in such a transition or "merely" forced to act. On the one hand, **supportive approaches** such as decarbonisation networks in the supply chain and capacity building programmes can accelerate the process and thus shorten the period in which car manufacturers have to take on the burden of offsetting the remaining emissions. On the other hand, changing **requirements in** progressively renewed **supply contracts** can force a reduction of the GHG emissions embedded in upstream products. While this would lead

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to the same outcome for the car manufacturer as in the previous case, it would also be left up to the supplier to decide how and whether to achieve this, including the corresponding consequences. The approach taken can have a significant impact on the speed and ability of supply chains to decarbonise, as well as on the survival of indigenous suppliers.

The points made largely and generally apply to many different sectors, even though this example focuses on the automotive industry – the more globalised, the more present in daily life the product is, the more the points made are likely to apply. The results of the second data collection of the Energy Efficiency Index of German Industry (EEI) 2021 [64] show sectoral patterns regarding the paths followed as well as a connection between what is experienced and what is done: 60 % of the participating companies in the computer and electronics industry (sector 26) make requirements in supply contracts and 64 % of them stated that they are confronted with requirements in supply contracts (across all companies: 38/32 %). Of the manufacturers of metal products (sector 25), 39 % work with their suppliers through decarbonisation networks and 42 % of them report that their customers do the same with them (across all companies: 26/ 22 %).

Most companies depend on loans or investments made available by banks or (long-term) investors to fund the set-up or change of operations, if not the operations in general. As indicated with the pressure points (see section 3.2), **remaining attractive to investors,** which increasingly abandon non-futureproof business models, is a critical factor for companies. 100 banks and long-term investors managing approximately 4 trillion dollars of assets voluntarily subscribed to the 'energy efficiency financing principles of G20 participating countries', its associated bank statement, and UNEPs Principles for Responsible Investment around the World Climate Conference 2015 in Paris (COP21). The share of global investors who place a high(er) **emphasis on sustainability aspects in financing requests has increased significantly** since then [91-92]. Two legislative frameworks of the European Union put further pressure – but also offer opportunities – on the issue of access to funding: The so-called EU taxonomy regulation (EU)2020/852 is meant to aide identifying sustainable activities and thus to help financing sustainable growth within the European green deal [93]. The non-financial reporting directive 2014/95/EU "require[s] large companies to publish regular reports on the social and environmental impacts of their activities" [94]. Even though strictly speaking of a non-financial nature, company sustainability/energy managers consider their Corporate Social Responsibility reports (CSR) more than an obligatory exercise. In fact, managers of two companies interviewed in 2020 consider CSR reports as essential means to present their pledges and associated activities to remain investable. Wang and Buettner [95] describe further how sustainability key performance indicators (KPIs) within CSR reports can become a motivating vehicle for sustainable transformation of businesses.

3.3.3 Economic rationality: The perhaps strongest and most immediate motivation

Bosch [71] explained they would invest 2 billion Euros by 2030 to become carbon neutral by 2020. Nonetheless, it would essentially only cost them 1 billion Euros due to the savings achieved through energy efficiency and other interventions reducing costs.

To manage a full net carbon neutrality by 2020 – in Bosch' case within 20 months – a number of phases need to run in parallel. After a full assessment of the status quo in terms of emissions and means to structurally avoid them, it is necessary to swiftly change all sources of energy (economically) feasible to sustainable sources and offset the remaining emissions through the purchase of carbon credits. This is significant as technical interventions, such as energy efficiency measures, local self-generation of renewable energy and means to buffer store surplus energy must first be thoroughly planned, then approved by the authorities and finally be built/installed, tested and brought online. Consequently, over time, energy use will be successively more efficient and the

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amount of energy generated locally will increase in a manner which means that less sustainable energy needs to be purchased-in and/or less emission certificates will be required. In summary, while neutrality is achieved almost instantly, the way it is achieved will gradually change and become cheaper. Specifically, efficiency upgrades will have paid off at one point and the cost savings of energy generated on-site will exceed the investment and maintenance costs. The higher energy and/or emission prices are the quicker this will be the case.

Instead of (exclusively) paying others for energy supply and security, companies have the chance of **vertical internalisation**, meaning that they can get a number of these steps into their balance sheet envelope. For example, the costs of generation, procurement, transmission, and the margin that energy suppliers would otherwise have received can be internalised.

As described, the *easiest* means to expedite decarbonisation is **switching the energy tariff** to a green (or blue) energy tariff and to **compensate/offset remaining emissions –** at least it appears that way. In fact, the trick is in the detail and the overall picture, making it only supposedly simple: In 2019 about 43 % of German electricity came from renewable sources, but the industrial sector alone accounts for about 46 % of German electricity consumption [96,97]. Therefore, even without sectoral coupling (electrification), e-mobility and decarbonisation of industrial processes through green hydrogen, the demand for sustainable electricity will quickly exceed the supply. Roughly estimated based on EEI data [26], the additional renewable energy demand of industry by 2025 would be equivalent with a 25 % increase of renewable energy generation compared to 2019 if companies are (able to) decarbonise their operations as indicated in the survey [98]. Typically, a demand overshoot at least leads to sharp price increases (see for instance the price peak when the Texan energy system collapsed in early 2021) or even to no sustainable energy tariffs being accessible to new clients for the time being [99]. Additionally, as the market for renewable energy is swiped empty in such scenario, the GHG footprint of the standard tariff of everyone else will worsen leading to a societal zero-sum game as long as no substantial additional renewable generation is put in place, either on-site or attached to the grid.

Similarly, the number of and price charged by decent compensation schemes or certificates will increase in a situation of demand overshoot. Further, the risk that chosen schemes backfire increases as one needs to thoroughly assess how the compensation is done to avoid negative PR over questionable or even fraudulent compensation measures. For instance, burning down rainforest to make space to plant new trees, ensuring that planted trees will never be chopped down, or ensuring certificates are correctly computed [100] and newly protected forests were actually endangered [101].

Particularly (a) the steep increase of the European ETS price (from around 25 EUR per tonne of CO_2-equivalent in October 2020 to around 75 EUR in September 2022 [102]) since the EU raised its climate-protection ambitions for 2030 from a 40 % to 55 % emission reduction compared to 1990, (b) the introduction of the German emission price in January 2021, as well as reports that (c) ETS may become a playball to speculators encourage to take decisive 'counter measures' [103]. Thus, building one's decarbonisation strategy only on these supposedly simple measures may backfire in terms of cost, availability, or PR risks.

Therefore, timely action – be it through early acquisition and long-term contracts and/or through local efficiency upgrades and self-generation – constitutes an **early disconnect from increasing cost and supply shocks** and allows companies to gain control over energy and emission related risks & costs.

The outcome of these actions is a **reduction of payments to 'others'** in terms of the general cost of energy. The more of the decarbonisation activities are taking place locally or are secured through long-term contracts (including options and futures), the more this applies. Furthermore, the higher emission- or energy prices are, the higher the costs of inaction would be and the quicker countermeasures that were undertaken pay off.

