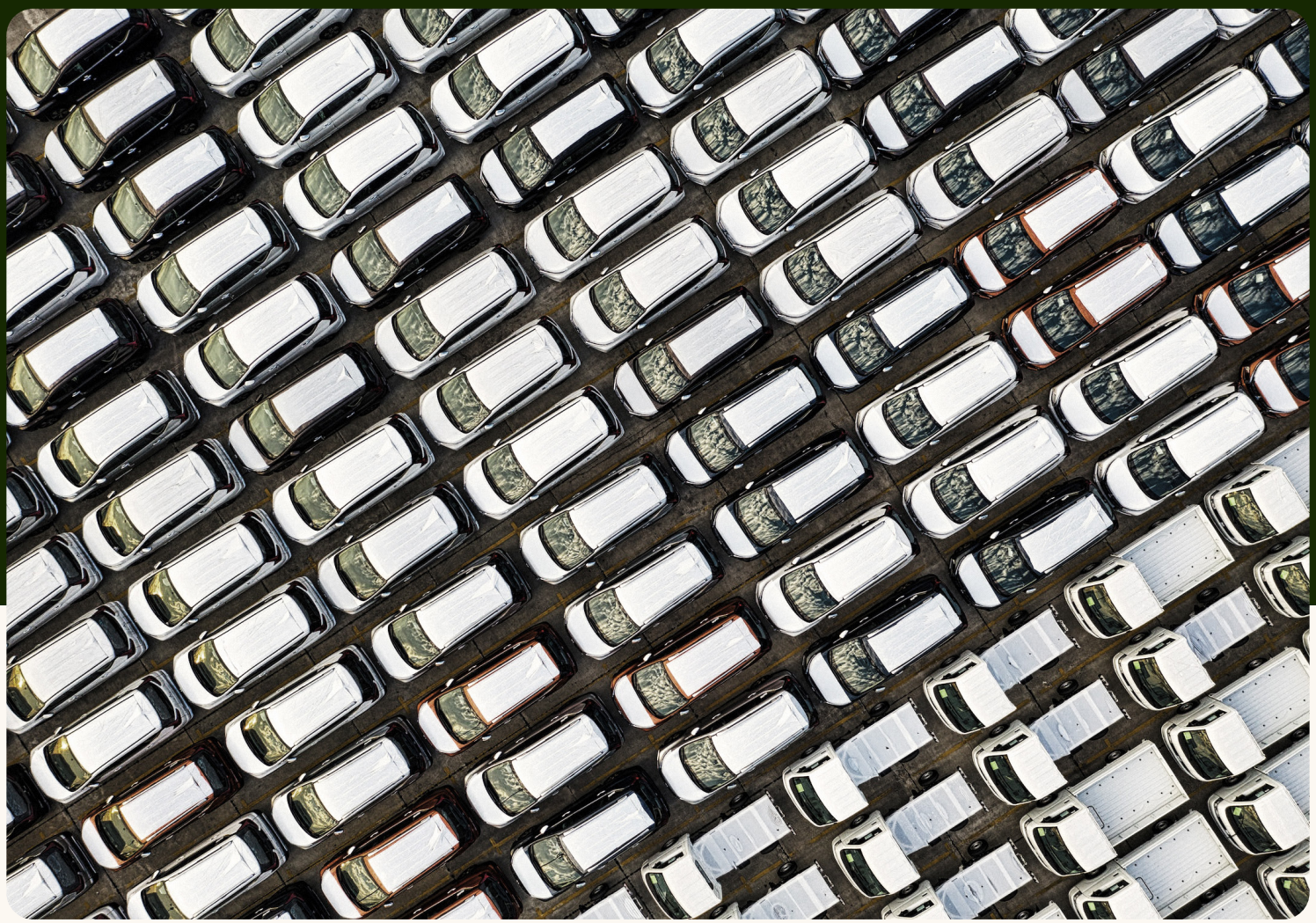
tset Calculated Value

# Carbon reduction in automotive supply chains

## Transparency, carbon pricing and supply chain development



Whitepaper

March 2024

# Contents

# Foreword

For many years, talking about production emissions of cars was a niche topic and didn't make it to the management board agenda. This has changed drastically in the last few years and we now see massive transformation programs getting rolled out. Automotive players are switching from a reactive to a proactive position anticipating future $CO_2$ levies and a change of consumer preferences.

OEMs and tier-1 suppliers need to understand that the majority of "embedded $CO_2$" of their products stems from their supply chain. Getting new electricity contracts and planting some square kilometers of forest will by far not suffice to reduce or offset emissions towards neutrality. We must establish full transparency of our product footprints and understand the most significant levers. Let us then put a price label on emissions and make the footprint a cost component. Only then will the topic get the required attention, and only then will we will be able to make the optimal decisions. But most importantly, we need to interact with our supply chain by standard definition, performance evaluation and new incentives.

Transparency, carbon pricing and supply chain development are crucial tools for cutting GHG emissions in the automotive industry and further beyond in the whole world of manufacturing. Those who manage sustainability pro-actively and in sync with all their other targets will emerge as winners from these times of volatility and uncertainty.

**Andreas Tsetinis**
CEO and Co-Founder of Tset

# Executive Summary

Humanity is running out of time when it comes to preventing climate change from reaching catastrophic levels. Indeed, this is now increasingly perceived as not only an environmental issue, but also a very real business risk. As one of the world's major polluters, the automotive industry plays an important role and is already subject to extraordinary scrutiny. Simultaneously, the industry is experiencing a transformation towards electrification of mobility through which manufacturing emissions will become an increasingly relevant factor.

As we enter 2024, addressing climate change demands comprehensive measures and innovative strategies from companies. In this context, three essential action points have emerged for companies to manage their carbon emissions, particularly within the framework of the evolving global climate policies, such as the Carbon Border Adjustment Mechanism (CBAM). We see three essential action points for companies to manage their carbon emissions.

# 01 Create transparency

Companies struggle to gather emission data accurately and timely. Without the ability to measure, they are unable to set goals and evaluate their performance.

We recommend defining measuring and reporting standards that comprise direct as well as indirect emissions and leverage modern tools to rapidly aggregate and analyze emission performance.

# 02 Use carbon pricing to make emissions a business case

Efforts to reduce GHG emissions have historically been detached from financial considerations and thus have received insufficient attention. Introducing carbon pricing has the potential to change that by uniting emissions and cost under a common metric. Given the length of production cycles and the fact that more and more jurisdictions are putting a price on carbon, it is imperative to evaluate today's decisions in the context of a carbon-constrained future.

