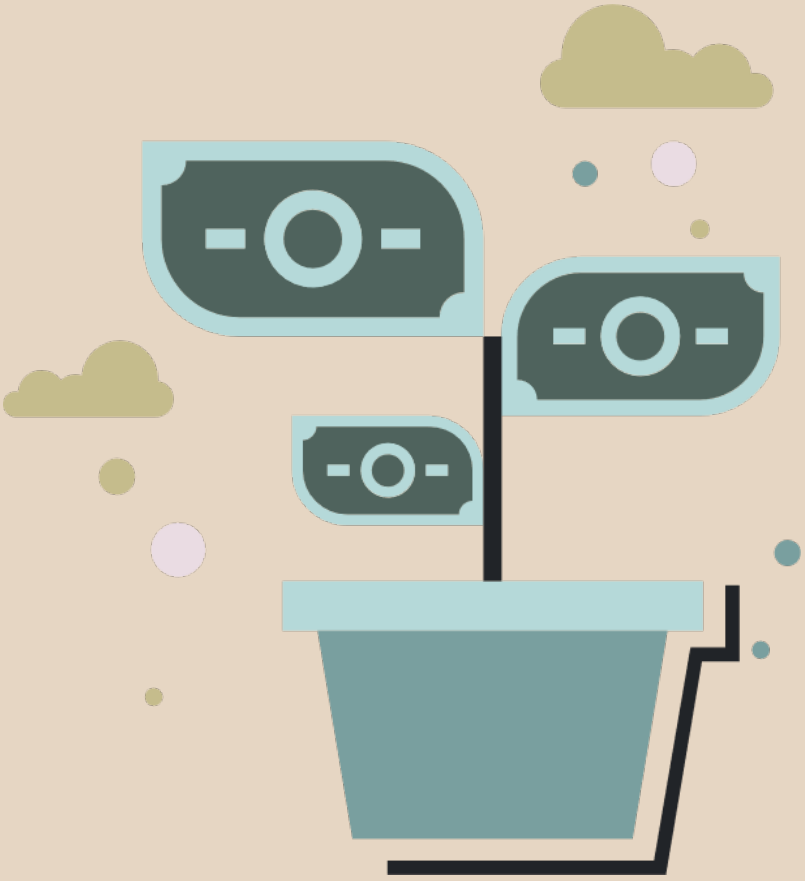

PM 2020:17

The green transition of the automotive supply chain

Why is the industry changing, what actions are they implementing and how are they creating control?

The automotive industry's supply chains are increasingly assessed based on suppliers' sustainability risks. At the same time, there are shortcomings in brand companies monitoring of the suppliers work when the regulations make it possible.

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Preface

Swedish Agency for Growth Policy Analysis, Growth Analysis, is analyzing and evaluating the state's efforts to strengthen Sweden's growth and business development. The purpose of the knowledge we develop is that it will be used to streamline, reconsider and develop growth policy and the implementation of Agenda 2030. We also develop methods for evaluating and analyzing Swedish growth policy.

How sustainable growth is created and can be affected by government initiatives are complex issues that require in-depth analyzes. We work with framework projects where we for up to two years shed light on a growth policy-relevant issue with different methods and from different perspectives. During a framework project, we present continuous sub-studies. Based on the results of the sub-studies, we present our conclusions and recommendations in a final report.

This is a sub-study that is part of the framework project "Sustainable global supply chains and the competitiveness of business and industry – what is the role of the state?". The study is written by Tobias Persson.

A warm thank you to everyone who responded to the survey and set up interviews, the industry organization for Scandinavia's suppliers in the automotive industry (FKG) which distributed the survey and the participants in the ramp project reference group who have contributed valuable input. A special thank you to Associate Professor Valentina de Marchi, University of Padua, for comments on the layout and analysis.

Östersund, september 2020

Thomas Pettersson Westerberg, Director Innovation policy and green transition, Tillväxtanalys

Contents

Summary

Why are firms in the automotive industry's global supply chains upgrading to more environmentally friendly production? Which actions are the firms taking? How do they monitor the risks in the supply chain and ensure that they are well managed? Through our analysis, we want to shed light on barriers that risk slowing down the green transition.

Regulations are the main driving force

Detailed regulations are the main driver for sustainability measures in the automotive industry's supply chains. The EU REACH regulation requires firms to know about, monitor and report on the use of hazardous substances throughout the supply chain. The US regulation on the use of conflict minerals contributes to increased transparency and concrete actions in the supply chains. As these regulations require firms to be able to report data on specific sustainability risks in the entire supply chain, firms also develop structures and working methods that could be used to handle other risk types as well.

In addition to regulations, our analysis identifies two other strong motives for Swedish suppliers to the automotive industry to switch to more environmentally friendly production: attracting customers and employees. Whether the firm is perceived as a role model in the sustainability field is today decisive for customers' choice of brands and employees' choice of employer.

Joint systems for assessment and monitoring of the supply chains are developing

Most of the brand companies in the automotive industry collaborate on systems for assessment and reporting of suppliers and subcontractors. As early as the end of the 1990s, IMDS (International Material Data System) was developed. The purpose was to collect information about substances used in different components of a vehicle. The system is today the basis for companies' REACH reporting.

In Europe and North America, respectively, there are also initiatives where the brand companies in the automotive industry collaborate on self-assessment questionnaires for suppliers and subcontractors. The questionnaire is designed to help brand companies evaluate suppliers' sustainability risks and assess their own risks throughout the supply chain. Several supplier answers must be substantiated with third party certificates. We also find examples where brand companies require potential suppliers to achieve a sufficiently high score to become, or continue to be, suppliers.

Shortcomings in the monitoring of several supply chain sustainability risks

Despite regulations and expectations from both customers and employees, our analysis shows that companies have a weak monitoring of many sustainability risks when there are no specific governmental requirements. In the analysis, we found that many requirements from the brand companies' disappear or are altered when propagated down the supply chain and that the information provided by suppliers is sometimes perceived to be of questionable quality.

The companies' action focus on reducing greenhouse gas emissions

In recent years, the automotive industry has increasingly steered its sustainability work towards reducing greenhouse gas emissions in the manufacturing process. For the previous decades, the focus was on emissions occurring during the use of vehicles, i.e. emissions from the combustion of petrol and diesel. However, with electric vehicles tailpipe emissions disappear, meaning that companies can focus more on the sustainability of the manufacturing process.

The automotive industry now focuses on two specific actions – to increase the share of renewable energy and to increase the use of recycled plastic, steel and aluminum. These actions are taken in both the own operations and as requirements on strategic firms' in the supply chain.

Two major barriers to the transition

In the analysis, we identify two barriers for the transition to green supply chains in the automotive industry:

- For the risk areas where there is a lack of specific state regulation, we see shortcoming in companies' monitoring of environmental risks at individual firms in the supply chains.
- There is a need of harmonized methods and standards for measuring the environmental impact and emission of greenhouse gases. A consequence is that products cannot be compared in a credible way.

Companies are developing systems to deal with the barriers

The brand companies work actively to deal with the two barriers. Among other things, they are implementing modern IT solutions that compiles information on whole supply chains in digital clouds and blockchains. The purpose is to enable a better monitoring and an increased understanding of the sustainability risks, including actions taken to limit physical climate-related risks. However, the development is hampered by a lack of trusted information about subcontractors, including who they are and where they have their factories. The information is crucial for the brand companies to be able to assess the risk of, for example, hurricanes and flooding.

Several brand companies also request suppliers and strategic subcontractors to be evaluated by the non-profit organization CDP and their experts on climate and water issues. This enables a more transparent comparison of companies.

A difficult balancing act for the state – to be a driving force without supporting vested interests

The analysis shows that the state has been an important driving force by requiring reporting over certain sustainability risks in the companies supply chains. At the same time, this type of state regulation is often criticized because it can 'force' companies into specific technical solutions and priorities. A fundamental question is therefore whether the state should introduce more specific regulations to force better monitoring of

sustainability risk in supply chains that are not clearly regulated today. The question becomes particularly relevant given that the state probably has even less knowledge than the industry about the actual risk the supply chains.

An alternative, and possibly a complement, to specific state regulation is more general regulation, requiring better management of all risk types. An advantage of this form of regulation is that the company keeps the responsibility for the actions and priorities. A relevant example of this form of regulation is mandatory reporting of environmental and human rights risks in the supply chains of larger companies based on due diligence. This form of regulation is already implemented in the French duty of vigilance and the European Commission has announces that it wants a similar legislation for the whole EU.

A difficulty for the state with both specific and more general regulation is that vested interests may affect their development and content. Specific regulation can directly benefit certain interests of stakeholders, while a general regulation tends to be influenced by values and priorities from the largest companies. To reduce the risk that vested interests will affect regulation, the state needs to increase its understanding of the market and its actors. This is something that we already has pointed out in a previous report 'Traceability and labeling of sustainable metals and minerals (see Tillväxtanalys, 2019).

Policy areas of special concern for the Swedish state

It is generally not possible for a small economy such as Sweden to influence the development of global value chains, such as the automotive industry, on its own. For the Swedish state, it is hence important to improve the understanding of both the development in the market and how policy regulations may effect this development. This knowledge is a prerequisite for being able to act objectively and proactively in for example the EU policy processes, in international standardization and in independent initiatives. It is important to assess which barriers the state should address and which should be left to other actors to handle. To enable this, the state should regularly assess market developments as in this analysis.

Such assessments needs to be done for all industry sectors of great importance to the Swedish economy. These assessments not only will create knowledge, which can be used to influence international initiatives. They can also be used to improve existing policy measures and development of new policy measures to strengthen the competitiveness of Swedish companies.

In our analysis, we want to highlight four areas that we identify as particularly interesting to consider in order to promote the competitiveness of Swedish firms:

- Swedish firms generally do not have high ratings in CDP supply chain programs (see Chapter 5.2.2).
- The lack of coherence between the automotive industry´s prioritization of recycled materials as an action to reduce greenhouse gas emissions and Swedish R&D support, which is primarily aimed at reducing process emissions for the production of materials from virgin raw materials (see Chapter 5.3.1).
- Initiatives that exist, not least in the EU, concerning how the climate footprint of materials and products should be calculated (see Chapter 5.3.1 and 5.3.2).

- The situation of small firms when meeting more advanced sustainability requirements from both the state and larger firms (see Chapter 5.2.2).

The three first point's concerns conditions that can be decisive for the competitiveness of Swedish companies in the transition to sustainably produced electric vehicles.

1. Green supply chains in the automotive industry

The automotive industry is in the middle of a major technological change in which OEMs (Original Equipment Manufacturers) electrify vehicles and make them increasingly more self-driving. This transition means that companies must replace their own expertise and that of suppliers who manufacture components for the drivetrain of gasoline and diesel vehicles with that of experts and suppliers in electronics and IT. Another consequence of this change is a greater environmental focus on the manufacturing of vehicles rather than on the operation of vehicles. Electrification means that the greatest environmental impact does not have to occur when driving a vehicle, resulting in a situation where a larger share of the environmental impact occurs during the manufacturing of the vehicle. Groupe PSA (owner of Peugeot, Citroën, DS, and Opel) has estimated that about two-thirds of the carbon dioxide emissions from a car with an internal combustion engine produced in 2018 were emitted during the use of the car and almost one-third in the supply chain, while the actual manufacturer (including logistics) only contributed 3-4 percent.[1] Since a vehicle with an electric motor does not need fossil fuels, the distribution of emissions will change, especially if electricity consumed during the use phase is fossil-free. One consequence of electrification may be that about 80 percent of carbon dioxide emissions will occur during the manufacturing of the vehicle, especially from the use of bulk materials[2] such as steel, aluminum, and plastic, or the manufacturing of batteries. Volvo Cars has estimated that as early as 2025, about two-thirds of greenhouse gas emissions will come from supply chains.

The transition of the automotive industry has also resulted in an increased interest in sustainability risks related to the use of materials: for example, the use of cobalt in lithium-ion batteries. Ten major OEMs of commercial and passenger vehicles jointly produced a report titled "Material change—A study of risks and opportunities for collective action in the materials supply chains of the automotive and electronics industries" in July 2018.

The complexity of the supply chain creates challenges for companies that need or want to control their sustainability risks. It is difficult to both identify risks and ensure that suppliers and subcontractors take adequate measures to mitigate risks when necessary. In the worst case, the inability to manage these risks can affect the ability to produce a vehicle. One example is the nuclear accident at Fukushima, caused by an earthquake. This catastrophe resulted in a 48 percent decline in vehicle production in Japan (Ye et al., 2012). The disaster also had consequences globally and not only in the region. Vehicle production declined by 20 percent in Thailand and by 24 percent in the Philippines due to difficulties in obtaining components from Japanese suppliers. Another example is the spread of the Covid-19 coronavirus. Most vehicle manufacturers had to shut down or curtail production because of difficulties in obtaining components from suppliers. Initially, several plants producing Hyundai, Kia, Renault, and Nissan cars in South Korea

[1] PSA (2019). 2018 registration document.

[2] Bulk material is material used in large quantities, for example around 75 percent of the weight of a car is steel, aluminum and plastic.

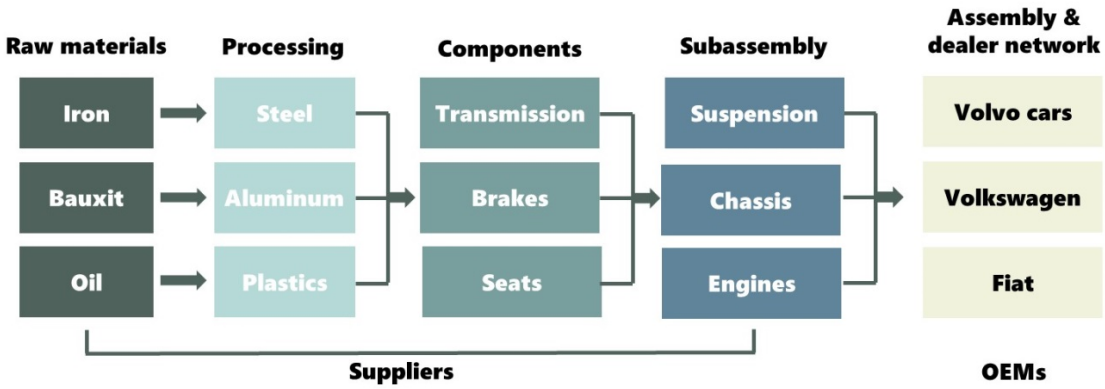
and Japan closed when they did not receive components from China. In mid-March 2020, most plants in the EU shut down production due to the shortage of components.