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Instead of buying emission certificates, investing into external compensation schemes, or paying for ETS or other emission price schemes outright, **setting up one's own compensation scheme** could be an interesting option for manufacturers of some types of products. Specifically, it has the potential to internalise functions and thus disconnect from price, PR, and availability shocks. This could be similar to the approach taken in energy efficiency obligation schemes, where energy providers need to ensure to save a certain percentage of their annual energy sold in the form of energy efficiency activities [104]. An example would be scrappage schemes where customers are asked to provide the specifications of their current fridge, to get a substantial rebate on a more energy efficient fridge acquired through the shop of the energy provider. In this case, the energy provider can claim the energy consumption difference for a typical use case as energy efficiency saving in context of its energy efficiency obligation. Typically, a provider would have a small range of replacement products on offer, allowing them to secure bulk-purchase prices and hence reduce the acquisition costs and the net cost of their scrappage scheme. Although it might be farfetched to transfer this idea to manufacturers and it would require thorough compliance-checks to count as compensation measure, self-initiated scrappage schemes using their own range of products could potentially save on emissions. Moreover, such schemes could lead to an increase end-use energy efficiency, have lower costs than external solutions and be beneficial for one owns economies of scale. For other types of products, it may be feasible to use them in external aid-based compensation projects and gain good press from doing so.

As described, optimising the energy consumption, internalising value creation, and generating energy on-site – in summary local decarbonisation action – not only saves money and builds resilience against external shocks, it also leads to **improved energy productivity, as well as increased competitiveness and resilience**.

Having successfully found a route to become, i.e., (net) carbon neutral comes along with much knowledge gained on the options, but also aspects that went well and those one would do differently. In the language of human resources, the company will have gained specific human capital. While a decarbonisation approach evolves even after net carbon neutrality is reached, there is the option to make use of the capacity built to **get paid for showing others** how to replicate becoming carbon neutral (as Bosch now does via Bosch Climate Solutions).

To conclude section 3.3, what most strategy-related announcements have in common is that **the timing matters**. So why did Bosch choose to announce their goal to become net zero carbon by 2020 at this point, why at all and what might have been the motivations behind such a decision? Whilst the real motivations are only known to those who took the decision, there are a series of indications that *might* have played a role, that are *likely* to have played a role and that Bosch *declared* have played a role.

On 23 May 2019, exactly two weeks after the carbon neutrality pledge, it was announced that Bosch was being fined 90 million Euros for its involvement in the *Diesel scandal* [105]. Before being fined there was an investigation by the relevant authorities, which usually takes months if not years. Even if it was not yet known by Bosch at the time, when and what fine they would be faced with, it is rather likely that they knew something was coming in the near future. This allowed them to pre-emptively take the bull by the horns, meaning they were able to make a move before the bad news became publicly known. As numerous examples by other companies involved showcase, the sequence of events makes a huge psychological and PR difference: those that are found guilty and who promised to do better are not appearing as genuine as those who have promised better before they were found guilty [106].

What is known, and also visible here, is that it is often strong exogenic factors or incidents that drive or trigger organisational change [107]. The Diesel scandal *may* have played a strong role for Bosch, as probably have many of the other factors described. Similarly, Volkswagen, with its dozen brands, would have probably not taken the most

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drastic choice of all large manufacturers towards e-mobility and zero carbon vehicles (at the point of handover) [108] without having been at the centre of the scandal [106]. However, whether these measures were put in place to pre-empt external pressures from unfolding their full weight or to reduce upcoming pressure early on can ultimately only be answered by those who were involved.

Driver of such organisational change, i.e., declaring to become climate or carbon neutral, can be one single or a combination of triggers. What has been uncovered in the analysis thus far is a set of pressure points and possible triggers, derived from findings of various disciplines, observations, anecdotal first-hand experience and news articles.

The following section is therefore taking a closer look at what companies are ready to disclose with regard to what actually motivates them most to reduce their greenhouse gas footprint.

3.4. Why decarbonise? What motivates companies most to decarbonise?

In the framework of the first iteration of the Energy Efficiency Index of German Industry (EEI) in 2020 [26], companies were presented with seven potential factors leading to a decarbonisation decision. These are derived from what has been discussed in chapter three so far, as it was necessary to limit the answer options to facilitate the telephone-based market research component: customer requirements, investor requirements, government requirements, image improvement (for instance attraction of skilled workers, or displaying leadership role), corporate social responsibility (CSR), long-term economic advantages and reduction of cost risks. Some of those factors can be classified as (external) drivers, such as customer-, government- and investor requirements and cost risks. Other are rather classified as motivators, such as long-term economic advantages, image improvements and corporate social responsibility. Companies were asked to indicate which (up to) 3 factors motivate their company *most* to reduce their greenhouse gas emissions.

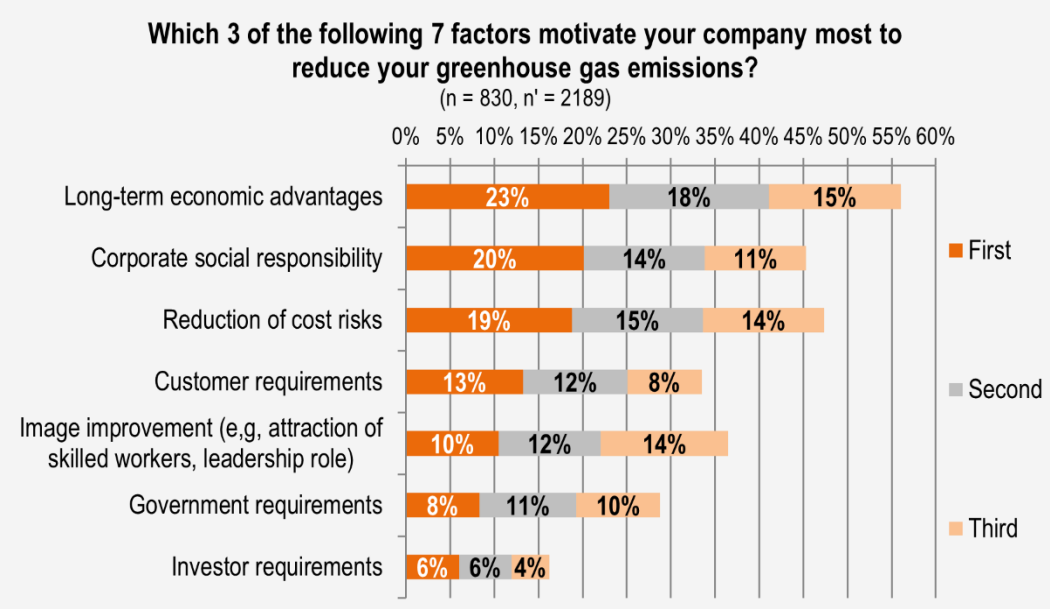

Figure 1: Top 3 motivators for Greenhousegas (GHG) reduction decisions, overall sample (n = 830) [26]