We propose introducing internal carbon pricing to stress-test all major investment and sourcing decisions.

# 03 Develop the supply chain

Upstream emissions are on average 11.4 times higher than those caused by a company's direct operations. Nevertheless, they have not received the appropriate level of attention. While supplier operations are significantly harder to monitor and influence than in-house operations, OEMs, Tier1's and suppliers have the power and vested interests to press for changes. We encourage setting up ambitious supplier development programs to understand and curb upstream emissions.

# Status Quo

# 01 The urgency for action

**Combatting climate change has become a concern for global financial markets as humanity is running out of time.**

The science underpinning anthropogenic climate change has been increasingly known since the 1950s. However, the concern for this issue among politicians, managers, investors and the general population has been low until recently but this is fortunately beginning to change. Humanity is running out of time and action needs to be taken now. In its latest special report[1], the Intergovernmental Panel on Climate Change (IPCC) highlighted that every bit of warming matters and calls for "rapid and far-reaching" action to prevent irreversible damage to entire ecosystems.

Aside from the effects on the environment itself, considering climate change has become crucial from a business perspective. A report[2] by McKinsey & Company evaluated the socioeconomic impact in 105 countries and found that every single one is "expected to experience an increase in at least one major type of impact on their stock of human, physical, and natural capital by 2030. Intensifying climate hazards could put millions of lives at risk, as well as trillions of dollars of economic activity and physical capital, and the world's stock of natural capital." It states, "climate change will also need to feature as a major factor for decision-makers", be it companies, cities, or financial institutions.

Increasingly, investors are demanding change and are using their financial power to force companies to adapt their business practices. Perhaps the best-known example is the Carbon Disclosure Project (CDP)[3]. It supports companies and cities in disclosing their environmental impact and ranks them by transparency and the extent of their sustainability actions.

This whitepaper focuses on GHG emissions as the most prominent aspect of sustainability. Nevertheless, we encourage companies to pay attention to other areas of sustainability as well. We believe that there will be equally significant business cases for other objectives, like the reduction of water pollution, and we are confident that many of our recommendations, such as creating transparency, will also apply.

**"Limiting warming to 1.5°C is possible within the laws of chemistry and physics but doing so would require unprecedented changes."**

**Jim Skea, IPCC**

# 02 The role of the automotive industry

**The automotive industry is among the largest polluters globally and its action moves from tailpipe to production emissions.**

The automotive and manufacturing industry is highly resource- and energy-intensive and among the largest globally. It thus plays a key role and has received special attention from policy makers. The Volkswagen Group, in its 2022 Sustainability Report[4], discloses emissions totaling 402.19 megatonnes of CO2. In relation to the European Commission's research, who estimate total global emissions in 2022 at 53.8 gigatonnes of CO2[5], Volkswagen is responsible for 0,7% of global emission.

Since 2009, the EU has set mandatory emission reduction targets for new passenger cars, and indeed, since 2015, targets on fleetwide average emission,6 which were tightened again in 2023.

While these measures will reduce emissions during usage, the manufacturing of cars also constitutes a significant share of the lifetime emissions. Estimates[6] for passenger cars range from 10% to 30% for internal combustion engines and 20% to 95% for battery electric vehicles. There is agreement that the share of electric vehicles will rise[7] significantly and that they have more so-called embedded carbon due to the energy and resource intense manufacturing process of batteries. VW[8] for instance puts battery-related emissions for the ID.3 at 43.3% of total. However, results vary considerably.

As a consequence, the automotive industry must address all sources of its emissions and this will take tremendous effort. At the same time, it offers the opportunity to transform from a major polluter to a pioneer and many major players have already self-committed themselves to ambitious targets.[9]

**GHG self-commitments of leading automotive players**

| Company | Scope 1 | Scope 2 | Scope 3 |
|---|---|---|---|
| **Toyota** | 2050 | 2050 | 2050 |
| **Volkswagen** | 2050 | 2050 | 2050 |
| **Mercedes-Benz** | 2039 | 2039 | 2039 |
| **Ford** | 2050 | 2035 | 2050 |
| **Bosch** | 2020 | 2020 | n/a |
| **Continental** | 2040 | 2040 | 2050 |
| **ZF** | 2040 | 2040 | 2040 |

# 03 The sources of a company's GHG emissions

**Scope 1 and 2 emissions of OEMs are neglible compared to the upstream emissions in their supply chains.**

When evaluating the GHG footprint of any company, it is essential to look at all emission sources. A greenhouse gas (GHG) is a gas that absorbs and emits radiant energy within the thermal infrared range and thereby contributes to the greenhouse effect. Since it makes no difference to the planet, who emitted greenhouse gases (but only how much were emitted), any saving is equally valuable. A common practice is to differentiate between scope 1, 2, and 3 emissions. This 3-tier system was established by GHG Protocol[10] and has been adopted by other standards such as ISO 14064.

## 01 Direct emissions

Emissions produced directly by the reporting organization, e.g. by the use of natural gas, heating oil, fuels.

## 02 Indirect emissions

Emissions from the generation of acquired and consumed electricity, steam, heat, or cooling.

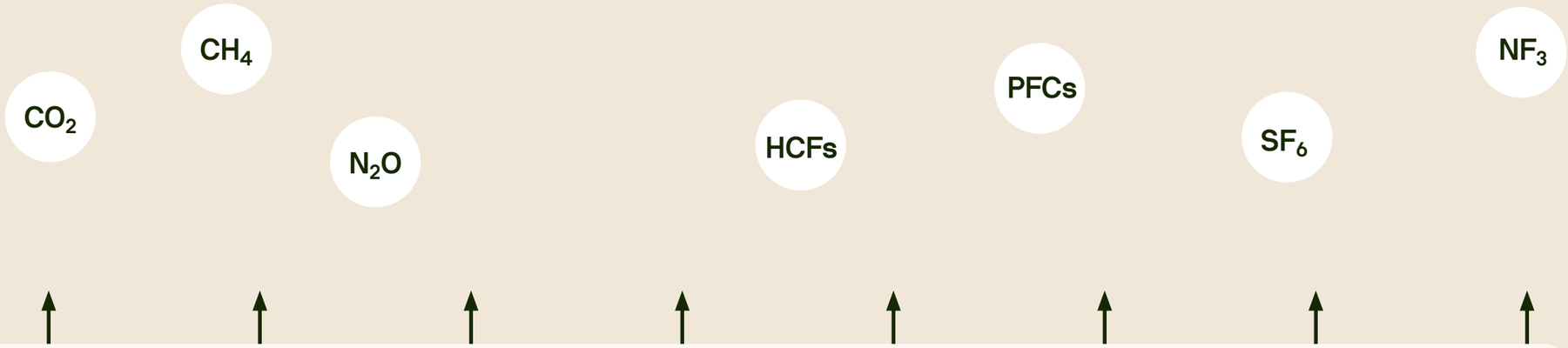
## 03 Upstream

Emissions which are related to the own supply chain, e.g. purchased goods, transportation, and downstream emissions related to the distribution and usage of the created products, e.g. use of sold products, transportation.