Table 1. Basic data for some automotive manufacturers in 2018

	Produced vehicles (millions)	Plants	Number of employees	Tier 1 Suppliers	Operating margin
Volkswagen Group (incl. Scania)	11.0	123	660,000	40,000	5.9%
Volvo Group	0.3	55	105,000	51,000	8.8%
Volvo Cars	0.6	10	43,000		
Groupe Renault	3.9	41	180,000	17,000	6.3%
Groupe PSA	3.9	41	210,000	8,000	7.7%
Daimler Group	3.4	25	300,000		6.7%
BMW	2.5	31	135,000	12,000	7.2%
Toyota	10.6	67	370,000		8.4%
Ford	6.0	61	200,000		2.3%
GM	8.4	43	175,000	18,000	3.9%
FCA	4.8	102	200,000	2,400	2.7%

A major challenge for the transition to green supply chains is its complexity. A typical automotive OEM produces millions of cars, has its own production facilities in several countries and on several continents, and has thousands of direct suppliers (Tier 1) who in turn have many subcontractors (Tier 2 to Tier N); see Table 1. A large part of the production cost of a vehicle comes from the purchase of components; PSA estimates this share to be 75 percent.

Figure 1. Schematic supply chain for the automotive industry



Simplified, the supply chain in the automotive industry can be described linearly as in Figure 1 (in reality, there are many lines of feedback for raw materials, components, and information). Raw materials are mined or extracted and processed into materials that are used in the manufacturing of components. Often, the components enter a sub-assembly factory that produces, for example, chassis, engines, sound systems, and safety systems, before the OEMs finally assemble the finished vehicle. The supply chain can therefore

consist of a group of companies that have completely different business operations, and several of them may sell raw materials or components to sectors other than the automotive industry.

1.1 An important sector for Sweden

In a previous analysis, we estimated that close to one-third (900,000) of the workforce in the Swedish private sector is working at companies belonging to global value chains (Growth Analysis, 2014). A significant share of these jobs is found in the automotive industry and its supply chains. The industry organization for suppliers and subcontractors for the automotive supply chain (FKG) has estimated that more than 160,000 people were directly employed in the automotive industry in 2019. OEM companies such as Volvo Cars, Volvo Group and Scania, which traditionally sell the product to the end consumer, employed almost 70,000 of them. Thus, the largest proportion of employees are working for suppliers or subcontractors.

Swedish suppliers and subcontractors to the automotive industry often face tough international competition, and relatively high Swedish wages mean that these companies generally have to compete on quality and delivery security. At the same time, OEMs demand continuous price reductions (Nurcahyo &Wibowo, 2015; Joshi et al., 2013). This tough situation will be even tougher for some companies in the transition to electric vehicles and self-driving technology. This particularly applies to companies that manufacture components for gasoline or diesel drivetrains. Companies' abilities to handle this change will have an impact on the Swedish economy. However, it is not known how a small state like Sweden can affect attractiveness. The automotive industry is global, and often Swedish firms have foreign ownership. For example, Scania is owned by the Volkswagen Group from Germany, and Volvo Cars by Geely from China. About half of the jobs in the automotive industry (excluding services) in Sweden are in foreign corporate groups.

1.2 Aim and structure of the report

The aim of this report is to identify obstacles, barriers, and market failures in the transition to competitive green supply chains in the automotive industry, in order to highlight the role that the state may have in dealing with these barriers.

In Chapter 2, we describe the analytical framework used to describe the automotive industry's transition to green supply chains. The theory provides three questions (Chapter 2) that can be used to analyze the transition to green supply chains. These questions are used to analyze OEMs (Chapter 3) and suppliers (Chapter 4). The results from the analyzes in Chapters 3 and 4 are used to identify obstacles and how the state can contribute to dealing with these (Chapter 5). Which ultimately provides some policy observations that are particularly relevant to the Swedish state (Chapter 6).

2. Analytic framework and three key questions for the analyze

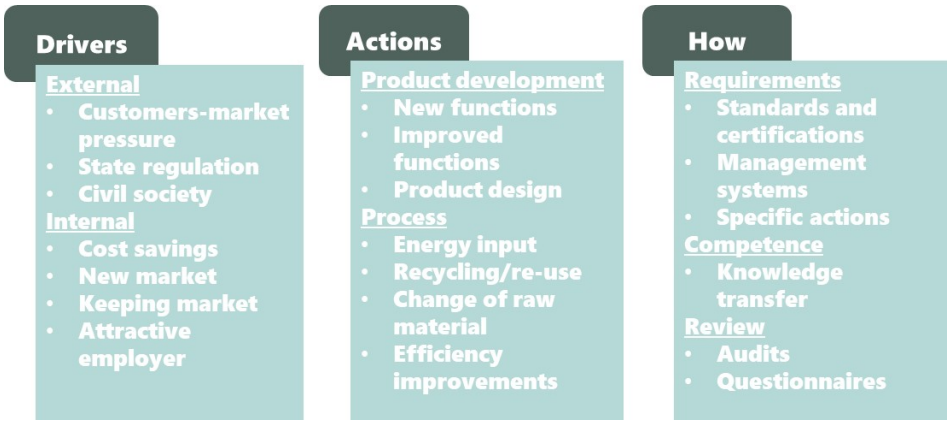
Analyzing the management of the global value chain (GVC) is about studying the content and interaction of decision-making at brand companies and between companies in the supply chain, the reasons why individual decisions are made, the methods chosen to implement them, the systems through which the results are monitored, and the consequences in the event of deviations (Ponte and Sturgeon, 2014). The academic literature shows that this dynamic tends to be controlled by large companies (the so-called brand companies or OEMs), which often have access to final markets and exercise bargaining, demonstrative, institutional, and constitutive power over suppliers and subcontractors (Dallas et al., 2019).

In recent years, the scientific literature on global value chains has begun to include social and ecological sustainability (see, for example, Barreintos et al., 2011; Evers et al., 2014; Milberg and Winkler, 2011; Bolwig et al., 2011; 2010). This development has meant that a greater focus has been placed on the influence of external actors on global value chains (De Marchi, 2011; Clarke and Boersma, 2015; De Marchi et al., 2019; Ponte, 2019). What is more, this concerns how different regulations and policy goals influence decisions and interactions in supply chains (see, for example, Horner 2017). But it can also be a matter of how companies try to create competitive advantages by becoming more ecologically sustainable, developing environmentally friendly products, making production more environmentally friendly, or creating an organization and business model that work to contribute to climate and environmental goals (Porter and Kramer, 2006; Orsato, 2006; Krishnan et al., 2017).

2.1 The green transition of global value chains

The framework used in several academic analyses is based on three aspects that describe the green transition of supply chains (see Figure 2). The first aspect concerns driving forces, answering the question of why companies are moving towards sustainability. The second aspect concerns the concrete activities that companies use to become sustainable. This aspect can also be formulated as activities that are internal to each company, since it only concerns the company's own operations. The third aspect is about the management of the transition of an entire supply chain.

Figure 2. Aspects for the understanding of the transition to green supply chains



Before we go into the three aspects in more depth, we need to define what we mean by *green transition* in this analysis. Green transition generally refers to an economy that has very low greenhouse gas emissions and is resource-efficient and socially inclusive, i.e. a green economy (UNEP, 2011). The focus is on sustainable consumption and production, as well as resource efficiency. Sustainable consumption and production aim to improve practices to reduce resource consumption and the generation of waste and emissions across the full lifecycle of processes and products. Resource efficiency refers to the ways in which resources are used to deliver value to society and aims to reduce the amount of resources needed and emissions and waste generated per unit of product or service. In the literature on global value chains, it is common to use the phrase environmental upgrading instead of green transition (de Marchi et al., 2019). Environmental upgrading is defined as any change that results in the reduction of a firm's ecological footprint—such as its impact on greenhouse gas emissions, biodiversity losses, or natural resource overexploitation. The definitions are thus very similar, as they focus on the same type of activities and actions. However, we have chosen to call it a green transition.

2.1.1 Why? Drivers for green supply chains

De Marchi et al (2019) have identified three key types of driving forces that justify the environmental upgrade of global value chains:

1. External pressure from external actors such as consumers, NGOs, the financial market, and the state.
2. Pressure from large companies on their suppliers along the value chain.
3. Internal motives at each firm to be more attractive and increase competitiveness.

State regulations were one of the first external driving forces examined in the literature on environmental economics. This literature emphasized the importance of public intervention in correcting market failures (Rennings, 2000). This is also one of the more important external driving forces for the transition to green global value chains. However, regulations often have unexpected, and sometimes undesirable, side effects. Hellsmark et al. (2016) show, for example, how governmental regulation counteracted the commercialization of more sustainable biofuels. The Growth Analysis report titled "The role of the state in green transformation through active industrial policy" (Tillväxtanalys, PM 2018: 10) contains a review of difficulties that exist with government regulation aimed at a green transformation of the industry.

In the absence of ambitious regulation, independent third parties and non-governmental organizations may be important in the transition to green global value chains. NGOs can create awareness among public and private customers (Poulsen et al., 2016). This results in a risk of branded companies getting a "bad reputation" if they are perceived as less environmentally conscious than their competitors are. This reputation risk not only affects demand but also the financial market's assessment of the company. An example where interest groups have successfully influenced development is the traceability system for the use of so-called conflict metals (3TG metals) developed by branded companies in the electronics industry after campaigns conducted by interest groups drew attention to how the trade in these metals was used to finance armed conflicts in Africa in the early 2000s (Young, 2015). Expectations of increased transparency regarding the ecological and social sustainability risks for companies and global value chains can thus be an effective driving force for change.

Large companies, often OEMs, have a unique role in global value chains, as they often have a direct relationship with end consumers. They are therefore directly affected by customer preferences. Large companies can therefore act as a driving force for the green restructuring of global value chains by implementing their own actions and engaging with their subcontractors (Khattak & Stirnger 2017; Poulsen et al., 2016). Jeppesen and Hansen (2004) have shown that large companies can stimulate the environmental change of value chains by encouraging suppliers to implement environmental innovation. By using its market power, large companies can create standards for their suppliers that force a green transition (Evers et al. 2014; Ponte & Ewert 2009; Raj-Reichert, 2019; Azmeh & Nadvi, 2014).

Companies can also have internal motives to become greener. This may involve creating a competitive advantage over direct competitors or creating new demand. This is therefore a proactive corporate strategy (Gonzales-Benito and Gonzales-Benito, 2006). Many times, measures that both reduce environmental impacts and lead to lower production costs are implemented (Orsato, 2006). This means that both OEMs and subcontractors may have internal motives for implementing green actions (Sako & Zylbergberg, 2017). In reality, several actors are often involved in the implementation of environmental measures: for example, through collaboration among OEMs, direct suppliers, subcontractors, and external players. These actors contribute their specific abilities and limitations (O'Rourke, 2006). Many times, local factors also play an important role. For example, interaction with local contexts where conflicts and tensions are developed are influencing the development of global standards (Neilson and Pritchard, 2009). The consequence of this is that decision-making and management processes are influenced by private and public actors who are both global and local (Lund-Thomsen and Nadvi, 2010; Gereffi and Lee, 2016).

2.1.2 What? Actions to reduce the environmental impact

A green transition can be achieved in different ways, focusing on different aspects of economic actors' actions. These actions can be divided into product and process development and business model development. In the literature, product and process development sometimes are grouped together under the label of technological environmental upgrading (Kattak et al., 2015).

The purpose of product development is to meet consumer needs or create new ones. The company thus works with product function or design. It can involve new functions or improved functions. The main purpose of process development is generally to reduce production costs or reduce material risks. Often this involves actions that improve the efficiency of processes or replace input goods or resources. It can therefore be seen as a synonym for the term resource efficiency. Business model development articulates how a firm creates and captures value and is associated with a transformation in the organization of a firm. It can therefore be seen referring to non-technological changes (Bohnsack et al., 2014). Sometimes, these three groups are treated simultaneously in the literature under the label organizational improvements (de Marchi et al., 2019).

2.1.3 How? Activities to manage the green transition

Changing a global value chain requires coordinated decisions, planning, and implementation between firms. How this is managed is therefore crucial to the outcome

of a green transition of global supply chains (Ponte and Di Maria, 2014). Activities can be divided broadly into support systems for requirements, skill-enhancing activities, and reviews.

Implementation of requirements is about the companies' ability to do business and control other companies' actions. An important part of this is digital support systems that may be necessary for companies to be able to collect and analyze information from the supply chains. Another important part is about ensuring that the information is relevant and accurate. To enable this, the industry develops its own standards and certificates. To ensure that suppliers and subcontractors live up to the requirements placed on them and implement the necessary measures, an audit by a certified third party is often used. However, it also happens that the audit is carried out by a first party (ie an internal audit) of the supplier or a second party audit (ie an external party that does not have certification).

However, the business of creating the conditions for a sustainable change of supply chains is not just about management and control. It is also about supporting suppliers and subcontractors in the transition. Knowledge transfer and support activities are therefore common. The purpose of these initiatives is to provide companies in the supply chain with specific knowledge on how to upgrade products, processes or organization and share experiences. Sometimes these activities can be managed and run by a trusted third party.

2.2 Three key questions

For this analysis, the above theories are used to formulate three questions:

1. Why are the automotive industry's supply chains becoming greener? In other words, what are the driving forces for OEMs and direct suppliers and subcontractors, respectively?
2. What do companies do to become green? In other words, what actions are companies taking to reduce the environmental impact of production and to become less vulnerable to physical climate risks?
3. How do companies act to create green supply chains? In other words, what organizational and governance changes are being implemented to create the conditions for the reorganization of entire supply chains?

Based on the answers to these questions, barriers, obstacles, and market failures in the transition to competitive green supply chains in the automotive industry are identified.

3. The OEMs and the transition to green supply chains

In this chapter we ask three questions—Why do OEMs aim to develop green supply chains? Which actions are prioritized? How do they manage, monitor, and audit suppliers? These questions are answered through official documents, as well as interviews with a number of OEMs.

3.1 Why the OEMs develop green supply chains

There are both external and internal motives for automotive OEMs to develop greener supply chains. However, most of these motives are related to the transition to electric vehicles and the increasing use of self-driving technology. As mentioned in Chapter 1, this transition most likely will result in a situation where vehicle manufacturing dominates the environmental burden instead of the consumption of gasoline and diesel. This transition has been driven by state regulations and new players that have started competing with traditional OEMs. One example is Tesla, whose market value in the mid-2020s was three times greater than the value of Ford and GM together, even though it is not close to producing the same number of vehicles (see Table 1). There are also several examples of suppliers (Tier 1) having starting producing vehicles themselves: for example Continental, Bosch, and Sony for passenger transport.

The electrification of vehicles is also driven by mandatory emission-reduction targets, especially EU targets, which were fully applied from 2015 onward (EC 443/2009) and became more ambitious in 2020 and onward (EU 2019/631). Following a phase-in from 2012 onward, a target of 130 grams of CO_2 per kilometer applied to the EU fleetwide average for new passenger cars manufactured between 2015 and 2019. From 2021 on, phased in starting in 2020, the EU fleetwide average emission target for new cars will be 95 g CO_2/km. In 2030, the target is 57.4 g CO_2/km. If average emissions for a manufacturer's fleet exceed its target in a given year, the manufacturer has to pay an excess emissions premium for each car registered. Since 2019, the penalty has been €95 for each subsequent gram per km in excess of the target. The more ambitious target will require electrification of the vehicle fleet (Fritz et al., 2019). The transition to electrification has also been influenced by other public policy measures, such as subsidies for electric vehicles, and countries and cities that have banned future sales or use of vehicles powered by fossil fuels. Although these requirements are not directly about the climate footprint of vehicle manufacture, the consequence is that these emissions will be more important to manage.