More than half (56%) of participating companies state that **long-term economic advantages** are among their top 3 motivators to reduce their greenhouse gas (GHG) emissions, while for nearly one-fourth (23 %) of them it is even their primary motivator (cf. **Figure 1**). Looking at the overall sample, no other motivator is indicated by companies

as often as their first, second or third priority. Additionally, many (not all) measures reducing emissions are accompanied by an increase in efficiency, a decrease of ongoing costs, as well as reduced emission costs. These side-effects influence the overall production costs and subsequently competitiveness. In terms of hard financial factors but also soft factors (i.e., surfing on the sustainability wave), decarbonising promises a company long-term economic benefits. These hard factors are also those leading to a **reduction of cost risks, which was the first priority for 19% of participating companies**. A reduced demand of energy delivered to the company from outside and reduced emissions both help to lessen the impact of emission and energy prices (and concerns about their availability). Therefore, it is not surprising that the reduction of cost risks is among the top 3 motivators to decarbonise by nearly every second company 48 %. That said, another factor is a primary motivator for more companies: **corporate social responsibility (CSR)**. Counting to the 'soft factors', CSR represented the first priority for 20% of participating companies. Moreover, the fact that 45 % of companies list CSR among their top 3 motivators underlines that taking (and displaying) responsibility already plays a significant role in the industrial sector. However, how genuine this is in comparison to those who are economically or resilience-driven can only be judged if the measures *actually* taken are compared in their impact on decarbonisation rather than targets announced only.

Even though **customer requirements** rank as the fourth most frequently chosen primary motivator, there is a substantial gap between it and the first three primary motivators (13 % vs. 19-23 %). When taking the top 3 motivators in aggregate (33 %), it even falls behind **image improvement** (36 %). What is interesting about comparing these two is that while the percentage of companies considering customer requirements as a top 3 motivator increases (third priority 8 %, second priority 12 % and first priority 13 %), it decreases for those considering image improvement a top 3 motivator. This *could* suggest that the image impact of decarbonisation efforts is a relevant consideration but not often the primary one. Given that the percentage figure for third priority is only as high / slightly higher with the motivation of long-term economic advantages (15 %) and reduction of cost risks (14 %), this assumption finds some support in the data. For customer requirements, this *could* indicate that if a company decarbonises to please its customer [109], they are more likely to do so if image improvement is higher up in their motivational priorities.

Government requirements are a motivator for less than a third of companies (29 %), suggesting that almost all other factors are stronger triggers for a company to increase its decarbonisation efforts. Similarly, **investor requirements** are a top motivator only for few companies (16 %). Nonetheless, this may look different for companies that have a high dependency on (long-term) investors. If one distinguishes between business loans (i.e., from a commercial bank) and long-term investments, the significance of investor requirements might be higher for larger companies that are not in private ownership and those that have higher capital needs. In fact, a deeper look into the data suggests this is to some extent the case for medium-sized companies (19 %), for whom investor requirements are primary motivator 50 % more often (9 % compared to 6 % on average). In light of the increasing popularity of ESG (Environmental, Social, and Governance) investments over the past years in combination with companies' desire to remain investable or increased direct pressure from shareholders it is likely that these figures would be higher if the same question was asked today; the same most likely also applies for the reduction of cost risks during the current energy crisis. According to recent studies of the Federation of German Industries (BDI) and the German Economic Institute (IW), the crisis also leads to postponing investments into the ecological transition, which is tragic, as the less companies invest into decarbonising their operations, the more they are hit by increasing emission and energy prices [110].

From a general viewpoint, the motivators such as economic benefits described earlier therefore have the highest motivational relevance in the decision to reduce one's

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greenhouse gas emissions. Purely external drivers in contrary are ranked almost consistently below these motivators. This is essentially in line with the findings of earlier presented literature that internal motivation outweighs external pressure [15-17]. Further, this suggests that aiming to successfully trigger intrinsic action might lead to at least higher motivation and potentially even better outcomes than applying external 'force'. However, the results of this study differ from Boiral et al. [17] in that long-term economic advantages were found to be the most significant motivator rather than being less important than environmental and social concerns (except for micro companies). Additionally, in comparison to previous studies, the reduction of cost risks was discovered to be of higher significance than image improvement (reputation).

As the industrial sector is very diverse, it makes sense to explore how this analysis differs when looking at it from a company-size (Section 3.4.1), a supplier-state (Section 3.4.2), an energy-intensity (Section 3.4.3), and a sectoral (Section 3.4.4) viewpoint, as well as depending on company's primary decision determinants (Section 3.4.5). Before doing so, considering different dependencies and underlying strategies in the choice of priorities as suggested in Sections 3.1-3.3, it makes sense to also assess how the company's GHG reduction ambitions differ, depending on their primary decarbonisation motivator.

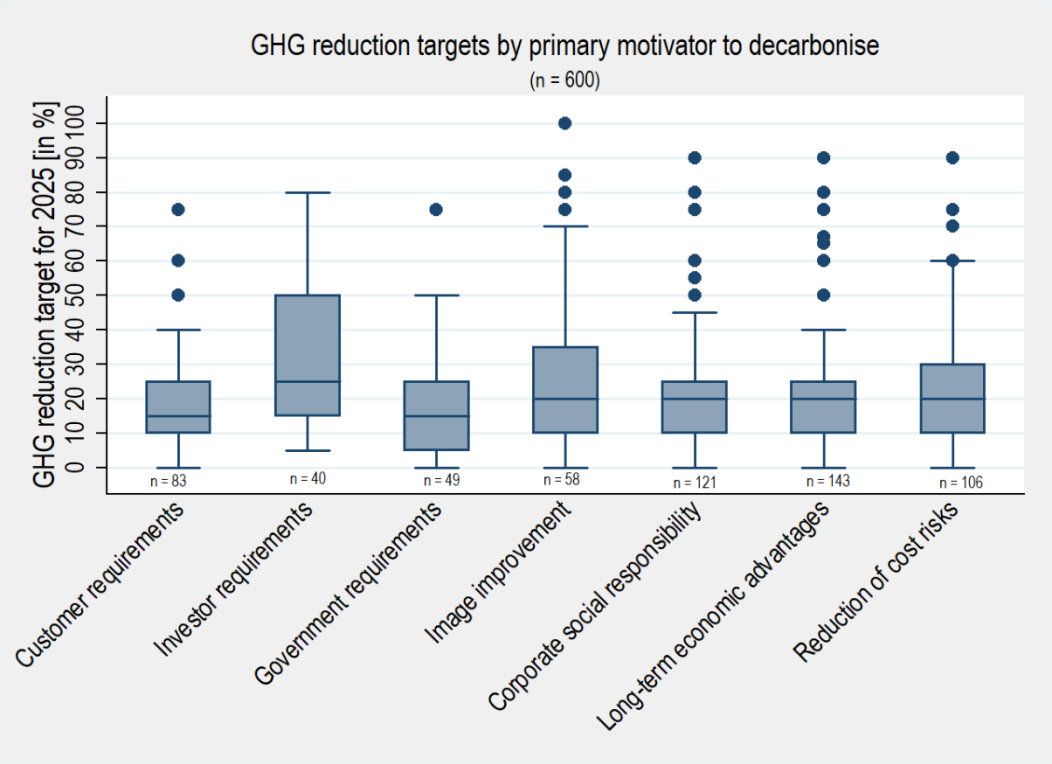

Figure 2: GHG reduction targets by primary motivator to decarbonise (n = 600) [26]

Only a small proportion of companies (16 %) have declared investor requirements as one of the top motivators in May 2020. Nevertheless, for those attributing such requirements as their primary motivator to decarbonise (6 %), the associated level of ambition is substantially higher than with any other primary motivator, including all quartiles and whiskers **(cf. Figure 2)**. Given (a) conversations with entrepreneurs who stated that remaining investable is critical to the survival of the business, (b) the increasing trend to preferentially invest in funds that carry a green or sustainable label, and (c) the new EU taxonomy, the number of companies motivated by investor requirements may have increased significantly since the data was collected.