## 04 Downstream

Emissions from the distribution, usage and recycling of the product.

# Greenhouse gases




Need for systematic, soft-ware-based product footprint calculation

Need for know-how, data and supplier qualification

**Scope 3: Indirect upstream emissions**

**Supply chain:**
Purchased goods, transportation

**Scope 1: Direct emissions**
Company facilities and vehicles

**Scope 2: Indirect emissions**
Purchased electricity, heating, etc.

**Scope 3: Indirect downstream emissions**

**Supply chain:**
Transportation, usage, recycling

**$CO_2$ share**
(indicates the proportion of total emissions over lifetime associated with a scope.)

| | | | |
|---|---|---|---|
| Typical data availability | ? | ✓ | ✓ |
| Influenceability | High | High | Low |
| Priority | High | Low | Medium |

# Solutions

01 Creating transparency

02 Using carbon pricing to make emissions a business case

03 Developing the supply chain

04 Other levers to reduce emissions

# 01 Creating transparency

**Having numbers readily available requires the introduction of measuring and reporting standards, as well as adequate governance and IT setups.**

Creating transparency on GHG emission performance is the foundation for all further action. Without the ability to measure, it is impossible to set quantitative goals and evaluate one's performance. This in turn prevents initiatives from being taken seriously and being effective.

## Challenges

Companies face several challenges when striving for more transparency. It is still hard for companies to get relevant data accurately and timely. This is due to a lack of universal measuring and reporting standards, the vast number of different factors that could be considered, a lack of appropriate tools or the absence of some of required data. These challenges are usually exacerbated the further one goes down the value chain. In addition to the issue of data collection and metrics, there is also a lack of optimized and well-established analysis, storage and reporting of such information. Essentially, adequate software is missing. This is in stark contrast to financial reporting which companies have become excellent at.

**"Whereas every large company has a sophisticated and robust IT infrastructure for generating financial reports, few firms have reliable systems for measuring environmental, social and governance performance (ESG). [...] Indeed, one of the main obstacles today for many companies wishing to produce an integrated report is that their ESG information is rarely available at the same time and in a comparable format as financial information."**

**Harvard Business Review**[11]

## What to do

To address these challenges and create transparency, companies should do the following:

### 01 Define

Measuring and reporting standards. Choosing standards is a trade-off between bureaucratic burden, market position / strategy and stakeholder requirements.

### 02 Set

Goals for one's direct and indirect emissions and work towards better understanding scope 3 emissions to be able to consider them in emission targets.

### 03 Evaluate

Existing IT setups (data warehouses, analysis / reporting software) to investigate to which extent adaptations are beneficial and where new software is needed for evaluating and managing GHG emission performance.

### 04 Raise

Awareness in (top) management across all functions as data needs to be collected (and savings can be made) virtually everywhere in the company.

### 05 Make

GHG emissions a part of benchmarking. Companies often compare pricing, functionality, and other aspects of products without taking their respective emission performance into consideration. This approach may overlook competitive advantages that are increasingly relevant as the world strives to reduce its emissions.

Several international standards have evolved over the past years:

**ISO 14040** — **"Life cycle assessment – Principles and framework"**

**ISO 14044** — **"Life cycle assessment – Requirements and guidelines"** provides a general framework on how to measure environmental impact of products, from manufacturing over usage to recycling.

**ISO 14064** — **"Greenhouse gas accounting and verification"** specifies requirements for GHG inventories, quantification and reporting on an organizational level. It covers both GHG emissions and removals.

**ISO 14067** — **"Carbon footprint of products"** is focusing on reporting on the product level.

There are further standards, e.g. giving requirements for validation and verification institutions.

When it comes to the organizational setup to deal with carbon reduction, several governance adaptions should be taken into consideration. The calculation of carbon footprints is currently often performed by sustainability departments. They have been seen to be attached to either the CEO, engineering, procurement, sales or legal function. Often sustainability teams lack the necessary technical understanding to efficiently provide carbon footprints. It should therefore be considered to move this capability to cost engineering or VA/VE teams. A central coordination role for sustainability can be installed in any corporate function, but all parts of a company need to contribute and therefore set up their own $CO_2$ expertise and update their relevant workflows. Finance can use carbon reduction measures to justify green bond emissions, Production implements energy efficiency measures and switches to green energy, Legal will include lifecycle analysis requirements into purchase conditions and so forth.

# 02 Using carbon pricing to make emissions a business case

**Long-running production cycles press automotive players to incorporate future GHG levies already now with internal carbon pricing.**

Companies need a strategy of how to factor GHG emissions into business decisions. Otherwise, they are likely to not receive the attention they deserve. Efforts to address GHG emissions will continue to be detached from financial and other considerations and companies will struggle to identify the best measures and implement them. This is not only regrettable for combating climate change but also short-sighted from a business perspective.

## Challenges

Common challenges include quantifying the value and the acceptable cost of GHG emission initiatives, balancing the former with financial and other targets, as well as dealing with uncertainty surrounding factors such as future legislation and technological advancements.