There are also state regulations forcing OEMs to increase the environmental transparency of their supply chains. In interviews, it has been clear that mandatory due-diligence laws have an impact. The French Duty of Vigilance law has forced Groupe PSA and Renault to work on these issues more seriously. A similar law is under discussion in Germany, and the industry is preparing for its implementation. This law not only requires companies to take measures to identify risks within their supply chain and to prevent violations; it also specifies that those measures must be adequate and effectively implemented. Hence, the law cannot be interpreted as a formal "box-checking" exercise. The measures will also be public and enable stakeholders to scrutinize whether a company has correctly identified

the risks caused by its activities and whether the measures taken to address those risks are adequate and effectively implemented. Finally, judicial mechanisms have been included to enforce the law and sanctions.

In recent decades, states have also regulated the use of hazardous chemicals and materials. This is still an important topic for automotive OEMs. In several interviews, the EU regulation on registration, evaluation, authorization, and restriction of chemicals (REACH) has been mentioned as an important driver for transparency in supply chains. To comply with the regulation, companies must identify and manage the risks linked to the substances they manufacture and market in the EU. The aim of REACH is to improve the protection of human health and the environment from risks that can be posed by chemicals.

The increased interest in supply-chain environmental impact is also a consequence of the gap in trust after "Dieselgate": i.e., the Volkswagen emissions scandal that got noticed in 2015. Even if the scandal was about the manipulation of emissions from the engines and not the supply chain, it affected risk management in supplier and subcontractor factories. Anders Kärrberg, head of global sustainability at Volvo Cars, concludes that the traditional automotive industry has lost acceptance due to recent years' ethical and environmental scandals, not at least being Dieselgate. In the interviews for this project, it was also evident that Dieselgate also negatively impacted the ability to attract skilled people to the automotive industry and to most of its supply chains.

The new market situation means that business models are changing and that new values drive profitability. From several OEMs annual reports, it is evident that the environment, climate, human rights, and working conditions in the whole value chain have been increasingly important factors in value creation. For example, Volkswagen aims to be an environmental role model, going beyond requirements found in regulations. For all products and mobility solutions, the company aspires to minimize environmental impacts across the entire lifecycle—from raw materials extraction until end-of-life—in order to keep ecosystems intact and to create positive impacts on society.[3]

3.2 Which actions do OEMs take to create green vehicles?

In official documents from OEMs, it is evident that several of them prioritized two areas related to vehicle manufacturing:

1. CO_2-neutral mobility, with a focus on electrification but also highlighting the use of renewable energy and recycled bulk metals (steel, aluminum, and plastics) in the manufacturing of vehicles.
2. Resource efficiency and the transition to a circular economy. This relates to the use of energy, water, chemical, plastics, and metals, as well as other substances.

Both these areas mean that automotive industry OEMs have a lifecycle perspective: i.e., their aim is to do end-to-end analyses, including sustainable sourcing of materials, sustainable production for the entire supply chain, and sustainable use of vehicles, as well as recycling and reuse. This means that they have to work through actions to reduce

[3] Volkswagen, Mission statement Environment

the environmental impact in their own business (including reuse of components) and the upstream supply chain, as well as the recycling industry. A crucial part of this transition is interaction with suppliers and subcontractors and control of the actions they take.

3.2.1 On the way to climate neutrality

During recent years several car manufacturers have prioritized the transition to CO_2-neutral mobility from a lifecycle perspective. Mercedes-Benz has set a goal of making its fleet of new cars CO_2-neutral for the vehicle's entire lifecycle by 2039. Volvo Cars will be climate neutral by 2040, while Volkswagen, PSA, Scania, and Toyota will do so by 2050.

Increasing numbers of OEMs are also making short-term emissions targets. Volvo Cars has the ambition of reducing emissions by 40 percent between 2018 and 2025, from a lifecycle perspective. To achieve this target, 50 percent of global sales by 2025 will be fully electric cars, the global supply chain will reduce its emissions by 25 percent and emissions from the company's own manufacturing and logistics will be reduced by 25 percent. Martina Buchhauser, responsible for procurement at Volvo Cars, notes that this journey must be made together with suppliers and subcontractors and that the whole business is under threat if the transition does not start immediately. Four hot spots have been identified—the production of lithium-ion batteries, steel, aluminum, and plastics. All hot spots are thus under the control of suppliers and subcontractors. Emissions from these hot spots will be reduced by increasing the use of renewable energy and shifting to recycled materials. This is particularly relevant for aluminum, whose carbon footprint is planned to be halved by 2025, mainly through a shift to recycled aluminum.

Volkswagen has targets that are similar to those of Volvo Cars. By 2025, greenhouse gas emissions per car will be reduced by 30 percent relative to 2015. A large fraction of this reduction is supposed to come from manufacturing, where CO_2 emissions will be reduced by 45 percent per car by 2025 compared to 2010. Volkswagen's new model ID.3 is noted to be climate neutral. The target for Mercedes-Benz is that half of the cars sols in 2030 should be fully electric or plug-in hybrids.

In 2017, Renault decided that the carbon footprint per car should be reduced by 25 percent by 2022 compared with 2010. As of 2019, emissions were reduced by 17.9 percent. Already by 2016 Renault decided that the emissions from manufacturing (including suppliers and subcontractors) should be reduced by three percent annually. The French competitor PSA has not formulated a numeric target and instead express it as achieving emissions from Groupe PSA and its suppliers and subcontractors that are in line with the ambitions of the Paris Agreement by 2035. However, the lack of a common and accepted method for calculating greenhouse gas emissions from production is a major challenge for this work, according to Eric Richter at PSA. Currently, different methods are used, which makes it more or less impossible to define requirements based on CO_2 emissions during the production of components. Kristina Schrader at Volkswagen notes this same barrier for purchasing.

FCA (Fiat Chrysler Automobiles) has a target of reducing greenhouse gas emissions from its own assembly and stamping factories by 32 percent per vehicle by 2020 relative to 2010. Toyota's target is to reduce emissions per vehicle from a lifecycle perspective by at least 25 percent between 2013 and 2030. During the same period, emissions from Toyota's own plants will be reduced by 35 percent.

Truck manufacturers also have goals and activities seeking to reduce greenhouse gas emissions. However, a truck generally has a larger share of its emissions during the use phase compared with a car, and the shift to electrification is expected to take a longer time, especially since the lifetime of a truck model is much longer than that of a car. The Volvo Group estimates that the use phase accounts for 95 percent of the total climate footprint of a truck. Unlike cars, the electrification of the powertrains is not as certain, either. For example, Scania has identified four alternatives for propulsion—batteries, fuel cells, biodiesel, and gas—in its documentation for a change toward fossil freedom by 2050. By 2025, Scania's goal is to reduce greenhouse gas emissions by 50 percent from the company's own plants relative to 2015, while emissions from overland transport will be reduced by 50 percent relative to emissions in 2016. By 2020, all electricity used will already be fossil-free.

3.2.2 Increased share of renewable energy

Scania has identified the importance of the energy mix in reducing greenhouse gas emissions from manufacturing. This applies in particular to German vehicle manufacturers, since the lack of a nuclear power option means a need to focus on the transition to renewable energy sources. Mercedes-Benz, for example, aims to ensure that all the company's plants in Germany will be supplied with carbon-neutral energy sources by 2022. Electricity will come exclusively from renewable energy sources. In order to meet the target by 2022, however, Mercedes-Benz will have to use carbon offset projects, including emissions from the combustion of natural gas in the company's own cogeneration plants.

The aim of the BMW Group is for all of its own factories to be supplied with renewable electricity by 2020. Like Mercedes-Benz, this will be done by contracting renewable electricity and increasing self-production of renewable electricity. Volkswagen has also made the choice for renewable electricity; see Box 1. Volvo Cars has similar activities, but it has also allowed the possibility for nuclear power to be part of the solution to reducing emissions from their own plants. However, suppliers to Volvo Cars are required to increase the use of renewable energy. A consequence of this can be that the requirements on suppliers are tougher than those on the own business.

The French OEMs PSA[4] and Renault are also implementing measures to increase the share of renewable energy. In 2018, PSA plants in Slovakia and Brazil were supplied with 100 percent renewable electricity. In 2019, a contract was signed with a Spanish electricity trader to supply three PSA plants in Spain with renewable electricity. Renault's goal is for the share of renewable energy in its own factories to be 20 percent by 2020.

FCA has a goal of 100 percent renewable electricity in all its plants in Europe, Russia, the Middle East, and Africa by 2020. Ford aims to have all energy used in the company's plants come from renewable energy sources by 2035. Toyota has the same goal for their plants but does not expect to achieve it until 2050.

3.2.3 Recycling and reuse

Greenhouse gas emissions are also reduced through a transition to recycled materials and reuse of components. For example, Volvo Cars wants 30 percent of all material to be

[4] PSA (2019). Climate report—Driving climate leadership.

recycled or bio-based by 2025. PSA has a similar goal, but it will not be achieved until 2035. Toyota has a long tradition of reusing batteries from the Prius electric car and since 2012 has collected over 40 tons of magnets in order to recycle their rare earth elements. A model plant is also built in Vietnam to efficiently recycle materials from end-of-life vehicles.

Since the use of steel and aluminum for primary raw materials has been identified as a significant source of a vehicle's greenhouse gas emissions, some vehicle manufacturers have made greater efforts to increase the proportion of recycled steel and aluminum. For example, FCA has established a closed system for steel and aluminum recycling in Europe. Today, up to 25 percent of the aluminum used in some vehicles manufactured in Italy is recycled. Audi has initiated a pilot team working with the aluminum industry to increase the proportion of recycled aluminum by creating a closed system.

Several vehicle manufacturers carry out activities to increase the proportion of recycled plastics. Ford's ambition is that in the future vehicles will only contain plastics that are recycled or produced from organic raw materials. FCA requires suppliers and subcontractors to increase the proportion of recycled plastic. Toyota is developing plastic recycling technology that enables quality and performance requirements to be met. PSA aims to have at least 15 kg of recycled plastic in all of the group's vehicles by 2025, which corresponds to about half of the total amount of plastic in a vehicle. Renault aims to increase the proportion of recycled plastic by 50 percent between 2013 and 2022.

3.2.4 Towards no use of fresh water

Even if the focus is on greenhouse gas emissions, other areas of concern are also highlighted in OEM environmental reporting. One of these areas is water scarcity, and especially the use of fresh water. Several OEMs have specific goals and activities for the use of water in their own plants. These are primarily short-term goals. Ford will reduce water use by 30 percent by 2020 relative to 2015. FCA will reduce its use of water by 40 percent per produced vehicle by 2020 compared to 2010. BMW fill reduce its use by 45 percent per vehicle between 2006 and 2020, while Daimler has a target of 15 percent reduction by 2020 compared to 2015. Volkswagen has a target of 45 percent less water use per vehicle by 2025 compared to 2010. Renault's target is a 20-percent reduction between 2013 and 2020. These reductions will primarily be a result of a shift to production technologies that require less water and a shift to other water sources: for example, wastewater from other industries.

Some vehicle manufacturers are also making more extensive investments in plants located in areas where water supply is more problematic. For example, since 2016, FCA has used a risk assessment method for identifying areas where the water supply is particularly critical. This risk assessment has motivated the implementation of projects in the company's production in India. This project uses rainwater, and local personnel are trained in water management.

A few OEMs have long-term targets. Both PSA and Ford have the ambition of achieving zero freshwater use in the company's plants by 2050. Toyota has the long-term ambition of minimizing the use of water and adjusting water use to local circumstances.

3.2.5 External physical climate risks

Both climate neutrality and the use of water could be described as actions to manage transition environmental risks: i.e. they are the result of the company's own businesses. Almost none of the OEMs highlight external physical climate risks in their reporting: i.e., acute risks such as hurricanes and floods, and chronic physical risks associated with long-term climate change (e.g., drought and sea-level rise). The exception is the French companies PSA and Renault.

Renault writes, "Certain extreme climate events may disturb or even, in the most serious cases, temporarily stop operations at some of the Group's plants and logistics facilities." The main climate risks likely to impact Renault plants are flooding (for example, the French plants in Choisy-le-Roi and Flins, located close to the Seine River), typhoons (for example, the Busan plant in South Korea), and hailstorms (in particular, the plants in Santa Isabel in Argentina, Valladolid in Spain, Flins in France, Revoz in Slovenia, and Pitesti in Romania). Hail has already affected plants. To protect itself against these risks, the company took measures between 2010 and 2013 to protect vehicles standing in storage areas from being destroyed by hail. However, there are also plans for mitigation measures against floods and typhoons.

In their CSR report, PSA notes the consequences of more frequent extreme weather events or natural disasters, which can damage the production facilities owned by the Group and its supply chain, disrupt production, lead to costly delivery delays for end customers, and result in plant repair costs. They also conclude that these risks have an impact on the cost of insurance.

3.3 How are OEMs managing the transition to green supply chains?

A starting point for the OEMs' work with environmental issues in the supply chains is the sustainability requirements they have on their direct suppliers (Tier 1) and on strategic subcontractors. They expect Tier 1 suppliers to impose similar requirements on their suppliers: i.e., subcontractors. This is the most common way of creating sustainability throughout the supply chain, generally called the cascade method. One disadvantage of this cascade approach is that it is difficult to assess the information for the entire supply chain: for example, if a supplier or subcontractor reports incorrect information or double-counts the same product on different specific sustainability certificates. This is further complicated by the fact that the OEMs do not fully know all companies in the supply chain and the location of their plants.

Vehicle suppliers generally assess suppliers' sustainability risks based on information gathered using four different methods:

4. Self-assessment questionnaires answered by suppliers.
5. Assessment of the specific national risks for the countries where the supplier has production facilities.
6. Reporting of the materials and chemicals used in the manufacture of component.
7. More in-depth review of suppliers and subcontractors who have or are deemed to have greater sustainability risks.

3.3.1 The OEMs collaborate

In recent years, most European automotive OEMs have begun to collaborate in the "Drive Sustainability" initiative. One of the most important actions in this initiative is a joint self-assessment questionnaire on supplier sustainability risks, generally called the SAQ. The purpose of the SAQ is to streamline the work of providing vehicle OEMs with information on sustainability risks in the supply chain. Many suppliers and subcontractors have multiple OEMs as customers, and through these questionnaires, most of them only have to reply to one questionnaire. The Automotive Industry Action Group (AIAG)—the American counterpart to Drive Sustainability—uses a nearly identical survey called the SSSA. This means that a supplier only needs to complete one survey, even if it has several OEMs as customers. Most OEMs today have implemented the SAQ or the SSSA (see Table 2). The questionnaires have similar content. They relate to suppliers' internal work in four areas—business ethics, social risks, environmental risks, and how the suppliers impose requirements on their suppliers and how they support their suppliers in sustainability improvements.