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The data further illustrates that the more ambitious half of companies, which is primarily motivated to decarbonise by image considerations, is also significantly more ambitious in relation to its GHG reduction goal than the average. Considering the ever-increasing skills gap due to demographics and a shift in the type of skills needed, it could very well be that 'being more attractive' to applicants than competitors in terms of ambitions could explain to some extent the above-average goals of this group of companies. On the flip side, doubts have been voiced concerning the honesty of targets, particularly when they appeared to be image-driven (i.e., greenwashing) [111].

Similarly, but to a slightly lesser extent, the more ambitious half of companies, whose primary motivator to decarbonise is the reduction of cost risks, have also targeted GHG goals that are significantly above average. In the current situation, the war in Ukraine, the resulting increase in energy costs, the security of supply issues, and the high emission cost combine to a particular challenge. Consequently, there is a chance that both the weight and the level of the motivator of reducing cost risks is increasing further. In particular, resilience against price and supply shocks can be increased by a 'sustainable' decrease of the emission footprint along with boosting on-site decarbonisation efforts, such as energy efficiency and self-generation of renewable energies [112].

In contrast, companies that are primarily motivated to decarbonise because of customer requirements show a below-average level of ambition. It cannot be distinguished whether the responding companies consider a customer or the company they supply to as the end client. The data cannot confirm whether these companies set their target to show just enough ambition to maintain the contractual relationship with their customers or to be able to sell their products, but these could be considerations of these companies. Provided this assumption is correct, there is a high likelihood that the level of ambition set by these companies would rise if the question was asked again today. The Energy Efficiency Index of German Industry found in early 2022 that 7 out of 10 manufacturing companies plan work to be able to sell their products with a net-zero emission footprint. Nearly half of these 70 % stated that they impose or will impose requirements on their supply chain to fall in line and reduce their emissions to achieve this goal [64].

The lowest level of ambition is found in companies whose primary motivator to decarbonise are government requirements. As all other motivators contribute to maintaining a successful business model (keeping clients and investors happy, being attractive to the outside and new recruits, looking caring and ensuring long-term profitability whilst reducing any risks), it appears that external demands, which limit the company's freedom without contributing to its business goal, are catered for like a check box exercise: The company does just enough to meet the requirements. In other words, it appears that there is only a willingness to do more for motivators promising a benefit for the company. Accordingly, for motivators which are about not being penalised, companies are more likely to do just as much as necessary.

Therefore, the key takeaway from **Figure 2** is that positive drivers appear to lead to higher ambition. Consequently, strategies to motivate companies to decarbonise or set ambitious goals should refrain from building on regulatory requirements and instead focus more on motivators and market tools. **Policy measures that *indirectly* impact any of these could hence have a stronger effect on ambition levels than imposing *direct* requirements.**

In light of this, holding companies accountable to actually achieve their goals is a whole other issue, but that is to be analysed elsewhere.

While **Figure 2** illustrated the envisaged GHG emission reduction ambitions of participating manufacturers in general in consideration of their respective primary motivator, the box plot figures in the following subsections allow a deeper view, showcasing how ambitions vary depending on company size, supplier state, energy intensity, sector and primary decision factor. Even though on these levels the sample size is still considerable, caution has to be applied and results should be considered as indications only. For this

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reason, the analyses of these figures are limited to highlighting the most striking differences between the categories shown.

3.4.1 Company size perspective on primary motivators for GHG reduction decisions

Switching to a company size viewpoint (cf. **Table 4**) makes clear that role and weight of the motivating factors differ across company sizes:

Table 4: Primary motivators for GHG reduction decisions, by company size (n = 817) [26]

	micro company	small company	medium-sized company	large company	total
Long-term economic advantages	22%	21%	20%	29%	23%
Corporate social responsibility	25%	15%	19%	24%	20%
Reduction of cost risks	21%	19%	17%	19%	19%
Customer requirements	14%	14%	12%	13%	13%
Image improvement	10%	15%	12%	4%	11%
Government requirements	6%	10%	10%	7%	8%
Investor requirements	3%	6%	9%	5%	6%
Observations	174	222	246	175	817

Whereas long-term economic advantages are the most frequently chosen primary motivator in general, this is not the case for all company sizes. Taking responsibility – possibly due to a high share of locally embedded and family-owned companies – is the most frequently chosen primary motivator for micro companies (25 %), followed by economic advantages (22 %) and cost risks (21 %). Small companies are the only company size where cost risks are second most often chosen (19 %). For them, the image factor is the primary driver much more frequently (15 %) than for medium-sized (12 %), micro (10 %) or large companies (4 %). On the other hand, CSR is by far the least frequently chosen primary motivator for small companies (15 %). While medium-sized companies are closest to the average distribution, large companies stand out with a significantly higher share of companies nominating long-term economic advantages as primary motivator (29 %) and a significantly lower share choosing image considerations as the primary driver (4 %) at the time of data collection.

Looking at GHG reduction targets from a company size perspective (cf. **Figure 3**), considerable differences can be observed. Medium-sized companies that consider customer requirements their primary motivator set considerably higher GHG reduction targets than companies of other sizes. While micro companies who are mainly motivated by government requirements indicate considerably lower than average GHG reduction targets, the opposite is the case for large(r) companies. One possible explanation is that regulatory policy often focuses on large(r) companies, while most micro-enterprises may not be sufficiently affected to envisage higher GHG targets. Many small and micro companies who consider image improvement their primary motivator set substantially higher GHG reduction targets than other companies. While many medium-sized companies who are primarily motivated by the reduction of cost risks set higher GHG reduction targets than the other companies, the opposite is the case for micro companies. Micro-enterprises often do not have the necessary expertise on energy and decarbonisation aspects unless the company is energy intensive. Therefore, either the share of energy costs is not high enough or there is a lack of awareness of the possible negative consequences of inaction (especially if charges increase).