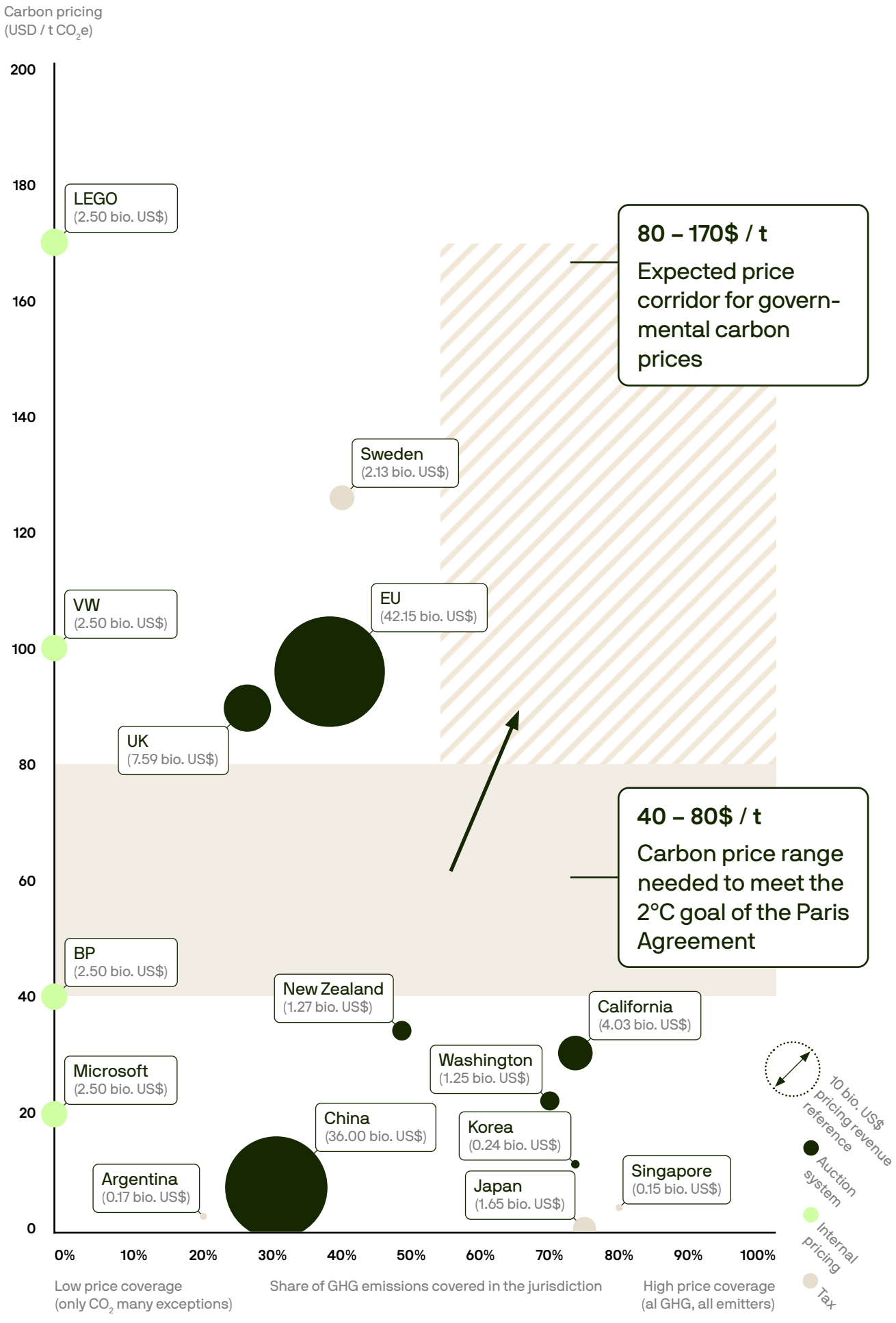
As automotive production cycles span several years, and both engineering and sourcing start long before the first car leaves factory gates, it is foreseeable that carbon legislation will change in many jurisdictions until end of production. Therefore, carbon emissions need to be set into the context of changing regulatory environments.

## What to do

An approach to put GHG emissions on the agenda that has received a lot of attention, and is considered the most effective by many economists,[12] is carbon pricing. It has come in the form of emission trading systems, carbon taxes, and internal prices. When speaking of carbon pricing, we mean a price for any emission which contributes to global warming. A better name would be GHG pricing, but the former expression is better known, and many greenhouse pollutants are not yet being monitored reliably. To compare the effects of the various GHG, typically the impacts along 100 years are set in equivalence to $CO_2$[13].

The according unit is $tCO_2e$, where the "e" stands for "equivalent".

As of April 2023, there are 73 carbon taxes or emission trading systems in operation worldwide on either a subnational, national or supranational jurisdiction level. Since April 2022, new instruments in Austria, Mexico (regional initiatives), Indonesia, Montenegro and USA (regional initiative) have started[14]. Since these regulations apply to different sectors, have different exceptions, and consider different greenhouse gases, comparisons need to be done carefully.


Carbon pricing
(USD / t $CO_2$e)
200
180
160
140
120
100
80
60
40
20
0
LEGO
(2.50 bio. US$)
VW
(2.50 bio. US$)
BP
(2.50 bio. US$)
Microsoft
(2.50 bio. US$)
Argentina
(0.17 bio. US$)
UK
(7.59 bio. US$)
Sweden
(2.13 bio. US$)
EU
(42.15 bio. US$)
China
(36.00 bio. US$)
New Zealand
(1.27 bio. US$)
Washington
(1.25 bio. US$)
California
(4.03 bio. US$)
Korea
(0.24 bio. US$)
Japan
(1.65 bio. US$)
Singapore
(0.15 bio. US$)
80 – 170$ / t
Expected price corridor for govern-mental carbon prices
40 – 80$ / t
Carbon price range needed to meet the 2°C goal of the Paris Agreement
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Low price coverage
(only $CO_2$ many exceptions)
Share of GHG emissions covered in the jurisdiction
High price coverage
(al GHG, all emitters)
10 bio. US$ pricing revenue reference
Auction system
Internal pricing
Tax

Companies are paying attention, and some have even publicly voiced their support of carbon pricing. Herbert Diess, former chairman of the board at Volkswagen, demanded[15] "a clear $CO_2$ price for all sectors" and said that "100 Euro per ton is not outrageous". In 2023, Diess' barrier of 100 Euro per ton was already crossed for the EU ETS and we can expect even higher prices in the future.

Companies have in fact been trying to quantify their emissions and consider the implications of carbon pricing for quite some time. For example, in 1991 Imperial Oil concluded[16] that only a carbon tax (of CAD $55 per ton of $CO_2$) would stabilize Canada's emission levels at that time. A report[17] by the Center for Climate and Energy Solutions claims that "companies across sectors and geographies are turning to an internal carbon price as one tool to help them reduce carbon emissions, mitigate climate-related business risks, and identify opportunities in the transition to a low-carbon economy".

Depending on their objectives and the specific business situation of a company, different approaches have emerged: Carbon fees which generate revenue streams; shadow prices which are used for modelling but not paid; and implicit prices calculated retroactively based on measures implemented and a combination of these.

There are a number of reasons why companies have introduced carbon pricing, most notably:

## GHG reduction

By using the same unit (a currency) to measure cost and emissions, companies need no longer focus on two potentially conflicting goals. Revenue streams generated by carbon fees can also be used to invest in emission reduction initiatives or to pay for carbon offsets.