Table 2. The use of different reporting systems

	Environmental management system	IMDS	SAQ	SSSA	CDP
Volkswagen Group (incl. Scania)	X	X	X	X	X
Volvo Group	X	X	X		
Volvo Cars	X	X	X		
Groupe Renault	X	X	X		
Groupe PSA	X	X			
Daimler Group	X	X	X		X
BMW	X	X	X		X
Toyota	X	X	X	X	
Ford	X	X	X	X	X
GM	X	X		X	X
FCA	X	X		X	X

The environmental part of the SAQ is focused on the existence of a formal environmental policy, the implementation of a certified environmental management system (e.g. ISO 14001) and energy management system (e.g. ISO 50001), procedures to identify and manage substances with restrictions, education and training of employees, and how suppliers work with subcontractors.

The OEMs require suppliers to have a certified environmental management system like ISO 14001 (see Table 2, ISO 14001 is explained in Chapter 4.2.3), but the requirement is implemented differently. Some of them, e.g. BMW, include the requirement for suppliers with more than 50 employees. Groupe PSA also allows suppliers to demonstrate that they are taking steps to become certified if they not already are certified. Toyota is very specific in that business partners are required to confirm, advise and direct environmental management systems with their upstream business partners, i.e.

subcontractors in Tier 2 to Tier N. Tesla's code of conduct for suppliers contains a requirement on environmental management systems to ensure compliance with all applicable environmental laws and regulations. However, the system does not need to be certified.

Several OEMs have goals that relate to the proportion of suppliers who have answered the questionnaire. In addition, some OEMs have goals for the results, which means that suppliers can be disqualified if the sustainability risk is considered too large. The Volkswagen Group is one example where this has been applied since the beginning of 2020. This transition has been a challenge, as several key suppliers risked not meeting the required score. Joelle Moché at Sustainability Procurement Scania, which belongs to the Volkswagen Group, notes that significant efforts have been made to train suppliers, and in some cases, individual in-person meetings have been needed in order to increase the score of key suppliers.

For the use of substances with restrictions, the OEMs also have developed a database for detailed reporting, called the International Material Data System (IMDS)[5]. All traditional automotive suppliers are using this system today (see Table 2). The purpose of the system is to collect, maintain, analyze, and save information on the materials used in the manufacturing of a vehicle. This is information that vehicle suppliers need to report in order to comply with various legal requirements, but it is needed when materials will be recycled. For example, this information may be needed when specific chemicals are banned (e.g., under the REACH regulation) or if the supplier shows that 95 percent of a car can be recycled. The system requires all banned substances to be reported and for at least 90 percent of all materials (in relation to weight) to be reported.

3.3.2 CDP supply chain programs

Several automotive suppliers also encourage their suppliers and subcontractors to report, set targets, and review greenhouse gas emissions and water use through CDP (formerly the Carbon Disclosure Project) programs (see Table 3). The CDP not only increases transparency in reporting but also allows for comparisons between competitors. The SAQ has specific questions regarding participation in the CDP.

In the interviews, it was evident that automotive suppliers are involved with the CDP because it is judged as a trusted actor, as it is a non-profit organization and a high CDP score is positively linked with financial results. When the CDP asked its members about the importance of being able to demonstrate leadership in ecological sustainability, 95 percent responded that it is financially better to have suppliers and subcontractors who are leaders in the environmental field, while only 5 percent responded that these supplies are more expensive (CDP, 2019).

Table 3 summarizes the climate change ratings of some companies, including OEMs, steel producers, and other suppliers. Only a few of them have the highest score, A; in this group you find, for example, PSA, Ford, Toyota, and the steel producer TyssenKrupp. Several companies are rated A- or B. Swedish companies tend to have lower ratings. This is not true only for the automotive sectors. In Table 4 we see that French and Japanese

[5] The system was originally developed in the late 1990s jointly by Audi, BMW, Daimler, Ford, Opel, Volkswagen, Volvo, and DXC. Today the system is used by virtually all global vehicle manufacturers.

companies generally received As, while almost all Chinese companies have the lowest score, F.

Table 3. Climate-change rating in the CDP database for 2019 (Swedish firms in bold)

	A	A-	B	C D E	F
OEMs	PSA, Toyota Hyundai & Kia, Ford, Paccar	BMW, Daimler, Renault, VW, GM, FCA, Mazda	Suzuki, Honda, Mitsubishi		Geely, **Volvo Group**, Tesla, Saic, Donfeng
Suppliers		BASF, Faurecia, Aisin Seiki, JTEKT	Continental, Mahle, Schaeffler, Valeo, Denso, Robert Bosch, Sumitomo, Aptiv	**Thule**, Magna, Lear	**SKF, Gränges**, Plastic Omnium
Steel	ThyssenKrupp	Voestalpine, ArcelorMittal, Salzgitter, POSCO, Hyundai Steel	Nippon Steel, Tata Steel, JFE	**SSAB**	Baoshan

Table 4. The share of companies with specific CDP climate-change ratings in different countries and all sectors

	A	B	C	D	F	Number of companies
Sweden	10.3	18.0	14.5	6.0	51.2	117
France	20.4	10.8	7.3	5.0	56.5	260
Germany	9.2	18.8	11.2	7.1	53.7	197
Italy	11.1	24.4	5.6	6.7	52.2	90
Netherlands	11.8	20.6	20.6	5.9	41.1	68
USA	13.1	20.1	16.7	7.0	43.1	435
Japan	18.1	27.1	9.2	7.4	38.2	541
China	0.5	0.4	1.8	3.4	93.9	815

CDP ratings are based on a self-evaluation by companies. It is a very comprehensive self-evaluation, but there is a shorter version for companies with a turnover of less than 250 million Euros. Mona Freundt at CDP states that they often receive feedback that the evaluation is an administrative burden but that it also contributes to companies themselves achieving a better understanding of what measures are effective.

The self-evaluation requires suppliers and subcontractors to:

- Identify transition[6] and physical[7] climate risks that can have a significant financial impact on business.
- Describe these risks in terms of likelihood, consequences, when it may arise, and an estimate of financial impact.

[6] Divided into risks cause by policy/regulation, technical, market development and negative news.
[7] Divided into acute and chronic risks.

- Identify climate-related opportunities that may have a financial or strategic impact on the business.
- Describe these opportunities in terms of what they are in the supply chain, type of opportunity[8], when it may arise, probability of realization, and an assessment of financial impact.
- Annual calculations of greenhouse gas emissions from own operations (Scope 1); indirect emissions from the use of electricity, heat, and steam (Scope 2); and indirect emissions from upstream and downstream activities in the supply chain (Scope 3).
- Greenhouse gas emission targets for Scope 1, 2, and 3, including whether these are based on the methodology of Science-Based Targets for greenhouse gas emissions[9].
- Actions taken to reduce emission and estimates of their effect.
- Distribution of greenhouse gas emissions between different customers during the past year.

Soline Bonnel, head of the automotive supply chain at CDP, notes that reporting has improved in recent years. This is partly because vehicle manufacturers (OEMs) have made clearer requirements on the supply chains, but also because they have joined the CDP in webinars with the aim of explaining why these requirements are important, as well as supporting suppliers and subcontractors in their evaluation. A particularly intensive effort is now being made to increase the response rate from Chinese companies and to get more companies to define Science-Based Targets for greenhouse gas emissions.

3.3.3 PSA has chosen a different pathway

There are vehicle suppliers who do not base their environmental assessment of the supply chain on self-assessment questionnaires. This includes PSA, which since 2015 has based its assessment of sustainability risks on the company EcoVadis. A major difference with this approach is that a third party assesses suppliers' sustainability risks, which include country-specific risks. In 2018 the suppliers of PSA received an average score of 48.2 out of a maximum of 100, compared to 42.2 points for all companies included in the EcoVadis database.

PSA also has short-term targets for supplier results in EcoVadis assessments. For environmental risks, the target for 2019 was a score of 54 points, and the result was 54, which is an increase of 1 point. The target for 2020 is to stay at 54. They also have a separate target of 70 percent of key suppliers demonstrating a CO_2-trend that complies with the Paris Agreement. In 2019, 67.7 percent of key suppliers (based on turnover) were in line with this target, an improvement of 7 percent relative previous year. In the same way, PSA has targets for the social sustainability score.

All suppliers and subcontractors in the PSA supply chain are required to participate in the EcoVadis assessment. If deviations occur, action plans must be created and implemented. In 2018, 93 percent of PSA purchases went through the process. The result of the evaluation from EcoVadis is also used by PSA to identify where to focus activities and is a part of the due-diligence process.

[8] For example, improved resource efficiency, shift of energy sources, changes in production and services.

[9] Implemented Jointly by CDP, UN Global Compact, World Resource Institute och WWF. https://sciencebasedtargets.org/

A major difference between the self-assessment questionnaire (SAQ) and the method used by EcoVadis is that the later adjusts the questions based on the company's operations, location, and size. This means that a large company in a high-risk country may get 50-70 questions to answer (much more than in the SAQ), while a smaller company in Sweden may get fewer than 10 questions (fewer than in the SAQ). According to Håkan Asp at EcoVadis, the method used by the company is closer to an on-site audit than a self-evaluation. He also concludes that the lowest scores tend to be on questions targeting the management of supply chain risks.

One reason for PSA to work with EcoVadis is, according to Erik Richter, head of procurement at PSA, the possibility of getting experiences from sectors other than automotive. Other EcoVadis customers include the telecom operator Atlinks, the insurance firm AXA, the coatings company Beckers, the nutrition, health, and wellness company Nestlé, and the electronics company Schneider Electric.

3.4 Main observations

This analysis can be briefly summarized in four points:

- Government regulation is the main motive for OEMs to transition to sustainable vehicle production. This is done both directly, by regulating the use of harmful chemicals and materials (for example through the EU regulations REACH), and indirectly, by requirements that lead to the electrification of vehicles. This has meant an increased focus on vehicles' total climate footprint.
- Greenhouse gas emissions from manufacturing are increasingly important in OEMs' sustainability reporting and policy documents. The two most important activities to reduce emissions are (i) a transition to recycled steel, aluminum, and plastic, and (ii) a transition to renewable energy.
- OEMs generally only impose sustainability requirements on direct suppliers and on a few strategic subcontractors. The idea is that these suppliers will pass on the requirements in the supply chain.
- Most OEMs collaborate with supplier evaluation and capacity-enhancing activities. In those areas where there are significant legal requirements (for example, from REACH), this has resulted in common reporting systems for direct suppliers and subcontractors.

4. The transition to green suppliers and subcontractors

In this chapter, we ask the same questions for suppliers—why do suppliers switch to green supply chains? What are the priorities? How do they manage, monitor, and control the transition? However, the answers to these questions are more divergent, as supplier companies are a more heterogeneous group than OEMs (see Chapter 3). There are suppliers that have larger turnovers and more employees than some of the OEMs. In 2018, seven suppliers had total revenues from the sale of components to the automotive industry that exceeded Volvo Cars' total revenues (see Table 5).[10] At the same time, there are suppliers with fewer than 50 employees selling components to the OEMs.

Table 5. The largest direct suppliers in the automotive industry

	Revenue from the sale of automotive components (millions of $)	Components
Robert Bosch Germany	49,525	Powertrain solutions, chassis systems controls, electrical drives, electronics, steering systems & battery technology.
Denso Corp. Japan	42,793	Thermal, powertrain control, electronic & electric systems, small motors, telecommunications.
Magna International Inc. USA	40,827	Body exteriors & structures, power & vision technologies, seating systems & complete vehicle solutions.
Continental Germany	37,803	Advanced driver assistance systems, electronic brakes, stability management tires, foundation brakes, chassis systems, safety electronics, telematics, powertrain electronics, injection systems & turbochargers.
ZF Friedrichshafen Germany	36,929	Transmissions, chassis components & systems, steering systems, braking systems, clutches, dampers, active & passive safety systems, driver assist system including camera, radar & lidar.
Aisin Seiki Co. Japan	34,999	Body, brake & chassis systems, electronics, drivetrain & engine components.
Hyundai Mobis South Korea	25,624	Automotive electronics, infotainment, ADAS, EV systems, module systems, lighting, airbags & brakes.
Lear Corp. USA	21,149	Seating, electrical systems.
Faurecia France	20,668	Seating, interiors, electronics, clean mobility.
Valeo France	19,683	Micro hybrid systems, electrical & electronic systems, thermal systems, wiper systems.

[10] Automotive news (2019). North America, Europe and the world—Top Suppliers.

Some of these suppliers have several OEMs as customers, while others have one dominant main customer, which in some cases reflects their entire revenue. Another difference is that some suppliers primarily produce components for diesel and gasoline engines, while others primarily sell components used in automated electric cars. In other words, some suppliers are producing components for a growing market, while others target a shrinking market.

In order to understand how heterogeneity affects the answers to our questions, a questionnaire was sent to more than 150 Swedish suppliers to the automotive industry. Unfortunately, only 32 of these companies responded, which means that the results in this chapter should be interpreted with some caution. This is especially true for small companies with fewer than 50 employees; the data is much more reliable for medium-sized (roughly a quarter responded) and large companies (about half responded). The questions in the questionnaire and the companies' answers can be found in Appendix 1. The questionnaire has been supplemented with interviews and official documents.

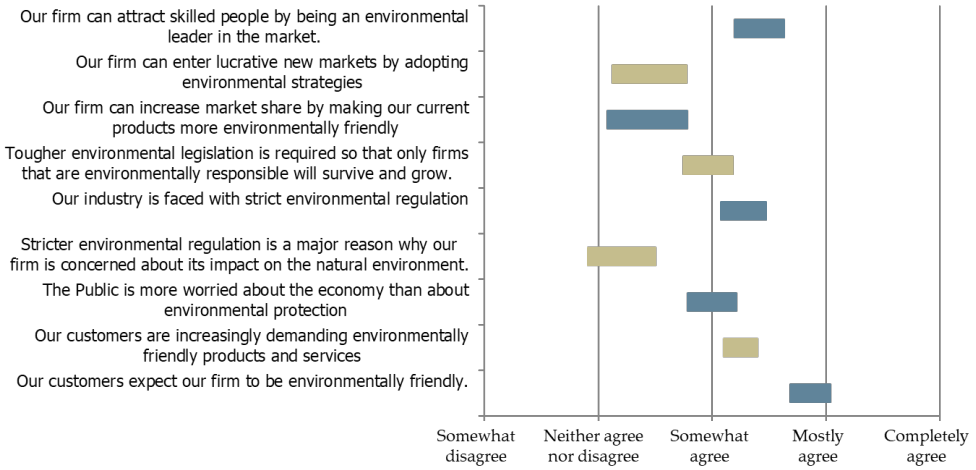
4.1 Why suppliers improve environmental performance

4.1.1 Customer expectations are the most important driver

In the questionnaire, suppliers were asked to indicate their agreement on statements related to customer concerns (in this case, the OEMs or other suppliers as buyers of material or components), regulatory governmental forces, and competitive advantages as drivers for environmental improvements. Generally, customer concerns were the most important driver for environmental improvements, and especially customers' expectation that the firm be environmentally friendly (see Figure 3). According to the nomenclature presented in chapter 2.2.1, this is an example of "lead firms" as drivers for transition. Requirements from customers, which also will be seen to be a lead-firm driver, are also an important driver for environmental improvements in production. In the questionnaire, the supplier rated customer demands for environmentally friendly products as one of the most important drivers. It is also an aspect that was highlighted in the interviews. One example is AC Floby who believes that environmental requirements from customers have become increasingly important and that this will require changes in their own operations, but perhaps even more so those requirements are also imposed on the company's own subcontractors.