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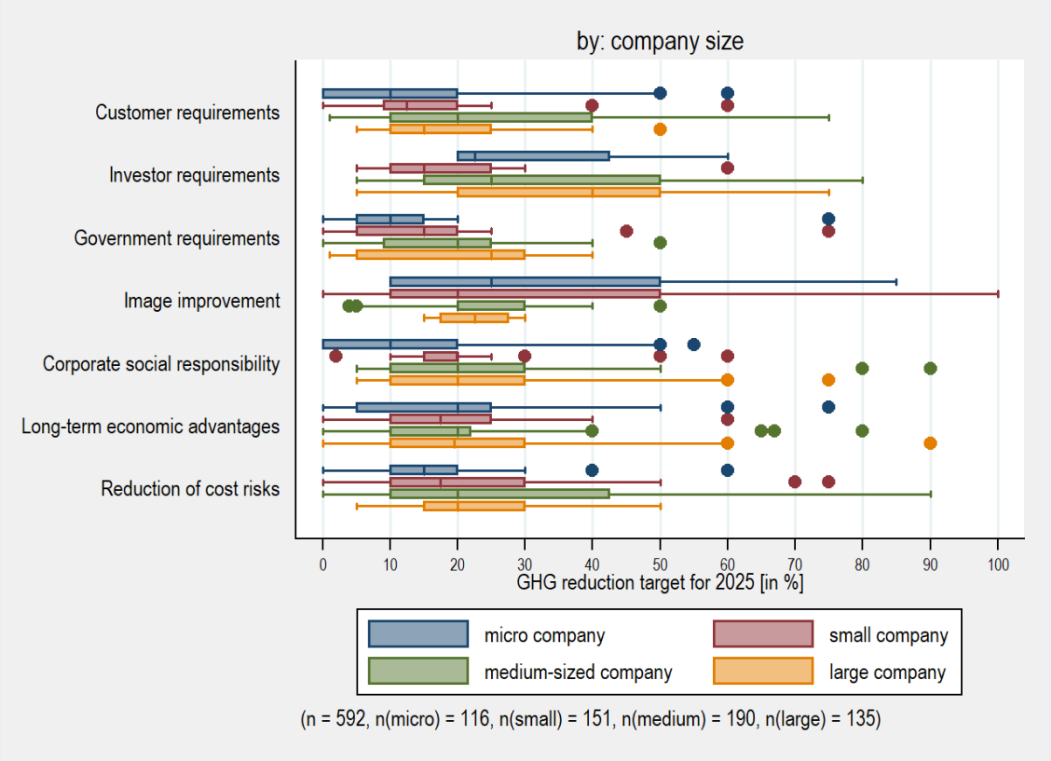

Figure 3: GHG reduction targets by primary motivator to decarbonise (n = 592), by company size [26]

3.4.2 Supplier perspective on primary motivators for GHG reduction decisions

It appears that those companies at the end of the supply chain, meaning those companies that are not suppliers of other companies (cf. **Table 5**) are considerably more often motivated by long-term economic factors (26 %) and by CSR aspects (23 %) than the average and than companies considering themselves mainly as suppliers. Being at the top end of the supply chain could allow more degrees of freedom for decisions based on principle and entrepreneurial foresight. At the same time, large companies that fall into this category are more likely to fall under the EU CSR directive and thus under the CSR reporting obligation [95]. It remains to be checked whether, in the case of suppliers, customer requirements deviate in importance from the average when looking at the secondary or tertiary motivator. Regarding primary motivators, with 14 % such a deviation is – somewhat surprisingly – hardly visible.

Table 5: Primary motivators for GHG reduction decisions, by supplier status (n = 821) [26]

	Do you consider your company primarily as supplier to other companies?		
	Yes	**No**	**Total**
Long-term economic advantages	21%	26%	23%
Corporate social responsibility	19%	23%	20%
Reduction of cost risks	19%	18%	19%
Customer requirements	14%	12%	13%
Image improvement	12%	8%	11%
Government requirements	9%	9%	9%
Investor requirements	7%	5%	6%
Observations	564	257	821

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Whether a company is predominantly a supplier to other companies appears to lead to the biggest differences in level of ambition if 'investor requirements' are the primary motivator (cf. **Figure 4**). In the face of increasing demands on the upstream supply chain, this can be an attempt to pre-empt or meet them and thus protect the company's value or remain investable and secure the financial resources to fund implementation (see section 3.2 and section 3.3.2). That suppliers set more ambitious goals if they are primarily motivated by 'customer requirements' or 'image improvement' appears more intuitive (cf. requirements in supply contracts, being in the 'good books', etc). As suppliers are, in consequence of their state as supplier, involuntary risk-takers (dependent of what their client may or may not want of them) a bigger spread of GHG reduction ambition level when it comes to 'reduction of cost risks' as primary motivator appears understandable.

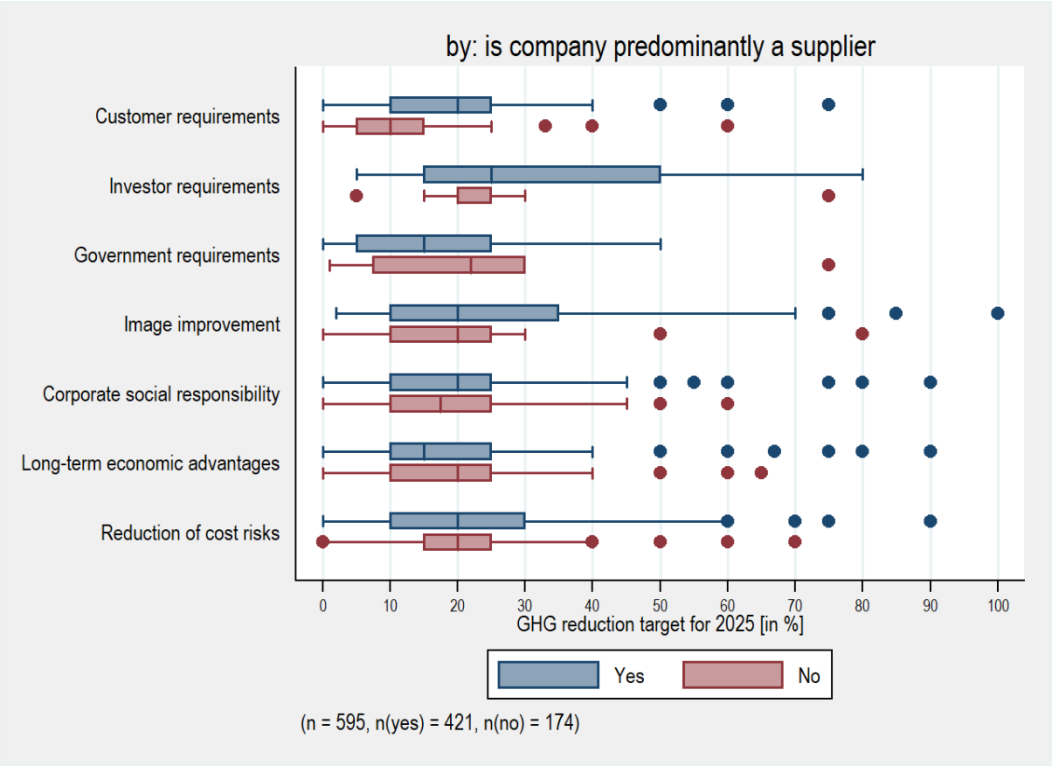

Figure 4: GHG reduction targets by primary motivator to decarbonise (n = 595), by supplier state [26]