## Stress testing

By evaluating the competitiveness of investments in a carbon constrained future, companies can test the impact of potential regulation, the resilience of their supply chains and the value of their portfolio. Uncertainties regarding GHG emissions can be accounted for in the same way as financial uncertainties when making investment decisions. With the rising awareness for sustainability and tightening regulations, we expect carbon pricing to become an integral part of risk management of the future.

## Investor and shareholder relations

Putting a price tag on emissions allows to effectively communicate one's approach and conveys to externals the importance of sustainability. Already in 2004, the Global Investor Statement on Climate Change[18] representing more than $24 trillion in assets called for governments to "Provide stable, reliable and economically meaningful carbon pricing that helps redirect investment commensurate with the scale of the climate change challenge."

## Transparency in procurement and sales

In sales, companies may want to advertise their products for having a lower carbon footprint than those of competitors and potentially charge a premium. In procurement situations, vendors may try to justify price increases with emission taxes or necessary investments for emission reduction efforts. Companies need to be able to evaluate these claims or else will face disadvantages during supply chain negotiations or sales price setting.

## Justification of charging premiums

There is evidence that consumers are increasingly willing to pay a premium for more sustainable cars provided they do not have to compromise on performance standards. The DAT-Report 2020[19] stated that 53% of buyers were willing to pay more for a car with lower $CO_2$ emissions. For used cars, the share was 39% of respondents.

We believe that companies should start early to lay the foundation for an effective carbon pricing scheme that can be tailored to future demands. At the moment, many companies are ill-equipped. For instance, BlackRock[20] considers good data to be a crucial element to accurately assessing climate risk with deficits particularly prevalent regarding scope 3 emissions and calls for corporate managers to improve disclosure.

The European Commission is already implementing a carbon border adjustment mechanism (CBAM) which leads companies to assess their value chain more critically and should hinder them to relocating carbon-intensive production to non-EU countries where less strict regulations apply. This measure is explored in more detail in section "CBAM" (p.48)

Under such a regulation, companies could no longer avoid carbon costs by relocating carbon-intense production to non-EU-countries where less strict regulations apply. Some companies already take extensive action, for example Microsoft with its internal carbon fee which addresses all scopes and fuels a fund to subsidize green initiatives and offset residual emissions. Microsoft is not alone: an internal carbon pricing instrument is already implemented in more than 850 companies worldwide across many different industries."[21]

## Financial instruments to tackle $CO_2$ risks

In 2018 RWE financially hedged $CO_2$ for four years to ensure earning neutrality during carbon price changes.[22]

BlackRock developed a tool that allows its portfolio managers quantifying a company's sensitivity to carbon prices and stress test scenarios.[23]

WWF is using a "stranded asset total return swap" with Deutsche Bank to protect their portfolio against the impacts of climate change.[24]

**“In July 2020, we will start phasing in our current internal carbon tax to cover our scope 3 emissions. […] Our fee is paid by each division in our business based on its carbon emissions, and the funds are used to pay for sustainability improvements. […] We will start at a lower price per ton than our current fee for other emissions, but we will phase in increases over time until all our scope 1, 2, and 3 emissions are charged the same rate.“**

**Microsoft**[25]

Defining an internal GHG price is, nevertheless, just one part of the equation. To apply the pricing, GHG emissions need to be known – down to the part level, perhaps even split by supplier. Thus, there is a need for efficient GHG footprint analysis.

When it comes to manufacturing in particular, product costing and GHG footprint analysis yield synergies because they rely on a similar set of part-specific input parameters and need the same technical manufacturing processes assessed. Such detail information on the manufacturing steps is often already available in a typical bottom-up cost calculation. Linking product costing with GHG footprint analysis can therefore pave the way forward to the introduction of GHG pricing.

It should be pointed out that companies do not need to have an internal price to start performing analyses and obtaining useful results. An intermediate solution is to introduce eco-efficiency as a metric. Here, a financial component is divided by the amount of GHG emissions associated with it. A typical result is the amount of money spent per ton of GHG emitted or saved. This already allows for example to compare the effectiveness of investing in different clean technology initiatives, rank suppliers by carbon intensity, and calculate a budget for carbon offsets. Perhaps most importantly, it reveals the break-even price at which investing money to reduce emissions is financially viable.

# 03 Developing the supply chain

**Immense GHG savings can be realised in the supply chain, but require adaptations to sourcing processes, trainings, certifications, performance evaluations and incentives.**

## We identified five main reasons for making the supply chain a core aspect of sustainability initiatives:

### 01 The scale is immense

A CDP report[26] across all industries, mostly covering OEMs, found "upstream emissions on average around 5.5 times greater than those related to a company's direct operations" with manufacturing even averaging a factor of 6.5. At the same time efforts to reduce upstream emissions often still do not progress beyond a company's direct relationships with first tier suppliers.

### 02 There is significant room for improvement

Companies are less engaged in a supplier's operations than in their own even though they are usually far less mature. A paper[27] by researchers of the Pennsylvania State University found that while "multinational companies have increasingly embraced a sustainability strategy", this sharply decreases the further you go down the value chain, "despite lower-tier suppliers having a higher incidence of violations with more acute environmental and social impacts". A report[28] by EY found that "many companies still do not have a comprehensive understanding of the performance, risks and sustainability impacts of their supply chain" and in order to change "technology will continue to play an increasing role in supply chain sustainability, offering modular, cloud-based, sector-specific solutions [...]"

### 03 Supplier sustainability impacts OEM success and reputation

Furthermore, an extensive literature review[29] on the International Strategic Management Review found that good supplier sustainability has benefits such as product differentiation and customer satisfaction while shortcomings pose a reputational and financial risk to the far more visible OEMs.

## 04 Supplier cooperation is essential for data collection

As outlined in a previous chapter, it is difficult to collect high-quality emission data within a reasonable time. This problem is exacerbated through complex supply chains. Only when suppliers are included in transparency efforts and dedicated tools are being leveraged, can companies understand their carbon emissions.

## 05 OEMs might become liable for suppliers' violations

In 2017, France passed a law[30] mandating large companies to identify human rights abuses and environmental risk within their supply chain. Violations are subject to a penalty of up to 10 million euros. In Germany, a similar initiative receives widespread support from NGOs and even companies such as BMW and Daimler. It was recently halted in light of the COVID-19 pandemic, but we expect the performance of supply chains to come under increasing scrutiny. While high GHG emissions alone are unlikely to qualify as environmental risk, companies acting early could turn a regulatory risk into a competitive advantage and become a role model of supply chain sustainability.