Regulatory forces are generally believed to be a less important driver for environmental improvements. This is an example of an external driver (see chapter 2.2.1). Most suppliers neither agree nor disagree with the statement that stricter regulation is a major reason for improvements. At the same time, suppliers generally somewhat agree that they are faced with strict environmental regulation. In the interview, several suppliers explicitly mentioned REACH. They also somewhat agree that stricter environmental regulation is required, and thus only suppliers that are responsible will survive and grow.

Figure 3. Supplier's indication of agreement on a statement related to consumer concerns, regulatory forces, and competitive advantage (standard error of the mean)



Data from questionnaire; see Appendix.

The internal driver, the possibility of obtaining a competitive advantage, was generally the least important driver for environmental improvements for the respondents. Thus, being an environmentally leading supplier is not important for increasing market share or entering new markets. This can be interpreted as reflecting the fact that external expectations and requirements are more important for the environmental restructuring of companies' operations than internal drivers are. This result is also supported by the fact that the respondents to the questionnaire indicated that economy is a more important issue than environmental protection. This was also evident in some interviews, as they conclude that the price of the product is the most important factor. Environmental regulation motivates investments, even though they can drive up costs and thus affect profitability.

However, there is one example of an important "internal driver" for environmental improvement. Many firms believe it is important to be an environmental leader in order to attract skilled employees. This aspect was also mentioned in several interviews, most often in relation to younger skilled people.

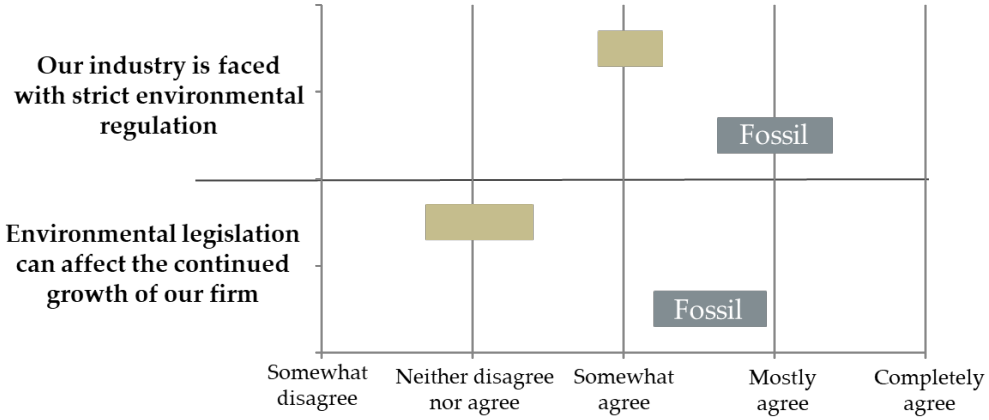
4.1.1.1 Governmental regulations as a more important driver for suppliers producing components for fossil fuel engines

The answers to the questionnaire about drivers did not differ significantly depending on turnover, number of employees, or whether the firm had a primary customer who accounted for more than half of revenue. This means that medium-sized enterprises with fewer than 250 but more than 50 employees generally experienced the same drivers as larger suppliers.

The biggest difference that can be found relates to suppliers who primarily sell components for gasoline and diesel engines. These suppliers tended to rate state regulation as a more important driver. These suppliers mostly agreed with the statement that the industry is faced with strict environmental regulation (Figure 4). Compared to other suppliers, they also believed that environmental regulation could affect the

continued growth of the firm. This is not surprising, given that countries and cities are increasingly discussing restrictions on the sale and use of gasoline and diesel vehicles.

Figure 4. Suppliers' agreement on statements regarding state regulation (suppliers mainly producing components for gasoline and diesel engines, i.e. fossil fueled, versus other suppliers)



Data from questionnaire;see Appendix (Standard error of the mean).

4.2 How suppliers improve environmental performance

Suppliers need to be aware of their sustainability risks in meeting customer and regulatory requirements. This knowledge is needed for reporting and also for the company to be able to reduce its own risks.

4.2.1 Suppliers generally do not have good monitoring of risks in the supply chain

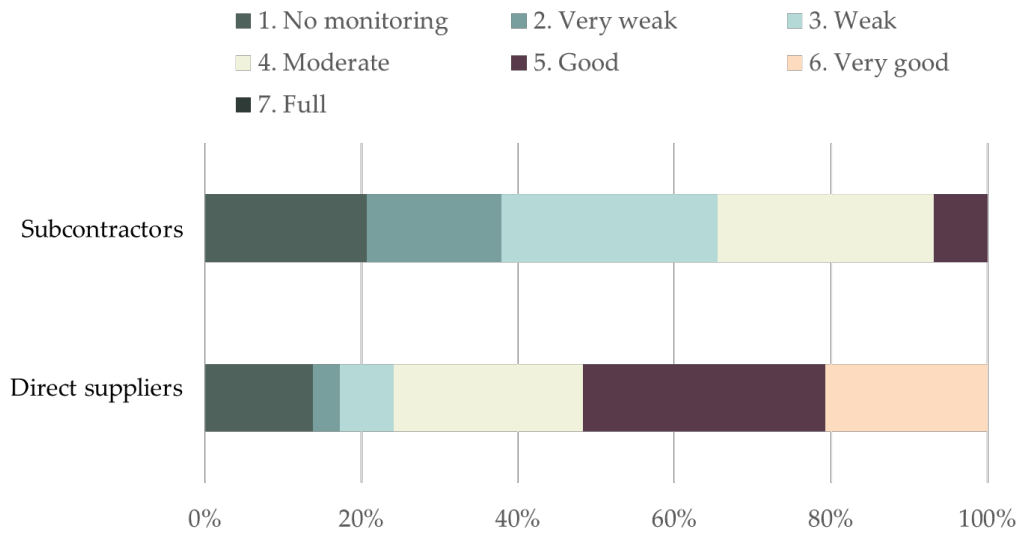
More than half of the suppliers assessed themselves as having good or very good monitoring of the environmental risks of direct suppliers (Tier 1). Still, several of them do not have any monitoring at all (see Figure 5). Most firms also believed they were better than their competitors; more than 50 percent of the suppliers believed they had better monitoring of environmental risks in their supply chain.

However, the situation is different when it comes to monitoring risks with subcontractors. About two-thirds of suppliers assessed themselves has having no, very weak, or weak monitoring of the environmental risks of their subcontractors (Tier 2 to Tier N). The understanding of sustainability risks for direct suppliers is thus much greater than that for suppliers further upstream. The answers do not indicate any significant difference between the size of the company or the type of product produced.

On the other hand, this can change rapidly, as OEMs have begun to put requirements on reduced emissions of greenhouse gases. In the interviews, it emerged that at least some suppliers have begun to carry out lifecycle analyses in order to identify subcontractors with significant amounts of emissions. This will then form the basis for requirements on emission reductions. One example is AC Floby, which will begin to put emission reduction requirements on supplies in order to meet the requirements of its largest customer, Volvo Cars. AC Floby already aims to be climate neutral by 2030 within their own operations. The company has also implemented measures, including moving to

train transfers from suppliers in Germany. At the same time, the lifecycle analysis shows that almost the entire climate footprint comes from the purchase of goods. Therefore, in order to meet the requirements of Volvo Cars, they will have to put requirements on their subcontractors. However, the focus is not on all suppliers. The lifecycle analysis is used to identify potential hot spots for greenhouse gas emissions.

Figure 5. System in place to monitor environmental risks in supply chain



Data from questionnaire; see Appendix.

4.2.2 Suppliers have more control over social and health risks

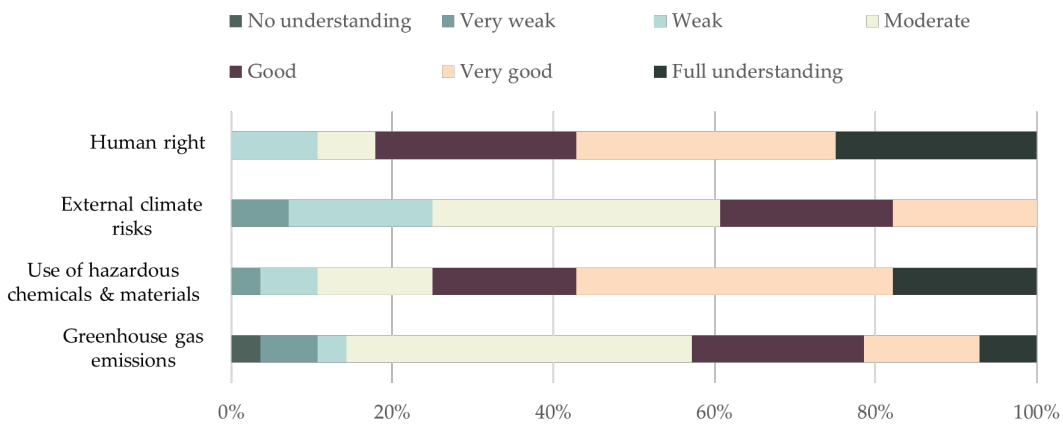
Although suppliers do not have control over their environmental risks, this does not indicate whether or not companies have risk management systems. One exception is the understanding of risks from using hazardous materials and chemicals. Approximately 80 percent of respondents to the questionnaire believed that they had a good, very good, or full understanding of these risks in their supply chains (see Figure 6). This corresponds to the suppliers' assessment of their knowledge about the risk of human rights abuses in their supply chains. Suppliers' understanding of other environmental risks is lower. Around 60 percent of supplies believed they had a very weak, weak, or moderate understanding of the risks of greenhouse gas emission in their supply chain, or external climate risks such as storms, hail, or drought.

One important reason for this difference between managing sustainability risks is that there are well-developed systems for reporting and monitoring risks regarding hazardous chemicals and materials, as well as for certain social rights, such as conflict minerals. The use of hazardous chemicals and materials are reported in the International Material Data System (IMDS) developed by the OEMs (see chapter 3), and the information is used to show compliance with REACH. Transparency on the use of minerals from conflict regions is based on OECD due-diligence guidelines, and the information is used to show compliance with the U.S. regulations (the Dodd-Frank Act).[11] This type of system does not exist for other environmental risks, and for many

[11] For more details, see Tillväxtanalys (2019). Spårbarhet och märkning av hållbara metaller och mineral—insatser för ökad transparens, trovärdighet och efterfrågan. PM 2019:01.

environmental risks, there is no internationally accepted methodology to assess the risks. For example, one problem mentioned in several interviews was the absence of a method on how the carbon footprint of products should be calculated. Several methods are used, which means that firms have difficulties in comparing the carbon footprint of products and communicating their own carbon footprint.

Figure 6. Suppliers' understanding of risks in their supply chains



Data from questionnaire; see Appendix.

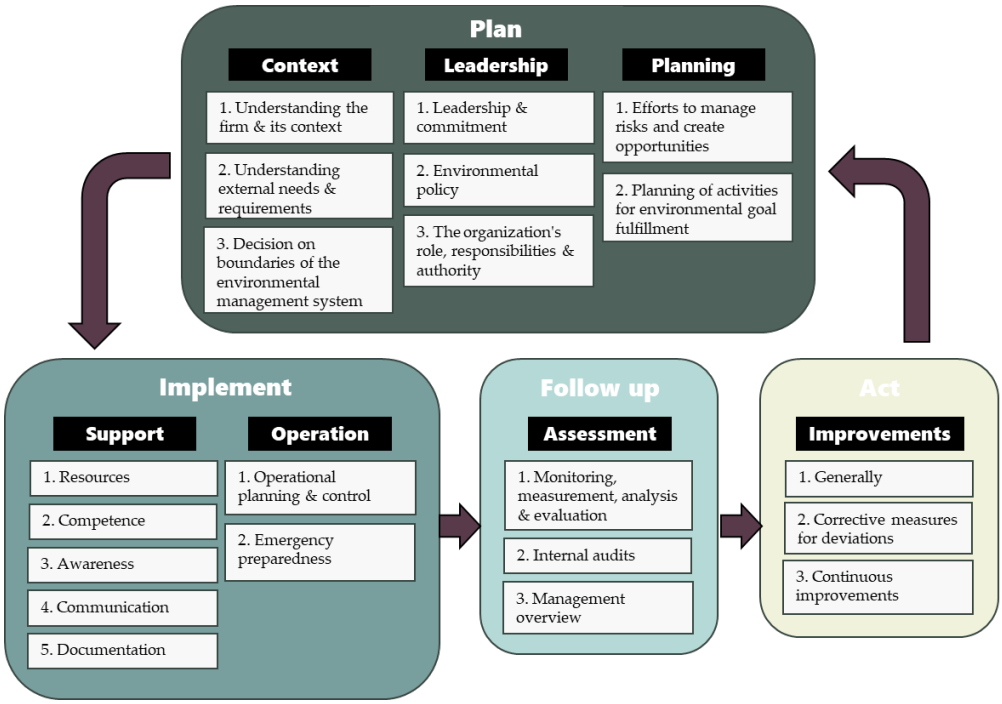
4.2.3 Almost all direct suppliers have a certified environmental management system

A key part of OEMs' assessment of suppliers is whether they are certified according to the ISO 14001 standard for environmental management systems. Out of the Swedish companies that are members of the Vehicle Components Group (FKG) and that have more than three employees, we found that at least 86 percent have ISO 14001 certification (see Table 6). This applies regardless of size; even companies with fewer than 10 employees were certified. However, there is a difference between industries. Virtually all traditional companies for the automotive industry—that is, companies that process and/or manufacture products made of metal, plastic, textile, or leather—are certified. However, several companies that provide vehicle manufacturers with electronics and other services do not have ISO 14001 certification. One reason for this difference in the implementation of ISO 14001 is cultural; the system is less frequently used within the electronic industry in general. Just under one-third of companies that manufacture electronics components and are members of the Swedish electronics trade association are certified.