3.4.3 Energy intensity perspective on primary motivators for GHG reduction decisions

Table 6: Primary motivators for GHG reduction decisions, by energy intensity (n = 622) [26]

	not energy intensive	less energy intensive	moderately energy intensive	energy intensive	Total
Long-term economic advantages	22%	19%	24%	23%	22%
Reduction of cost risks	19%	20%	19%	30%	20%
Corporate social responsibility	16%	23%	17%	23%	20%
Customer requirements	16%	15%	14%	2%	14%
Image improvement	10%	9%	11%	14%	10%
Government requirements	9%	9%	7%	7%	8%
Investor requirements	7%	6%	8%	2%	7%
Observations	149	235	194	44	622

Taking a brief look at the primary motivators from an energy intensity viewpoint (cf. **Table 6**), the reduction of cost risks significantly sticks out, selected by 30 % of energy

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intensive companies, understandably as energy intensity often goes along with carbon intensity and a high associated footprint as well as associated costs. Long-term economic advantages are most often the primary motivator (24 %) of moderately energy-intensive companies. For energy-intensive companies, customer or investor requirements are a significantly less important motivator (2 % each) than for other energy intensities. Conversely, image plays a higher role (14 %) than on average.

When it comes to the level of ambition (cf. **Figure 5**) it strikes out that if 'investor requirements' are primary motivator then particularly not energy intensive companies set above average ambitions. Perhaps this is because it is comparatively easy for (many of) them to reduce the majority of their emissions by switching their source of fuel allowing them to drastically reduce emissions. If 'customer requirements', or 'image improvement' are primary motivators, many of these companies tend to set more ambitious targets the more energy intensive they are. This finding seems logical, as energy consumption is more visible and better known, which tends to increase (implicit external) demands for decarbonisation measures. Since energy and emission costs are more significant on companies' balance sheets the more energy-intensive they are, it stands to reason that ambitions increase with energy intensity if companies are primarily motivated by 'long-term economic benefits'. The same applies, with the exception of moderately energy intensive companies, regarding the 'reduction of cost risks'. The opposite appears to be the case with 'CSR', but possibly with the limitation that larger companies are required to have CSR reporting in place, which influences their ambitions.

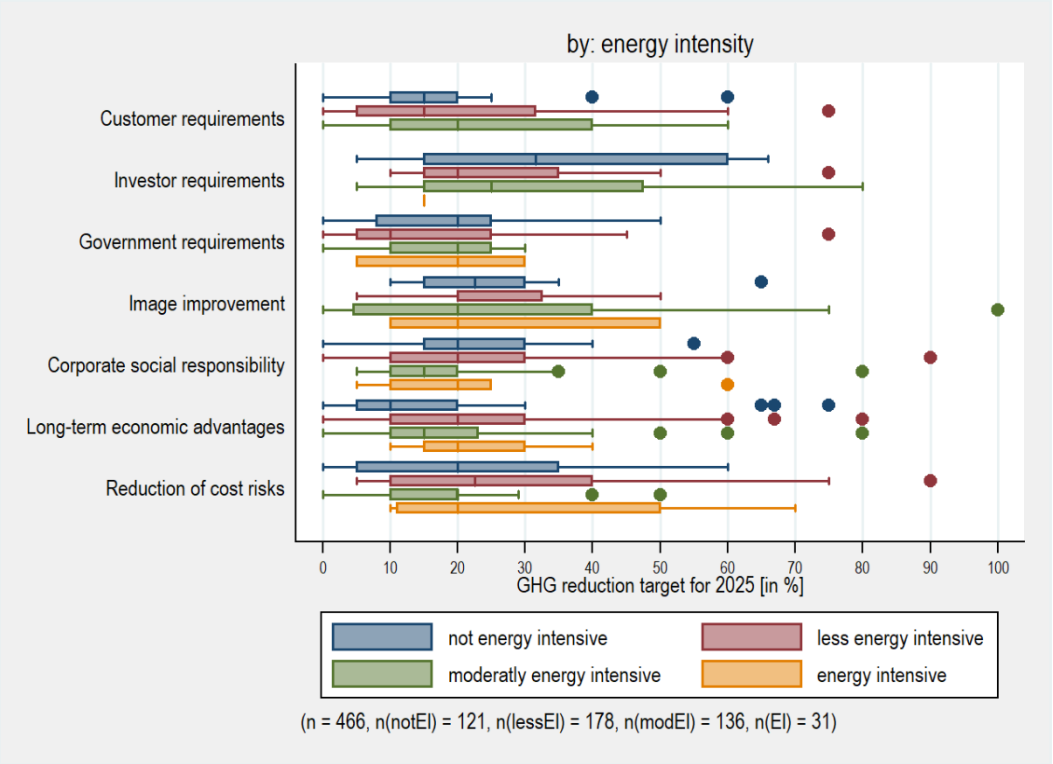

Figure 5: GHG reduction targets by primary motivator to decarbonise (n = 466), by energy intensity [26]

3.4.4 Sectoral perspective on primary motivators for GHG reduction decisions

As can be expected, from a sectoral viewpoint, the situation deviates significantly for primary industry motivators and requires a more in-depth analysis to allow qualified statements.

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Table 7 underlines that the significance of a primary motivator is nowhere as varied as when one distinguishes the companies by sector, with a difference of up to 35 percentage points between sectors. These large differences between sectors highlight the importance of a sectoral approach to decarbonisation, especially for policy measures: While 'long-term economic advantages' are primary motivator for 43 % of companies in the computer & electronics industry (26), the same motivator is named a primary one only by 10 % of companies in the leather industry (15). Potentially there is a link to the energy-intensity of the product range, as well as investment intensity for changing over the production machinery, that could explain the difference. On the flip side 'CSR' and 'customer requirements' are primary motivators most often for the leather industry (15; 35 % and 26 %), which suggest a high customer sensitivity to the way products are being created by this sector. The 'reduction of cost risks' is most often a primary motivator for the automotive industry (29), which is not surprising considering points made in section 3 so far. As oil and gas are responsible for large parts of energy-related emissions, it is not unexpected that 'image' is the most frequent primary motivator (23 %) for decarbonisation in this industry (06) and 'government requirements' most frequent for companies in the coal mining industry (05; 25 %). The fact that the chemical industry (20) is quite emission intensive and faces more difficulties in decarbonising their core processes possibly explains why 'investor requirements' are most often a primary motivator in this sector (13 %), combined with an above average rate for both 'reduction of cost risks' (24 %) and 'long-term economic advantages' (24 %).