Example

**Unfortunately, change is hard to come by for a variety of reasons ranging from high cost and uncertainty of return to a perceived lack of knowledge and concerns that suppliers will use their newly acquired skills to work for competitors. Supplier development is already a challenge, and introducing ambitious sustainability requirements complicates things even further. For example, BCG found[31] that "97% of chief procurement officers [...] are convinced that they've exhausted the effectiveness of their current supplier management strategies". Large companies often command a network of thousands of suppliers. Even if they enjoy temporary progress with their suppliers, once effort diminishes, the supplier base may expand, and old issues reappear.**

## What to do

To overcome these challenges, relationship management and clear objectives are key. A body of research[32] shows that most successful companies employ a set of similar strategies. In particular, we recommend the following:

### 01 Define standards

Sustainability standards can be integrated into the RFQ process. Questionnaires regarding $CO_2$ emissions can be requested as part of the offer.

### 02 Select carefully

A careful selection of suppliers could lead to a reduction of suppliers to a manageable number and more intense relationships with those (most promising) ones regarding $CO_2$ emissions can be requested as part of the offer.

### 03 Evaluate closely

Own and supplier performance needs close evaluation, e.g. by automated data capture, to improve response time, and performing onsite visits.

### 04 Offer support

Extensive support could include joint-teams and trainings.

### 05 Create incentives

Compliance incentives such as long-term outlook or sharing of risk and information might help reaching further $CO_2$ reduction with key suppliers.

Large companies often have such systems in place already. For example, Drive Sustainability[33] is a partnership of 16 leading automotive companies with the goal of promoting a common approach and to integrate sustainability in the procurement processes. It monitors compliance via self-assessment questionnaires, facilitates supplier capacity building and launched an ongoing raw material risk assessment in 2018. In terms of GHG emissions, suppliers are asked whether they have an environmental management system in place and whether they participate in voluntary CSR initiatives such as CDP, the latter being an optional question.

Such initiatives are a big step in the right direction. However, they usually fall short of providing a timely and granular understanding of a supplier's GHG emissions.

# 04 Other levers to reduce emissions

**GHG reductions require a multitude of measures including green power, material savings and carbon offset projects.**

This report focuses on transparency, carbon prices and developing the supply chain because of the huge untapped potential there. Nevertheless, we encourage companies to look at all areas of their business and critically evaluate how they can address GHG emissions in each of them. Other levers that are worth investigating include:

## GHG Emissions

| Scope 1 | Scope 2 | Scope 3 | | |
|---|---|---|---|---|
| **Sources** | | | | |
| Manufacturing facilities & company owned vehicles | Electricity purchased | Purchased goods and services | Upstream transportation & distribution | Use of sold products |
| **Triggers** | | **Biggest potential expected** | | |
| Energy efficiency | Carbon footprint reduction | Supply chain actions | | Emmission norms & fuel efficiency |
| **Measures** | | | | |
| Improve manufacturing | Increase green power share | Optimize sourcing | Supplier development | Increase EV share |

# Case study

## 01 Gearbox housing

# 01 Gearbox housing

## How bottom-up product costing in combination with carbon pricing can be used to make a sourcing decision

First, will compare the price per part for a common gearbox housing produced by a supplier in Stuttgart (Germany) or Suzhou (China) for a hypothetical Vienna-located client. For simplification, only the raw part without machining or special treatment will be considered.

There are three scenarios: Business as usual ("BAU") considers the current regulatory landscape and "BAU+CBAM" adds the effect of the carbon border adjustment mechanism starting in 2026. The "Progressive" scenario assumes a further strong increase in GHG pricing in both Germany and China.

It is important to note, that for both locations we do not start with a green-house gas price of zero. As of March 2024, the EU ETS certificates trade at ca. 58 EUR / tCO2e and the German carbon tax is fixed at 45 EUR / tCO2e. In China there is a carbon tax of ca. 7 EUR / tCO2e in place which targets electricity production. These pricing levels are our BAU scenario. In the progressive scenario, we assume that the price of the German carbon tax and the EU ETS converge at 100 EUR / tCO2e which matches the price required by 2030 according to the CPLC to achieve the Paris temperature target of staying below a 2 °C increase.

As we can see, adjusting the carbon price yields vastly different results for the part price. In the BAU scenario, production in China is considerably cheaper. But in the CBAM scenario we already see a cost advantage for the German supplier. Under the circum-stances of the progressive scenario, production in China is no longer competitive.

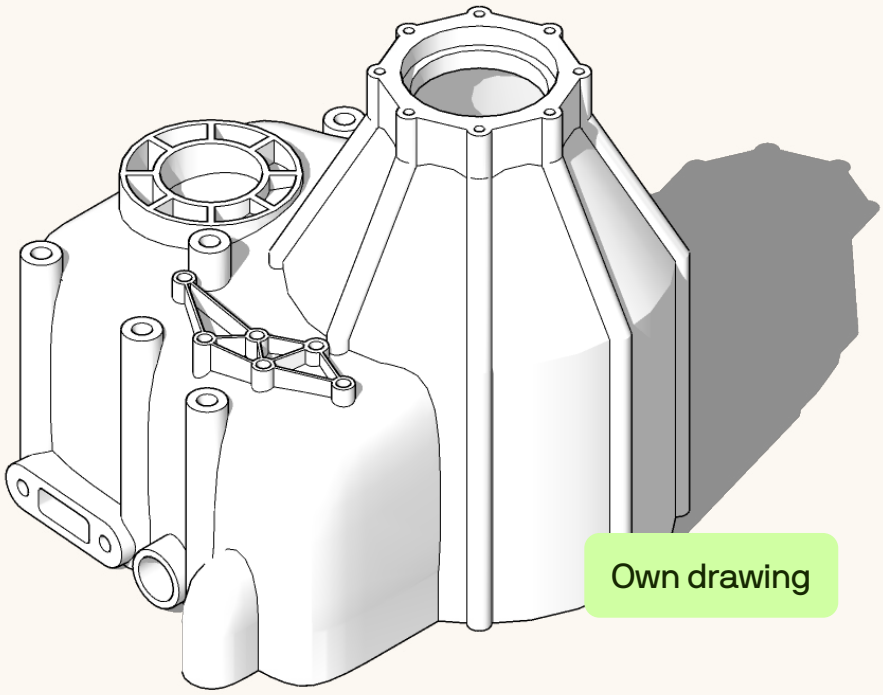
| | Business as usual | | | Progressive | | |
|---|---|---|---|---|---|---|
| | DE | CN | CN* | DE | CN | CN* |
| Scope 1 emissions | 45 | 0 | 0 | 100 | 50 | 50 |
| Scope 2 emissions | 58 | 7 | 7 | 100 | 50 | 50 |
| Scope 3 emissions Raw material | 58 | 7 | 58 | 100 | 50 | 100 |
| Scope 3 emissions: Ship transport | 0 | 0 | 0 | 50 | 50 | 50 |
| Scope 3 emissions: Truck transport | 45 | 0 | 0 | 45 | 50 | 50 |
| Scope 3 emissions: others | 0 | 0 | 0 | 0 | 0 | 0 |