The purpose of an environmental management system is to achieve continuous improvement in environmental performance: in other words, reduced environmental impact. Companies achieve this by, among other things, using the best possible technology, when this is financially motivated, and by complying with environmental laws. The system is based on planning, action, measurement, and improvement (see Figure 7). The focus is very much on the direct environmental impacts from internal processes, but the system also encourages upstream and downstream effects to be taken into account. The standard requires the firm to find out which internal and external issues or conditions may affect the environmental management system's results. It applies to all environmental aspects that the firm can influence or be affected by. The

company, therefore, needs to keep track of how relevant stakeholders are affected by the business. This helps the company to identify and report on risks and opportunities that exist, assess them, and, if necessary, respond appropriately. In other words, the standard is based on risk-based thinking.

Figure 7. A schematic structure of the environmental management system ISO 14001



Although a large proportion of Swedish suppliers have an environmental management system that is certified in accordance with ISO 14001, it is clear that the situation is different for subcontractors. At Haldex, which manufactures brake and air suspension systems, less than 40 percent, or about 850 subcontractors, were certified in 2018. German ZF Friedrichshafen AG aims to increase the proportion of subcontractors that are certified according to ISO 14001 or the equivalent, by having this as a requirement when new subcontractors with greater environmental impact are contracted. The ambition is thus lower than for OEMs, as they generally have ISO 14001 certification as a requirement for all suppliers or only except small firms from this requirement.

Tabell 6. Share of suppliers with an ISO 14001 certification

	Number of firms	ISO 14001 certified
Total	**184**	**86%**
Traditional suppliers	**123**	**94%**
Electronic components	**38**	**69%**
Consulting and logistics	**19**	**68%**

The numbers are based on an internet-based check of ISO 14001 certifications for the members of FKG.

4.2.4 The reporting burden is large but for most reasonable

One aspect of the OEMs' requirements is the administrative burden: i.e., the time and cost it takes to respond to self-assessment questionnaires, reporting to IMDS, and the use of conflict minerals. In the interviews, several of the respondents mentioned the IMDS and especially the frequent updates of new regulatory requirements in REACH.

In the interviews, some suppliers also mentioned barriers for new customers. In the automotive industry, it is normal for suppliers to pay to submit a tender. It is also a very time-consuming process, including a lot of documentation, certification, and on-site audits before the potential customer makes a decision. At the same time, some suppliers like to have automotive OEMs as customers, as these normally turn out to be long-term contracts and relations. The process can, according to some suppliers, be seen as a form of preservative and a means to counteract change.

Although several interviews indicate that reporting is time-consuming, the questionnaire shows that most suppliers consider the burden to be reasonable, given its purpose. This is true even for medium-sized companies. However, there are indications that small firms have problems with the reporting burden.

4.3 What suppliers do to improve environmental performance

Suppliers and subcontractors to the automotive industry have generally implemented measures motivated by their environmental benefit. Normally, this is a natural part of the implementation of the ISO 14001 environmental management system. These may be energy efficiency measures, waste reduction measures, conversion to renewable energy, and shifting to recycled or reused material. However, they may also include industrial synergies. For example, Eket-Uppåkra has a collaboration with the steelmaker Ovako. Mikael Carlsson at Eket-Uppåkra explains that the steel chips formed as waste in production go back to Ovako in the same trucks that came from Ovako. In this way, resource efficiency is created.

At the same time, several suppliers and subcontractors note that the classic vehicle manufacturers are slow with their changes. They are happy to continue along proven paths. There are several reasons for this. During the interviews, it emerged that vehicle manufacturers sometimes want to avoid the risk that exists with new solutions, without having to comprehensively control how the quality and function of the product are affected over the long term. This is also the core of the traditional automotive industry—being able to produce hundreds of thousands of vehicles with consistent quality. Another reason mentioned in interviews for why change is difficult was the lack of internal consensus among the OEMs. For example, the purchasing departments of the vehicle manufacturers set environmental requirements (for example, a ban on hexavalent chromium), but in this case the requirement was eliminated when specific product requirements were made.

4.3.1 Half of suppliers already choose renewable energy

One of the most common measures to reduce environmental impact is to replace fossil fuels with renewable energy. In the questionnaire, around half of the respondents said they actively chose renewable electricity (Table 7). Almost one-fifth only used renewable electricity.

Almost half of the suppliers also used other energy media based on renewable energy: e.g., biogas, biofuels, or district heating based on biomass. However, in reality, all suppliers in Sweden at least have a small share of renewable energy under the reduction quota obligation in biofuels. A truck fueled with diesel thus uses a fraction of biofuel in its tank.

Table 7. Suppliers' use of renewable energy

	Electricity	Other energy
Only renewable	**17%**	**10%**
Partly renewable	**35%**	**38%**
No active choice	**48%**	**52%**

Data from questionnaire; see Appendix.

4.3.2 Several suppliers already use a lot of recycled material

Generally, a transition from primary raw materials to recycled materials, along with a change to renewable energy, are the most important actions to reduce greenhouse gas emissions in the manufacturing industry. As already mentioned in chapter 3, the focus in the automotive sector is on bulk metals: e.g., plastics, aluminum, and steel, as they are used in large quantities and therefore can contribute significantly to emissions.

The questionnaire indicates that around 40 percent of plastics, aluminum, and steel used are solely or mostly recycled (see Table 8). However, this should only be seen as an indication, since it only represents around 20 suppliers (one-third of the respondents do not use these materials directly). When it comes to the use of bulk metals, and especially the use of aluminum, it is also evident that several firms did not know the origin of their supplies.

At the same time, the focus on recycled bulk materials is disputed among suppliers, as well as within academia and in terms of national policy. The reason is that it is not expected to be possible to simply switch to recycled bulk materials. Some suppliers will need an inflow of primary material. There are therefore discussions about how the emission burden will be distributed between primary and secondary materials. From the interviews, it is clear that primary and secondary producers don't have a consensus on this issue and that there may be different views within companies.

Table 8. Share of primary and secondary bulk material

	Plastics	Aluminum	Steel
Only primary	6%	0%	15%
Some recycled	47%	32%	30%
Most recycled	23%	21%	30%
Only recycled	18%	16%	10%
Don't know	6%	32%	15%

Data from questionnaire; see Appendix.

4.4 Main observations

This analysis can be briefly summarized in four points:

- Customers' expectations and requirements are the main driver for suppliers and subcontractors to implement a green transition. Another motivation is that the company needs to be able to show that they are leaders in the environmental field in order to be able to attract competent employees (especially younger ones).
- Suppliers who manufacture components for gasoline and diesel vehicle drivetrains also believe that government regulation is a threat to future development. Firms producing other components for vehicles do not share this opinion.
- Suppliers and subcontractors rate themselves as having poor control over sustainability risks in their supply chains. The analysis shows that sustainability requirements that OEMs place on their direct suppliers can disappear when these companies make their own requirements.
- Suppliers and subcontractors consider the reporting burden to be burdensome, but to be reasonable given the purpose. One exception, however, seems to be companies with fewer than 50 employees (i.e., small companies). These companies may already have difficulty meeting customer requirements, and thus they risk not getting a high enough score on OEMs' self-assessment questionnaires.

5. Barriers to the transition to green supply chains and the role of the government

In chapters 3 and 4, we described and discussed why companies in the automotive industry are switching to greener production (i.e., external and internal driving forces), how companies make this change (i.e., through requirements, cooperation, etc.), and what companies are implementing actions to become greener and manage physical climate risks.

Based on this description, we ask three questions in this chapter: What are the barriers to the transition to a more sustainable supply chain for the automotive industry? How does the industry handle these barriers? What role can the government play?

5.1 What are the barriers to the transition?

From chapters 3 and 4 we can conclude that the automotive industry does not have very good monitoring of the sustainability risks in its supply chains. The analysis shows that it has relatively good monitoring of direct suppliers and of suppliers that have been identified as strategic further down in its supply chains. At the same time, the analysis shows that requirements and information disappear across supply chains. The idea is that sustainability requirements imposed on direct suppliers by brand companies (OEMs) will be passed on in the supply chain, but this does not always happen. In chapter 4 we showed that most direct suppliers to brand companies in Sweden have a certified environmental management system, as this is a requirement. However, by the next step in the supply chain, it is already the case that many companies lack a certified environmental management system. Suppliers also rate themselves (see chapter 4) as having significantly weaker monitoring of sustainability risks at their subcontractors.

One consequence of the fact that OEMs do not have good control over their supply chains and their location is that they have difficulty assessing the significance of physical risks such as volcanoes and tsunamis, or physical climate-related risks such as droughts and flooding, which are all expected to increase in the future. These risks tend to be highest further down in the supply chain (Growth Analysis, 2020): i.e., at factories where OEMs have less control or do not even know they use.

On the other hand, from chapters 3 and 4 it is evident that there are sustainability areas characterized by companies having better control of the supply chains. This applies to the use of chemicals and materials that can be hazardous to health and the environment, as well as the use of so-called conflict minerals (3TG and cobalt). This conclusion applies to both OEMs and their direct suppliers, but also to companies that we interviewed further down the supply chain (i.e., subcontractors).

What unites both of these areas is that they have been subject to specific, detailed government regulation for many years. To facilitate compliance with these rules, the automotive industry has developed common reporting systems.

Based on chapters 3 and 4, two major barriers for the transition to green automotive supply chains can be identified:

1. There are shortcomings in companies' monitoring of environmental risks at individual companies in the supply chains in the areas that do not have specific government regulations that require companies to have control.
2. There is a lack of harmonized methods and standards for measuring environmental impacts and greenhouse gas emissions, as well as other environmental risks, which means that companies or products cannot be compared in a credible way.

5.2 Barrier 1: Weak control of environmental risks at individual companies in the supply chain

One key barrier to the green transition is that OEMs in the automotive industry do not know how several of their requirements are handled in their supply chains or do not know the location of individual factories. This means that risks further down in the supply chain are largely out of their direct control. There is, therefore, a risk of "greenwashing," where the process becomes a check-the-box exercise for suppliers. This risk also increases as companies get overloaded with ever-increasing requirements for sustainability reporting in order to satisfy both legal and voluntary requirements (Farooki et al., 2020).

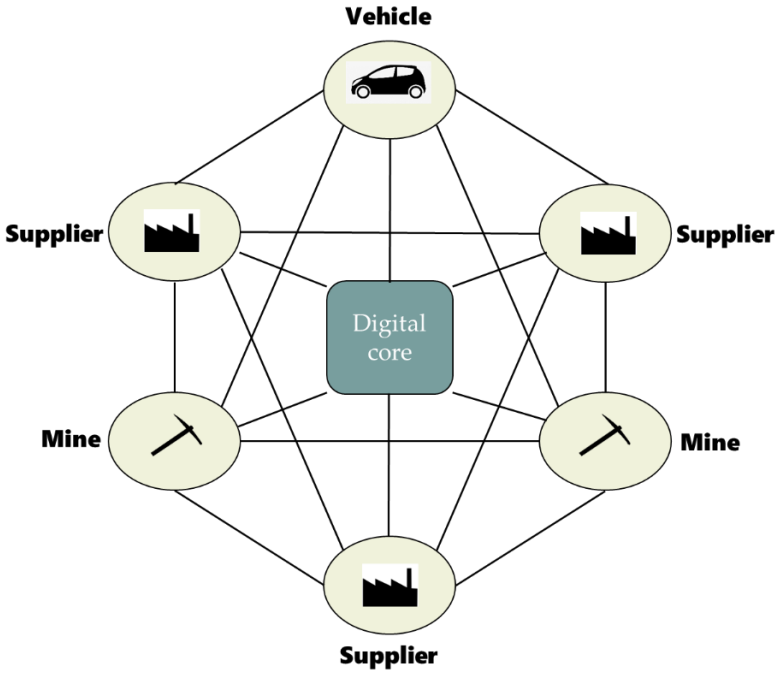
At the same time, there is a development in the industry towards creating better control through the use of modern IT solutions. This is a development that the industry is collaborating on within the Drive Sustainability initiative, but above all within individual OEMs.

5.2.1 Digital solutions to improve monitoring of the supply chain

During recent years, new supply chain technologies have been emerging that can dramatically improve end-to-end visibility across the supply chain and support much greater supply chain agility, collaboration, responsiveness, and resiliency. These are often referred to as "digital supply networks" and build on technologies such as IoT, cloud computing, 5G and AI. For end-to-end supply chain visibility and transparency, cloud computing and blockchain technologies are a focus. Both these technologies aim to create a digital core (see Figure 8) using data from suppliers across the whole supply chain.

In cloud computing, a network is created that allows access to shared pools of configurable system data that can be quickly provisioned with minimal effort. A cloud can hence be used to enable full-spectrum (end-to-end) visibility. A blockchain is an open, distributed ledger that can record data transactions between two parties in a verifiable and permanent way. It enables collaboration across competitive supply chain participants in order to improve collective supply chain performance.

Figure 8. The creation of a digital core for a network of automotive suppliers



5.2.1.1 Cloud-based systems for supply chain management

Several OEMs are developing cloud-based supply chain management systems. The tsunami of 2011, which triggered the meltdown at the Fukushima Daiichi nuclear power plant, incentivized GM to invest in new analytic tools that help them analyze the risks associated with suppliers and catastrophic events.[12] They have worked with the company Resilinc to develop cloud-based supply chain resilience tools. In these tools, supplier plants and logistics hubs are geocoded, which allows GM to directly identify which suppliers are impacted by an event such as a hurricane, or from isolated disruptions such as factory fires or labor disputes. The aim is to move from a traditional reactive crisis management approach to one of proactive crisis avoidance.

Volkswagen is one of the most ambitious automotive OEMs; moving its IT architecture over to a cloud-based platform solution will be the main task in the coming years on the road to what they call *digitalized manufacturing*. Volkswagen is creating its industrial cloud as an open platform, with the goal of incorporating companies from the entire value chain. In the long term, the aim is to integrate the complete global supply chain—with over 30,000 sites representing more than 1,500 suppliers and partner companies—into the cloud, creating a constantly growing system. The cloud-based platform, with its simplified data exchange, is also a vital prerequisite for making innovations available rapidly across all production sites. The main goal of the cloud is to become faster, more transparent, and safer. The first three plants were already linked up in 2019, all of them Volkswagen Passenger Cars plants. According to Gerd Walker, Head of Production for the Volkswagen Group, the intention is to bring 15 more plants into the cloud in 2020, including plants for Audi, Seat, Skoda, Volkswagen Passenger Cars, Volkswagen

[12] https://www.gmsustainability.com/manage/supply.html

Commercial Vehicles, Porsche, and Components brands. During 2020, the group working on the project is expected to grow from 220 experts to about 500.