Table 7: Primary motivators for GHG reduction decisions, by sector (n = 729, n(sector) ≥ 20 or **)

Primary motivation, by sector (n = 729, n ≥ 20 or **, *)	Long-term economic advantages	Corporate social responsibility	Reduction of cost risks	Customer requirements	Image improvement	Government requirements	Investor requirements	Observations
26 Manufacture of computer, electronic and optical products	**43%**	19%	14%	**0%**	14%	5%	5%	21
10 Manufacture of food products	32%	23%	13%	19%	10%	**3%**	**0%**	31
22 Manufacture of rubber and plastic products	32%	19%	14%	13%	10%	5%	8%	63
16 Manufacture of wood & of products of wood & cork, except furniture; manufacture of articles of straw and plaiting materials	31%	23%	13%	15%	**3%**	13%	3%	39
06 ** Extraction of crude petroleum and natural gas	31%	15%	**8%**	15%	**23%**	**0%**	8%	13
17 Manufacture of paper and paper products	28%	18%	**10%**	24%	10%	8%	2%	50
05 ** Mining of coal and lignite	25%	**0%**	25%	13%	13%	**25%**	0%	8
20 Manufacture of chemicals and chemical products	24%	**7%**	24%	13%	13%	4%	**13%**	45
24 Manufacture of basic metals	23%	25%	28%	8%	10%	5%	3%	40
28 Manufacture of machinery and equipment n.e.c.	21%	21%	20%	14%	11%	6%	6%	70
32 Other manufacturing	21%	21%	21%	10%	10%	10%	7%	29
31 Manufacture of furniture	21%	21%	**10%**	14%	**21%**	10%	3%	29
21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	20%	12%	20%	16%	12%	8%	12%	25
23 Manufacture of other non-metallic mineral products	20%	34%	20%	7%	7%	7%	5%	41
25 Manufacture of fabricated metal products, except machinery and equipment	19%	22%	22%	16%	**3%**	9%	9%	58
27 Manufacture of electrical equipment	19%	22%	17%	6%	14%	**16%**	6%	64
18 Printing and reproduction of recorded media	17%	26%	26%	13%	9%	9%	0%	23
29 Manufacture of motor vehicles, trailers and semi-trailers	16%	12%	**33%**	12%	8%	12%	6%	49
15 Manufacture of leather and related products	**10%**	**35%**	**10%**	**26%**	6%	6%	6%	31
Total	23%	21%	19%	13%	10%	8%	6%	729

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As underlined, the number of companies per sub-category shrink substantially the deeper one drills into details. This particularly applies for the sectoral perspective, which is why only the four sectors with most participating companies in this question are showcased for illustrative purposes (cf. **Figure 6**). The largest differences in level of ambition are found where 'investor requirements' or 'CSR' are primary motivator. What sticks out is that both the ambition level and spread are closest across sectors when it comes to 'long-term economic advantages' desire that understandably all companies have in common as it 'makes economic sense'. The pressures perceived by the automotive industry (29, cf. section 3.3.2) may explain their substantially higher average and range of GHG reduction ambitions. That ambition levels vary largely underlining that triggers stimulating to achieve higher targets can be very sector-sensitive. This point showcases the need for tailored approaches building on the pressure points, interdependencies and motivators highlighted in sections 3.1-3.3.

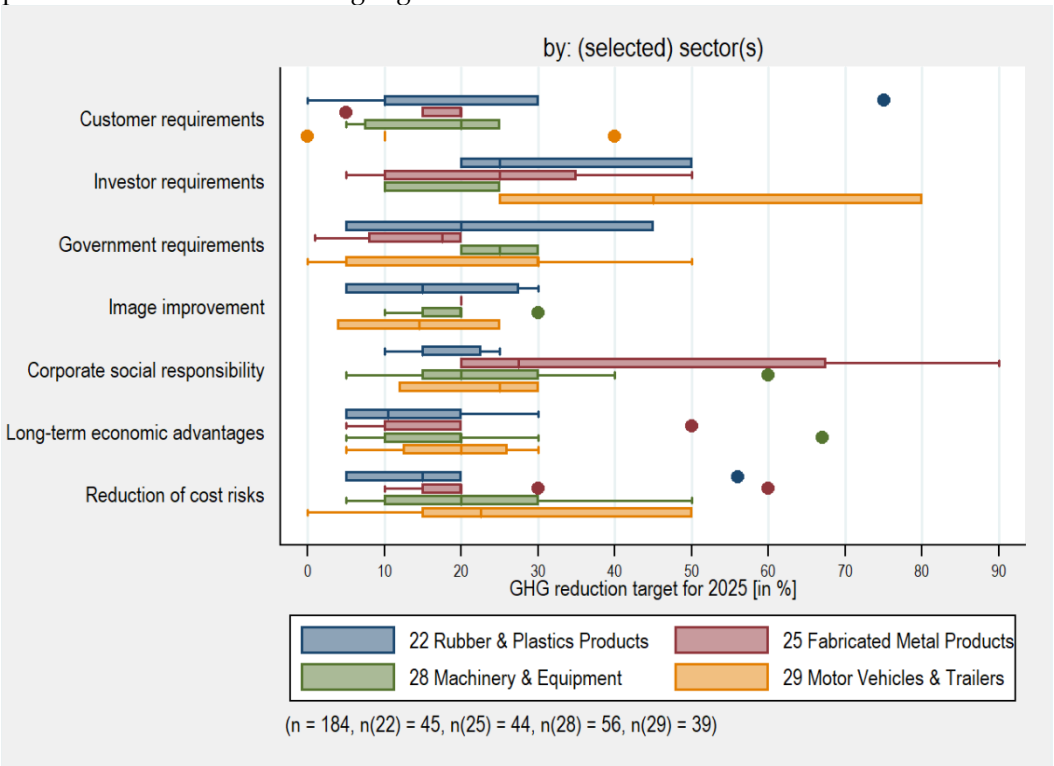

Figure 6: GHG reduction targets by primary motivator to decarbonise (n = 184), by sector [26]

3.4.5 Decision determinant perspective on primary motivators for GHG reduction decisions

In the EEI questionnaire [26], companies were also asked based on which primary decision criterion they take their decarbonisation decisions, which is analysed in its own right by Buettner and König [113].**Table 8** illustrates that primary motivators to decarbonise differ considerably, depending on which primary decision determinant a company uses to guide its decisions. Confirming what intuition would suggest, the 'long-term economic advantages' are most often the primary motivator for those that decide primarily based on 'expected increases in productivity'. In turn, the opposite is the case for those driven by the desire to avoid costs, which often suggest an ad-hoc and not a strategic approach. Where 'implementation competence' is the primary determinant, CSR considerations are least often a primary motivator (14 %); when the decision determinant is encompassing economic considerations, the 'reduction of costs risks' is more often a primary motivator than for other decision determinants. Furthermore, where

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'implementation competence' is the primary decision determinant, both 'customer requirements' (17 %) and 'image improvements' (16 %) are more often primary motivators than elsewhere. Interestingly, 'image improvements' are less often the primary motivator for those companies whose primary decision determinant is positive image effects. They are most often primarily motivated by 'long-term economic advantages' (23 %) and least often by 'investor requirements' (2 %). At the same time, while this group is primarily motivated by 'government requirements' more often (11 %) than all other determinant groups, they are overall least often motivated by 'investor requirements' (2 %).