[EUR / $tCO_2e$]

*including CBAM

EU ETS
DE carbon tax
CN ETS
Future int. agreement
No pricing

Example




# Gearbox housing

Technology
**High-pressure die casting**

Weight
**9 900 g**

Dimensions
**L400 x W300 x H280 mm**

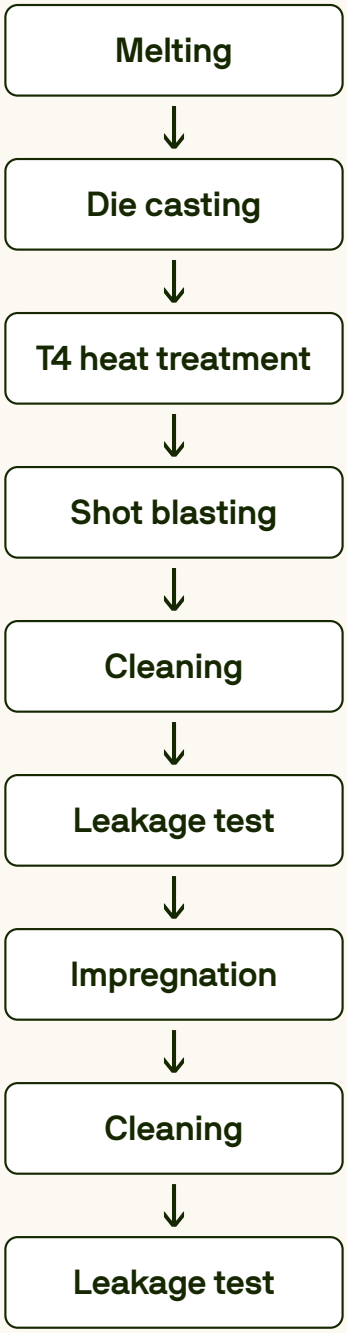
Material
**AlSi9Cu3**

Parts / year
**800 000**

Lifetime
**5 years**

Location
**Stuttgart / Germany vs. Suzhou / China**

Considered manufacturing steps



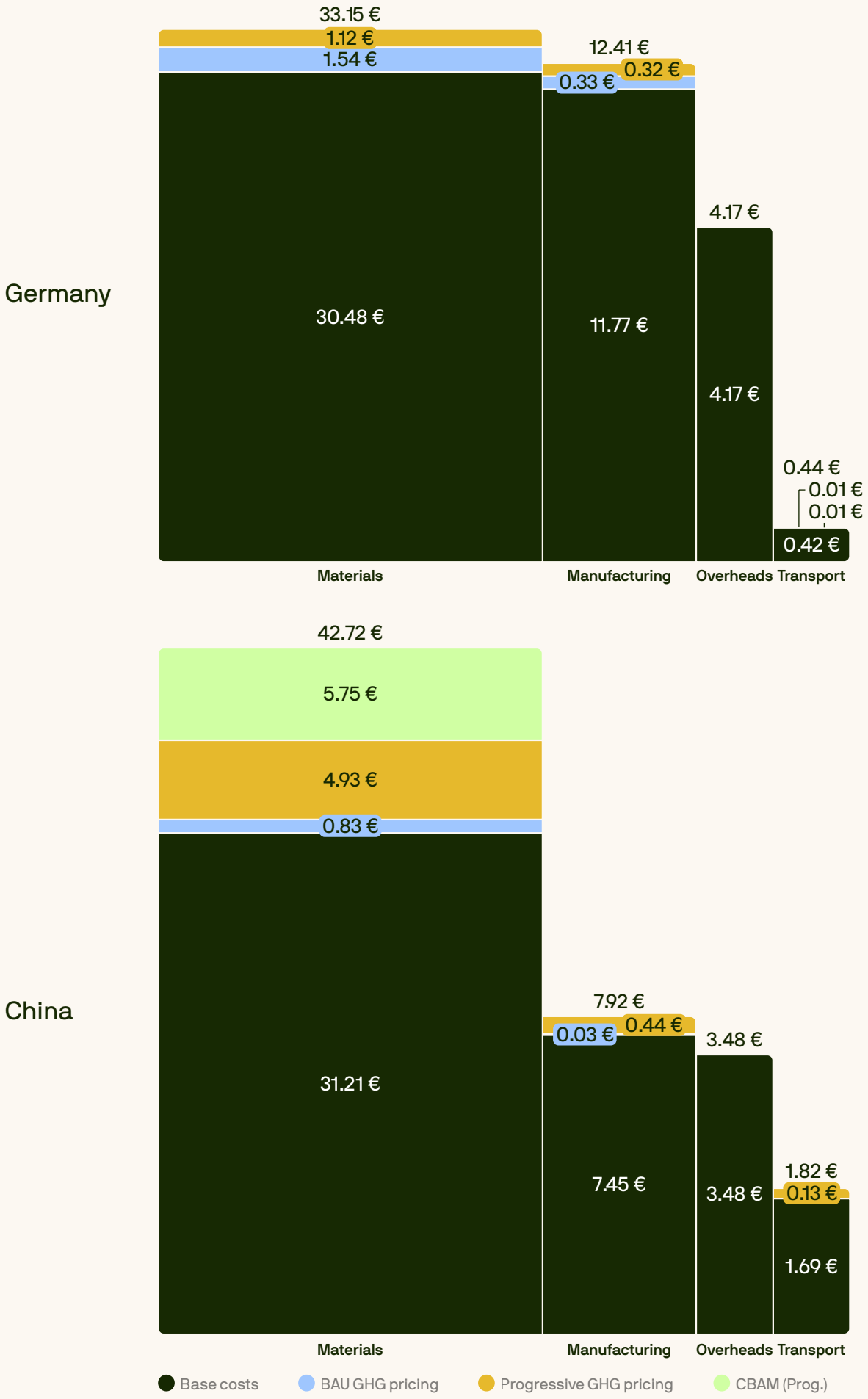

**Raw material emission intensities**

| [kg $CO_2$e / kg Al] | DE | CN |
|---|---|---|
| **Primary** | 8.0 | 17.0 |
| **Secondary** | 0.5 | 0.7 |