5.2.1.2 Blockchain solutions for responsible sourcing

Several OEMs are working on blockchain solutions. Most of them focus on responsible mining. Volvo Cars will become the first automaker to implement traceability for the cobalt used in its batteries by applying blockchain technology.[13] This statement came after Volvo Cars reached an agreement with its two battery suppliers, CATL of China and LG Chem (a subsidiary of LG Corp) of South Korea, in 2019. Technology firms Circulor and Oracle operate the blockchain technology across CATL's supply chain, while the Responsible Sourcing Blockchain Network (RSBN), together with responsible sourcing auditing firm RCS Global, the cobalt company Huayou, and IBM, are operating the technology in LG Chem's supply chain. Martina Buchhauser, head of procurement at Volvo Cars, stated "With blockchain technology we can take the next step towards ensuring full traceability of our supply chain and minimizing any related risks in close collaboration with our suppliers."

Volkswagen is collaborating with Minespider to trace the supply chain for lead from the point of origin to the factory, where the point of origin will be either the mine or the recycling source. Volkswagen has also, together with Ford, FCA, and the already mentioned Volvo Cars, joined the RSBN initiative for cobalt. Lisa Drake at Ford commented on the initiative when it was presented, saying "By working with other top industries in this network, our aim is to use state-of-the-art technology to guarantee materials produced for our vehicles will meet our dedication to shielding human rights and the environment."

In early 2020, Daimler tested a prototype blockchain that could help to create transparency, especially in business conducted by firms that are not direct suppliers: i.e. Tier 2 to Tier N suppliers. The aim is to ensure that all suppliers complied with standards and contractual commitments. If a subcontractor deviates, this behavior will become visible in the blockchain.

The competitor BMW is also working with blockchains to create transparency in its supply chains. Certain raw materials like cobalt and wolframite (tungsten) are a focus, as they are difficult to monitor and are mined in conflict areas. These supply chains can run through dozens of stations and intermediaries, paths that are susceptible to manipulation. This process includes not only blockchains but also includes barcodes and seals, as well as chemical traces, in order to prevent materials from being substituted or mixed.

A partnership agreement was signed between the Research Institutes of Sweden (RISE) and Volvo Group at the end of 2018 for a two-year study supporting the proof of concept phase for blockchain use in Volvo Group's supply chain. The aim is to be able to be transparent on environmental, social, and ethical aspects associated with the use of specific raw materials in the manufacturing of components, says George Fotopoulus at Volvo Group Purchasing. In the first step, the goal is to trace the origin of cobalt used in Volvo truck batteries.

[13] https://www.media.volvocars.com/global/en-gb/media/pressreleases/260242/volvo-cars-to-implement-blockchain-traceability-of-cobalt-used-in-electric-car-batteries

Both the Volvo Group and Scania are also participating in the TraceMet project (Traceability for Sustainable Metals and Minerals), which is financed by the Strategic Innovation Program called Swedish Mining Innovation. Two pilot blockchain systems will be developed as part of the project. One deals with responsible sourcing of steel for the manufacturing of buses and trucks. The second applies to copper and its use in electric cables. The aim is to create systems allowing the end-to-end carbon footprint to be traced when using metals, as well as the share of recycled metals.

5.2.2 OEMs are increasingly engaging in independent initiatives

OEMs are not just developing new IT solutions to gain better control of supply chains. More OEMs are becoming increasingly involved in initiatives where a third party supplies audits in a transparent and comparable way. The strategy of using an independent third party to create transparency in the absence of ambitious regulation is not unique and also occurs in other industries (Poulsen et al., 2016). Several vehicle suppliers encourage or require their suppliers to report, set targets, and be audited through the CDP greenhouse gas emissions and water use program (see chapter 3.3.2). CDP is believed to be a reliable independent player. One conclusion from chapter 3.3.2, however, is that Swedish companies in the automotive industry generally have a lower rating than certain other countries (especially European ones).

Since CPD ratings are already used in the assessment of whether companies should be able to become or even continue to be suppliers in the automotive industry, these lower Swedish ratings are a little worrying. In part, Swedish companies' slightly lower ratings may be due to cultural factors; in our interviews with companies, it has emerged that Swedish companies tend to be less specific than, for example, French competitors about how they meet legal requirements. In other words, French companies often have more detailed documentation, which is important for obtaining high marks on CDP evaluations. However, it may also be that Swedish companies are not leaders in this area, which also has been indicated to be the case in some of our interviews.

Another dimension of increasing documentation and ambitious goals is that it risks making it more difficult for smaller companies to survive or to be able to enter as suppliers. The analysis in chapter 4 indicates that small companies with fewer than 50 employees are having an extra-hard time with increasingly extensive sustainability requirements from OEMs. These companies often have very limited resources to participate actively in standardization work, answer OEMs' self-assessment questionnaires, and carry out activities that give them a sufficiently high score on these questionnaire (where CDP ratings are a part).

5.2.3 The government’s role for increased transparency and control

Modern IT solutions enable companies to establish much better control over supply chains. At the same time, the analysis above shows that several initiatives have prioritized areas that are under government regulation, especially conflict metals. These are examples of specific government regulations: i.e., regulations that require specific measures and efforts on the part of companies. A common criticism of this form of regulation is that companies can be forced into specific technical solutions or priorities (Bergek and Jacobsson, 2010; Lehmnann and Söderholm, 2017). A fundamental question

is, therefore, whether the government should introduce more-specific regulations to force better control over sustainability risks in supply chains that are not clearly regulated today. This question becomes particularly relevant, given that the government is likely to have even less knowledge than industry about the actual risks in supply chains.

One alternative and possible complement to specific government regulations is so-called general regulation. One advantage of this form of regulation is that the company retains responsibility for its choice of measures and prioritization of areas (Berger-Walliser and Scott, 2018; Wirth et al., 2016). This form of regulation also reduces the risk that rent-seeking may prevail. A relevant example of this form of regulation is mandatory reporting and due diligence for the environment and human rights. This form of regulation is already implemented in the French duty of vigilance, and the European Commission has announced that it wants similar legislation for the EU. A disadvantage of this form of regulation is that it is difficult to assess when companies commit violations. An important reason for this is that this form of regulation presupposes that companies have control over the sustainability risks of their supply chains and how these are managed and are transparent with this information, something this analysis has shown is not the case.

5.3 Barrier 2—Lack of harmonized methods and standards

One important part of the transition to green supply chains is that companies and end consumers should be able to choose products based on their environmental impact. However, this requires the existence of accepted and harmonized methods, as well as standards for how environmental impact is assessed. Today, harmonized methods and standards are often lacking. One example from this analysis is the lack of an accepted method for calculating greenhouse gas emissions from products.

5.3.1 OEMs are setting specific technical and sustainability requirements

As in many other industries (see, for example, Evers et al., 2014; Ponte & Ewert 2009; Raj-Reichert, 2019; Azmeh & Nadvi, 2014), brand companies in the automotive industry use their market dominance to create standards for the green transition in their supply chains. In order to deal with the problems resulting from the lack of internationally accepted standards and methods for assessing and calculating greenhouse gases, among other things, there is a tradition in the automotive industry of requiring suppliers to implement technology-specific activities. During the past year, it has become increasingly common for OEMs to require suppliers to use renewable energy and increase their proportion of recycled plastic, aluminum, and steel. This is also included in the self-assessment questionnaire from Drive Sustainability used by most OEMs. This is driven by the OEMs' ambitions toward climate neutrality and the development of a circular economy with an increased focus on recycling and reuse.

In the short term, these technology-specific activities can lead to a significant reduction in the climate impact of vehicles. However, in the long run, it can be a challenge to combine this strategy with the ambition of being climate neutral. Not all supply chains will probably be able to become completely circular in the long run, as there will probably be a need to get virgin raw material. However, creating climate-neutral processes for virgin raw materials requires innovation, something that is not stimulated by the chosen

strategy with a focus on renewable energy and recycling. This may, for example, have consequences for the Hybrit project at SSAB, LKAB, and Vattenfall, which aims to produce climate-neutral steel from new virgin raw material and where the automotive industry is expected to become an important customer.

It is also worth recognizing how Volkswagen has chosen for certificates for production-specified renewable electricity to be counted as renewable. This means that they can collaborate with LG Chem at a battery factory in Poland, despite the fact that the electricity system in Poland is dominated by coal power. Other companies, including several Swedish suppliers to the automotive industry, would instead recommend that this requirement be based on the national electricity mix and not on certificates. This is an issue that concerns large economic sums and thus reflects strong interests (see barrier 3).

However, having a technology-specific focus for activities is not a given. In the manufacturing industry, for example, technology-neutral requirements are more common (Tillväxtanalys, 2018): i.e., the requirements are set based on the amount of greenhouse gas emissions instead of how much emissions are reduced. This can be done, for example, by demanding environmental declarations (EPD) that contain the materials' greenhouse gas emissions. Since third parties audit these EPDs and there is a common calculation method, it is possible to compare both different manufacturers and different materials.

5.3.2 The role of the government in the development of methods and standards

In previous chapters, it has been shown that companies want government to take a clearer role in at least how greenhouse gas emissions are calculated. This has already happened in some areas of the EU, but not in a consistent way. In the EU directive on the promotion of the use of energy from renewable energy sources (EU 2018/2001), the reduction of greenhouse gas emissions from electricity produced with liquid biofuels will be calculated based on total emissions from the fossil fuel comparator for useful electricity. On the other hand, in the EU's work with Product Environmental Footprint, which, among other things, aims to influence the choices of end consumers and customers, certified production-specified electricity is used, where possible, secondly the emission intensity for the electricity supplier's total electricity production, and thirdly the value of the electricity mix where the production takes place. The question is, therefore, whether the government can administer this in a credible way or whether special interests (see barrier 3) have too much influence. One conclusion in Tillväxtanalys' report "Traceability and labeling of sustainable metals and minerals" (Tillväxtanalys, 2019) is that independent interest groups from the environmental side are probably most appropriate to develop a system for calculating greenhouse gas emissions, as they are generally considered more credible because they have no direct motive for representing special business policy interests. However, the government can have a role in participating by initiating this form of work and supporting weaker stakeholders in participating in the development of methods and standards.

5.4 Conclusion: The conditions are good for dealing with barriers, but there is a great risk that large companies will benefit more

The main conclusion from this chapter is that with modern information technology, the conditions are good for better monitoring of sustainability risks in supply chains. In addition to better monitoring, companies, industries, civil society, and governments need to develop and implement new standards, certification systems, and labeling. To achieve this, decisions need to be made about specific details, such as how the climate footprint of a product is to be calculated, what is to be considered recycled material, and so on. These details may seem simple at first glance, but in reality they are complicated. The definitions, calculation conventions, and standards that need to be developed can be designed in many different ways, and the specific design will have a decisive effect on environmental impacts and which companies will benefit or be disadvantaged. There is therefore an obvious risk that companies that have sufficient resources to influence decision-makers can use this strategically to further strengthen their market power.

The practice of companies trying to increase their revenues by influencing governmental regulation and political ambitions that define the market conditions is often called rent-seeking and is seen as an argument against government intervention in industrial markets (Tillväxtanalys, 2018). This also applies to the automotive industry, where companies want to influence, among other things, whether vehicles should be electrified, and if so, at what rate. Sweden, for example, has chosen to raise the climate bonus limit from 60 grams of CO_2 emissions per kilometer to 70 grams when the EU introduced the new tougher but more realistic driving cycle, WLTP, for testing emissions from car models. If the government had not chosen to raise the limit, 11 car models from traditional car manufacturers—seven of them Swedish—would not have met the limit. This is an example of a decision that, at least in the short term, does not benefit new vehicle manufacturers who want to compete with traditional ones.

In the development of government R&D programs, standards, and specific legislation, it is therefore important to understand how they will affect the market and how the market will affect the outcome of government efforts. This requires the government to have a very good understanding of the market, which is also one of the most important conclusions in the Growth Analysis report "The state's role in green transformation based on active industrial policy" (Tillväxtanalys, 2018), which is often highlighted in the academic literature (see, for example, Rodrik, 2014). One measure that can enable a greater understanding of how the market is affected is to support less-resource-intensive actors, both companies and interest groups, in discussions about new or improved policy measures. This was also one of the recommendations in the Growth Analysis report "Traceability and labeling of sustainable metals and minerals—Efforts to increase transparency, credibility and demand" (Growth Analysis, 2019).

This market understanding needs to take into account the fact that industrial sectors develop differently. It is not a given that the conclusions drawn in this report also apply to other industries. For example, it is very unusual in terms of collaborations between companies in the electronics industry with respect to how the sustainable transition of supply chains should be enacted, a form of collaboration that is very common in the automotive industry. Another difference among industries is that environmental issues

are generally more important in the automotive industry, while issues related to human rights are a higher priority in the electronics industry. If we look at the manufacturing sector instead, one big difference is that the end customer market is national, or at least very limited in geographic size. This means that regulations, even in a small economy such as Sweden's, can have a major impact on supply chains in the manufacturing sector.

6. Areas of special policy relevance for the Swedish government

In our analysis, we have identified the following barriers to the automotive industry's transition to green supply chains:

- Companies lack monitoring over what the environmental risks of individual companies in the supply chains are in cases where no specific government regulation requires detailed reporting from the whole supply chain.
- There is a lack of harmonized methods and standards for measuring environmental impacts and greenhouse gas emissions. This means that products cannot be compared in a credible way and that advocacy groups can affect the direction of the transition and the prioritization of various sustainability risks in regulations, certification systems, standards, and public strategies.

Since the automotive industry has one of the most globalized value chains, it is generally not possible for a small economy like Sweden to influence development itself. It is, instead, a matter of having a good knowledge of both developments in the market and the impacts of policy regulations on this development. This knowledge is a prerequisite for the Swedish government to be able to be objectively proactive in, for example, the EU, international standardization efforts, and independent initiatives. One important part of this is to be able to assess which barriers the state should handle and which the industry itself should handle. To enable this assessment, the state should regularly map developments in the market in a manner similar to what was done in this analysis.

The assessment should not only be done for the automotive industry but also for other industry sectors that are of great importance to the Swedish economy. This not only creates the conditions for influencing initiatives but can also form the basis for specific Swedish initiatives aimed at strengthening the competitiveness of Swedish companies. It does not only have to be a matter of new initiatives; such an assessment could also be a driver for change to existing initiatives.

In this report we identify four areas that specifically concern the competitiveness of Swedish companies:

- Swedish companies generally do not have the highest scores in CDP supply chain programs (see chapter 5.2.2).
- There is a lack of alignment between the automotive industry's prioritization of recycled materials as a way to reduce greenhouse gas emissions and Swedish R&D support, which is primarily aimed at reducing process emissions from the production of materials from virgin raw materials (see chapter 5.3.1).
- The initiatives that exist (especially EU regulations) concerning how climate footprints are to be calculated for products (see chapter 5.3)
- The situation of small companies who have to meet more advanced sustainability requirements (see chapter 5.2.2).

One thing that is common among these points is that they may be crucial for Swedish companies to be competitive in the transition to sustainably manufactured electric vehicles.