Table 8: Primary motivators for GHG reduction decisions, by primary decision-making criterion (n = 822)

	Please indicate which 3 of the following 6 points are the most decisive in determining your decarbonisation mix?						
	Level of investment	Cost per avoided tonne of CO_2-eq.	Expected increase in productivity	Technical aspects	Implementation competence	Image effect through visible measures	Total
Long-term economic advantages	23%	18%	31%	20%	24%	23%	23%
Corporate social responsibility	18%	21%	19%	23%	14%	22%	20%
Reduction of cost risks	21%	21%	20%	19%	16%	15%	19%
Customer requirements	15%	12%	10%	14%	17%	15%	13%
Image improvement	8%	10%	6%	11%	16%	12%	10%
Government requirements	7%	8%	8%	7%	7%	11%	8%
Investor requirements	7%	10%	6%	5%	5%	2%	6%
Observations	149	164	124	134	94	110	822

A more substantial assessment of the connections between decision determinants, motivators, and the rationale behind, including assessment of the GHG reduction levels targeted would necessitate a more in depth and more sophisticated statistical analysis and is thus an area for further research.

While the general assumption that companies of one sector respond to the question of primary motivator and ambition level quite differently depending on whether they are a supplier appears to hold true, the sample size is too small at this level of detail to safely confirm.

4. Discussion

The decarbonisation of industrial organisations can be considered a far-reaching project of institutionalisation driven by political actors, professional actors, social movements, the general public, as well as industrial organisations themselves. As institutional theorists claim, organisations require legitimacy to survive and thrive in their social environment [114,115]. The access to resources (from material resources such as capital or orders to non-material resources such as reputation or work force) therefore depends on whether the actions of industrial organisations are perceived as proper and appropriate by their environment.

Considering the contemporary discourse on decarbonisation, the pressure on organisations to achieve and maintain legitimacy will hardly decrease. On the contrary, due to regulatory measures (e.g., carbon pricing), normative elements (e.g., increasing professionalisation, guidelines, best practices) and cultural-cognitive aspects (e.g., public opinion, peer-pressure), combined with the inevitable interdependencies between

manufacturing organisations, actions to decarbonise are simply actions to survive in the long run for industrial organisations [116].

Buchenau points out that "many companies have realised the need to manufacture sustainably too late" [78]. According to Wolfgang Hahn, managing director of ECG Energy consulting, "most of smaller and medium sized companies still underestimate what the increasingly called-for climate neutrality and carbon certification actually means for their company" and that "increasing pressure from supply chain, politics and society calls for urgent action to secure one's own future" as a business [78]. Therefore, the opportunity costs of inaction are high. In the current environment of potential energy scarcity, security and price concerns, this statement may hold true even more. These circumstances and the question of how best to act [24] in light of the situation commends a rethink of economic viability calculations. The latter would lead to investment decisions being taken differently and, consequently, would underline why it makes even more sense now to prioritise on-site measures to decarbonise [112]. In other words, the 'pain' felt by companies in many respects may, under the current circumstances (cf. section 3.1), risk putting decarbonisation efforts on the back burner. However, if it is successfully highlighted how decarbonising their operations can ease companies' 'pains', it may even reassure and fortify their decarbonisation determination. Nevertheless, this is only the case if it is perceived as helping them in their core ambition to be a successful business – not if it appears as yet another regulatory burden in a time when business survival is hard enough.

By communicating the opportunity cost of inaction and supporting decarbonisation measures, companies' profit function may be shifted so that their business interest and thereby their motivations are in alignment with societal needs.

Therefor this article focussed on identifying aspects that may help stimulate an intrinsic action in companies (from inside or outside) which then triggers them to take decarbonisation action.

5. Conclusions

This article has endeavoured to answer the question of which underlying factors motivate companies in Germany's industrial sector to take the decision to decarbonise. In order to provide an appropriate basis for analysis, this article commenced with a review of the literature, establishing and explaining the categories of motivators and drivers. On the one side, motivators were defined as stemming directly from the business's key objective of maximising profit, including factors like image and future-proofing. On the other side, drivers were defined as external factors forcing businesses on a course of action they would not have naturally taken, including factors like government regulations and shareholder pressure. Subsequently, the qualitative case study examined Bosch to illustrate the different pressure points as well as the effect of interdependencies in the automotive sector. Particular attention was given to the strategic considerations behind the decision to decarbonise, such as preventive measures in the face of the Diesel Scandal or pre-emptive measures regarding expected supply chain pressures. To check and substantiate the findings of the case study, the quantitative part of the analysis relied on the results of the energy efficiency index of the German industry to find out what actually motivates German manufacturing companies to decarbonise. The quantitative analysis also highlighted differences in motivating factors depending on company size, sector, energy intensity, supply chain position and companies' determinants for decision-making. Contrary to previous studies, this article found that long-term economic advantages are the top motivating factor and that the reduction of cost risks is of higher significance than image improvement – even ahead of the current war in Ukraine and associated price peaks and uncertainties.

The analysis has shown that societal, workforce, supply chain and investor expectations play a large role when companies make a decision to decarbonise. Nevertheless,

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a large number of strategic considerations are also significant since they have the potential to make the business more resilient and profitable. Experience from the past, as well as the analysis of economic aspects and rare goods in the context of decarbonisation allude to the fact that companies not moving towards decarbonisation, may face a costly late-mover disadvantage. In general, motivators were found to have the highest motivational relevance in the decision to reduce one's GHG emissions, while external drivers are by and large ranked below the motivators. Moreover, the results regarding the factor priorities were examined in light of the companies' GHG emission reduction targets, showing that positive motivators lead to higher ambition levels than negative (external) drivers. Thus, policy measures that trigger an intrinsic reaction by strengthening the motivators would positively impact ambition levels and probably generate better outcomes than policies applying external pressure.

An Outlook: answers and transferability of findings

If the intrinsic reaction to decarbonise is triggered, it is however crucial to ensure that decarbonisation strategies are shaped and implemented in an effective manner. For this, there are a few questions that remain to be answered:

- Are companies sufficiently aware of their energy and process-related footprints?
- While it was already analysed which factors play the largest role in deciding which option to go for among feasible options? Are there further aspects that need to be considered to determine one's ideal mix?
- In general, what role will other means of non-fossil energy (i.e., nuclear) and other means of tackling unavoidable emissions (i.e., carbon capture, storage and utilisation) play in reaching reach net-zero?

Whilst all these new questions arising from the issues and data discussed remain unanswered for the moment, further data from the first iteration and new data from the second iteration of the Energy Efficiency Index in 2020 provide the basis for answers to many of these questions for German companies. In this paper, we focused predominantly on high-level data and evidence from companies manufacturing in Germany.

Whereas the sector coding and available technologies differ only little between industrialised countries, the general stance towards climate questions and approaches and hence towards decarbonisation may differ significantly. Cross-country analyses, based on identical questions asked in quantitative fieldwork – the technical foundation for this is laid -, would provide a relevant puzzle piece to shape overarching decarbonisation policies and strategies for industry.

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