In terms of Swedish policy, it is also be important to note that the automotive industry has chosen to limit itself to renewable energy as a measure to reduce greenhouse gas emissions. This means that contracting nuclear power is not including among potential measures to reduce emissions.

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7.1 Interviews

Name	Company/organization
Joëlle Moché	Scania
Eva Bennis	Volvo Group
Eric Richter	PSA Groupe
Kristina Schrader	Volkswagen
Jan Carlson	Volvo cars
Kaisa Tarna-Mani	Autoliv
Magnus Johansson	Automotive Components Floby
Jonas Svensson	Automotive Components Floby
Maria Thom	Proton finishing
Anders Carlsson	AQ Group
Thomas Svensson	Gnotec
Martin Johansson	Evs-Inmotion
Evalena Winkvist	Smidesprodukter
Mikael Carlsson	Ekets-Uppåkra
Göran Nyström	Ovako
Thomas Hörnfeldt	SSAB
Mats Lindberg	SSAB
Peter Bryntesson	Fordonskomponentgruppen
Pascale Lardin	Fédération des Industies des Equipements pour Véhicules
Håkan Asp	EcoVadis
Catalina Pislaru	Drive Sustainability
Marianne Kropf	Drive Sustainability
Mona Freundt	CDP
Soline Bonnel	CDP
Jörgen Sandström	World Economic Forum

8. Appendix 1

A questionnaire has been sent to the members of the Swedish industry organization for suppliers and subcontractors (Fordonskomponentgruppen, FKG). In total, more than 150 firms received the questionnaire. 46 percent of these firms had less 50 employees in 2018 (small), 26 percent had between 50 and 250 employees (medium), and 15 percent had more than 250 employees (large).

Basic description of respondents

- A total of 32 responding companies.
- 16 can be described as medium-sized enterprises, i.e. have less than 250 employees and a turnover below SEK 500 million. This means that the response rate of medium size firms was about 25 percent.
- 14 can be described as large firms with more than 250 employees. In this group the response rate to the questionnaire was over 50 percent.
- 2 can be described as small firms with less than 50 employees. In this group the response rate was less than 3 percent.
- 20 of the companies had a dominant customer who accounted for at least more than half of the sales revenue.
- 7 of the companies (named fossil) produced components mainly for the construction of diesel and internal combustion engines. 3 of the companies (named new) produced components mainly for the construction of batteries, electric engines, self-driving vehicles, while 20 produce mostly other type of components (named neutral).

Generally, the correlation between these characteristics and the answers below is very weak and insignificant. Since the response rate from small-firms was almost zero, we can't say anything about this type of firms from the questionnaire.

8.1 Which are the drivers for action?

The respondents were asked to indicate their agreement on a 7-digit scale (from completely disagree to completely agree) on 18 statements.

On average the respondents indicated that they mostly agreed (an average around digit 6) with four statements. These were:

- Our customers expect our firm to be environmentally friendly.
- The Public is very concerned about environmental destruction.
- Our customers feel that environmental protection is a critically important issue facing the world today.
- Our firm can attract skilled people by being an environmental leader in the market.

On average the respondents indicated that they somewhat agreed (an average around digit 5) with 7 statements. These were:

- Our customers are increasingly demanding environmentally friendly products and services.
- The Public is more worried about the economy than about environmental protection.
- Regulation by government agencies has greatly influenced our firm's environmental strategy.

- Tougher environmental legislation is required so that only firms that are environmentally responsible will survive and grow.
- Our firm's environmental efforts can help shape future environmental legislation in our industry.
- Our industry is faced with strict environmental regulation.
- By regularly investing in research and development on cleaner products and processes, our firm can be a leader in the market.

On average the respondents indicated that they neither agreed or disagreed (an average around digit 4) with 7 statements. These were:

- Environmental legislation can affect the continued growth of our firm.
- Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment.
- Being environmental conscious can lead to substantial cost advantages for our firm.
- Our firm has realized significant cost savings by experimenting with ways to improve the environmental quality of our products and processes.
- Our firm can enter lucrative new markets by adopting environmental strategies.
- Our firm can increase market share by making our current products more environmentally friendly.
- Reducing the environmental impact of our firm's activities will lead to a quality improvement in our products and processes.

There are some differences between the total average score and type of firm and business.

SME:s have a higher rate on "Our customers are increasingly demanding environmentally friendly products and services" which they mostly agree with. They have a lower rate on "Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment" which they somewhat disagree with.

Larger firms (non SME:s) have a higher rate on "Environmental legislation can affect the continued growth of our firm" and "Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment" which they somewhat agree with. They have a lower rate on "Our customers feel that environmental protection is a critically important issue facing the world today" and "The Public is very concerned about environmental destruction" which they somewhat agree with.

Firms with dominant costumer have the same pattern as larger firms.

Fossil firms have a higher rate on "Our customers are increasingly demanding environmentally friendly products and services", "Environmental legislation can affect the continued growth of our firm" and "Our industry is faced with strict environmental regulation" which they mostly agree with. They also rate "Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment" as somewhat agree with. They have a lower rate on "Our customers feel that environmental protection is a critically important issue facing the world today" and "The Public is very concerned about environmental destruction" which they somewhat agree with.

New firms have a higher rate on "Regulation by government agencies has greatly influenced our firm's environmental strategy" and "Tougher environmental legislation is

required so that only firms that are environmentally responsible will survive and grow" which they mostly agree with. They also rate "Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment" as somewhat agree with. They have a lower rate on "By regularly investing in research and development on cleaner products and processes, our firm can be a leader in the market", "Our firm can enter lucrative new markets by adopting environmental strategies", "Our firm can increase market share by making our current products more environmentally friendly" and "Reducing the environmental impact of our firm's activities will lead to a quality improvement in our products and processes" which they somewhat disagree with.

Neutral firms have a higher rate on "Our firm can enter lucrative new markets by adopting environmental strategies" and "Our firm can increase market share by making our current products more environmentally friendly" which they somewhat agree with. They have a lower rate on "Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment" which they somewhat disagree with.

8.2 Do companies have control over their sustainability risks in the supply chain?

The companies were asked to rate their performance compared to other firms in the automotive supply chain on a 5-digit scale (1 corresponding to 5 much better).

Table 2. Average rating performance compared to other firms in automotive supply chain (standard deviation in parenthesis).

	Complying with environ-mental regulations	Limit environ-mental impact beyond regulations	Educating employees about environ-mental risks	Monitoring the environ-mental risks in supply chain	Handling the Covid 19 pandemic
All companies	4.0 (0.74)	4.0 (0.95)	3.5 (0.72)	3.4 (0.93)	4.0 (0.63)
SME	3.9 (0.81)	3.8 (0.98)	3.5 (0.62)	3.3 (0.87)	3.9 (0.62)
Larger companies	4.1 (0.64)	4.2 (0.86)	3.5 (0.82)	3.4 (0.98)	4.1 (0.59)
1:st consumer over 50% of revenue	3.9 (0.83)	4.0 (1.00)	3.4 (0.90)	3.4 (1.12)	4.2 (0.53)
1:st consumer 50% or less of revenue	4.1 (0.62)	4.0 (0.89)	3.5 (0.50)	3.3 (0.70)	3.8 (0.65)
Fossil components	4.0 (0.53)	3.7 (0.70)	3.3 (0.88)	3.4 (0.90)	4.1 (0.64)
Neutral components	4.0 (0.79)	4.1 (1.02)	3.6 (0.67)	3.5 (0.88)	3.8 (0.60)
New components	4.0	4.0	3.3	2.7	4.3

The companies were asked to rate their monitoring of environmental risks in their supply chain on a 7-digit scale (1 – No monitoring, 2 – Very weak, 3 – Weak, 4 – Moderate, 5 – Good, 6 – Very good, 7 – Full monitoring). The question was divided into monitoring of Tier 1 suppliers, i.e. firms selling products to the company, and Tier 2 and Tier 3 suppliers, i.e. firms producing products/components to the Tier 1 suppliers or suppliers of raw or close to raw materials.

Table 3. Average rating of monitoring of environmental risks in supply chain (standard deviation in parenthesis).

	Tier 1 suppliers	**Tier 2 and Tier 3 suppliers**
All companies	4.2 (1.60)	2.7 (1.23)
SME	3.8 (1.67)	2.6 (1.48)
Larger companies	4.4 (1.59)	2.8 (1.01)
1:st consumer over 50% of revenue	4.1 (1.71)	2.9 (1.25)
1:st consumer 50% or less of revenue	4.3 (1.53)	2.8 (1.26)
Fossil components	4.4 (1.05)	3.0 (1.20)
Neutral components	4.1 (1.78)	2.8 (1.27)
New components	4.3	2.7

The companies were asked to rate their understanding of some sustainability risks in their supply chain on a 7-digit scale (1 – No understanding, 2 – Very weak, 3 – Weak, 4 – Moderate, 5 – Good, 6 – Very good, 7 – Full understanding).

Table 4. Companies average rating of the understanding of some sustainability risks in their supply chain (standard deviation in parenthesis).

	Emissions of greenhouse gases	**Use of hazardous chemicals and materials**	**External physical risks like storms and drought**	**Human rights**
All companies	4.4 (1.37)	5.4 (1.32)	4.3 (1.15)	5.5 (1.26)
SME	4.6 (1.08)	5.3 (1.30)	4.2 (0.98)	5.6 (1.20)
Larger companies	4.1 (1.60)	5.4 (1.29)	4.3 (1.28)	5.5 (1.24)
1:st consumer over 50% of revenue	4.4 (1.39)	5.7 (1.28)	4.6 (1.12)	5.7 (1.26)
1:st consumer 50% or less of revenue	4.5 (1.35)	5.0 (1.25)	3.9 (1.10)	5.4 (1.23)
Fossil components	4.6 (1.50)	5.6 (1.18)	4.7 (1.39)	6.0 (1.41)
Neutral components	4.4 (1.26)	5.2 (1.38)	4.2 (1.07)	5.4 (1.07)
New components	4.0	5.7	3.7	5.0

8.3 Some own actions

The companies were asked to rate their use of renewable energy on a 3-digit scale (No, Partly – some of the energy use, Yes – all energy use).

Table 5. Number of companies using renewable electricity respectively other renewable energy sources.

	Renewable electricity			Other energy use		
	No	**Partly**	**All**	**No**	**Partly**	**All**
All companies	15	10	5	16	11	3
SME	7	5	4	9	4	3
Larger companies	8	5	1	7	7	0
1:st consumer over 50% of revenue	10	4	0	10	4	0
1:st consumer 50% or less of revenue	4	6	5	5	7	3
Fossil components	3	2	2	3	3	1
Neutral components	8	8	3	10	7	2
New components	3	0	0	2	1	0

The companies were asked to rate their use of primary and recycled plastics, steel and aluminum on a 6-digit scale (Don't use the material, Don't know, Only primary, Some recycled, Mostly recycled, Only recycled).

Table 6. The use of primary and recycled plastics, number of companies.

	Don't use	**Only primary**	**Some recycled**	**Mostly recycled**	**Only recycled**	**Don't know**
All companies	11	1	9	4	3	1
SME	6	0	3	3	2	1
Larger companies	5	1	6	1	1	0
1:st consumer over 50% of revenue	6	0	4	2	2	0
1:st consumer 50% or less of revenue	5	1	5	2	1	1
Fossil components	3	0	3	0	0	1
Neutral components	7	0	6	4	2	0
New components	1	1	0	0	1	0

Table 7. The use of primary and recycled aluminum, number of companies.

	Don't use	Only primary	Some recycled	Mostly recycled	Only recycled	Don't know
All companies	10	0	7	4	3	5
SME	5	0	3	2	2	3
Larger companies	5	0	4	2	1	2
1:st consumer over 50% of revenue	5	0	4	4	1	0
1:st consumer 50% or less of revenue	5	0	3	0	2	5
Fossil components	2	0	4	0	0	1
Neutral components	6	0	2	4	3	4
New components	2	0	1	0	0	0

Table 8. The use of primary and recycled steel, number of companies.

	Don't use	Only primary	Some recycled	Mostly recycled	Only recycled	Don't know
All companies	9	3	6	6	2	2
SME	8	1	2	3	0	0
Larger companies	1	2	4	3	2	2
1:st consumer over 50% of revenue	4	2	3	5	0	0
1:st consumer 50% or less of revenue	5	1	3	1	2	2
Fossil components	3	0	3	0	0	1
Neutral components	5	2	3	6	1	2
New components	1	1	0	0	1	0

The companies were asked to rate their use of transport modes to and from their production plants.

Table 9. Transportation modes from and to production plans.

	Mostly truck	Mostly boat	Mostly train	Truck & boat	Truck & train	Intermodal
To plants	21	0	0	4	1	0
From plants	22	1	0	0	4	1

8.4 Reporting

The companies were asked about the administrative burden (time and cost) to respond to customers' environmental and human rights requirements (e.g. self-assessment questionnaires, reporting to IMDB etc). A 7-digit scale was use, ranging from 1 – Very small, 4 – reasonable, to 7 – Very large.

All companies	SME	Larger companies	1:st consumer over 50% of revenue	1:st consumer 50% or less of revenue	Fossil comp.	Neutral comp.	New comp.
4.2 (1.82)	4.4	3.9	4.4	3.9	3.7	4.3	4.3

The companies were also asked two questions regarding the use of modern digital transparency technology. 3 companies are involved in an initiative for end-to-end supply chain transparency of sustainability risks based on blockchain technologies. None of these companies are a SME. 4 companies are involved in an initiative for end-to-end supply chain transparency of sustainability risks based cloud computing. One of these companies are a SME.

Tillväxtanalys har regeringens uppdrag att analysera och utvärdera statens insatser för att stärka Sveriges tillväxt och näringslivsutveckling. Genom vår kunskap bidrar vi till att effektivisera, ompröva och utveckla tillväxtpolitiken samt genomförandet av Agenda 2030.

I vårt arbete fokuserar vi särskilt på hur staten kan främja Sveriges innovationsförmåga, på investeringar som stärker innovationsförmågan och på landets förmåga till strukturomvandling. Dessa faktorer är avgörande för tillväxten i en öppen och kunskapsbaserad ekonomi som Sverige. Våra analyser och utvärderingar är framåtblickande och systemutvecklande. De är baserade på vetenskap och beprövad erfarenhet.

Sakkunniga medarbetare, unika databaser och utvecklade samarbeten på nationell och internationell nivå är viktiga tillgångar i vårt arbete. Genom en bred dialog blir vårt arbete relevant och förankras hos dem som berörs.

Tillväxtanalys finns i Östersund (huvudkontor) och Stockholm.

Den kunskap vi tar fram tillgängliggör vi på www.tillvaxtanalys.se. Anmäl dig gärna till vårt nyhetsbrev för att hålla dig uppdaterad om våra pågående och planerade kunskapsprojekt. Du kan även följa oss på Twitter, Facebook och LinkedIn.

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