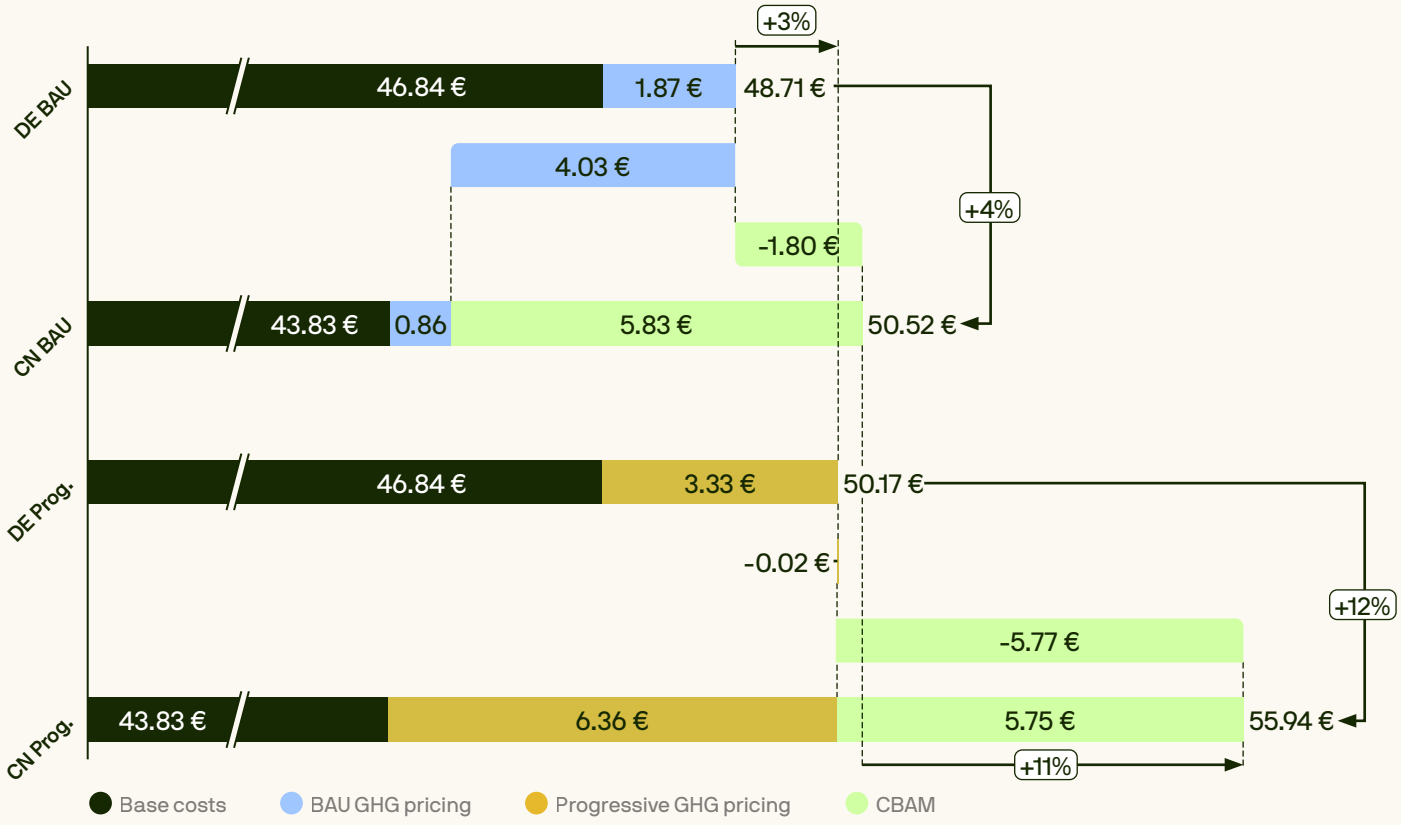
## Assumptions

- Emissions are calculated for aluminium alloy, electricity, natural, gas, die, and transport. There are no emission overheads.
- Aluminium recycling rate: 61 % Germany, 20 % China
- Scrap is considered.
- Factor costs as of Q2 2023. Same aluminium alloy price for Germany and China: 3 EUR / kg.
- Transport scenarios based on pier2pier.com:
  Stuttgart → Vienna by truck
  Suzhou → Shanghai by truck; Shanghai → Koper by ship via Suez canal;
  Koper → Vienna by truck

## Additional cost from GHG pricing



## Price comparison




For the progressive scenario, we assume that a future international agreement implements a carbon pricing at a level of 50 EUR. The CBAM fills the delta between the local Chinese price level and the EU ETS. We assume that the CBAM applies only to the electricity required for the aluminium electrolysis.

As the CBAM applies only to the difference between the China and EU price levels, an interesting effect occurs: In the progressive scenario, the Chinese pricing level is already so high that the CBAM cost is actually a bit smaller than in the BAU scenario.

Another finding is that the transport emissions are not so relevant compared to both the material and manufacturing emissions.

Overall, the main driver is of course the raw material and here especially the recycling rate and the emission intensity difference between China and Germany.

Due to the high uncertainty surrounding future developments and the complexity of the topic, it is not straightforward to predict how likely different scenarios are. Even putting all practicalities aside, setting an adequate price is notoriously difficult[34]. Here are several examples that illustrate the range of carbon prices that can be observed:

| | |
|---|---|
| **15 USD / t** | **internal carbon price used by Microsoft [35]** |
| **45 EUR / t** | **Carbon tax in Germany for the non-ETS sectors traffic and heating for 2024. The tax will further increase to 55 EUR/t by begin of 2025.[36]** |
| **100 EUR / t** | **Peak price of the EU emission trading system in 2023.** |
| **80 USD / t** | **internal carbon price used by bp[37] (2019)** |
| **40 – 80 USD / t** | **price target for 2020[38] by CBLP to reach Paris climate goals** |
| **156 USD /t** | **Carbon tax in Uruguay for 2023, applicable on emissions from gasoline combustion in any use.[39]** |
| **180 USD / t** | **environmental cost estimate by the German Umweltbundesamt[40] 2016** |

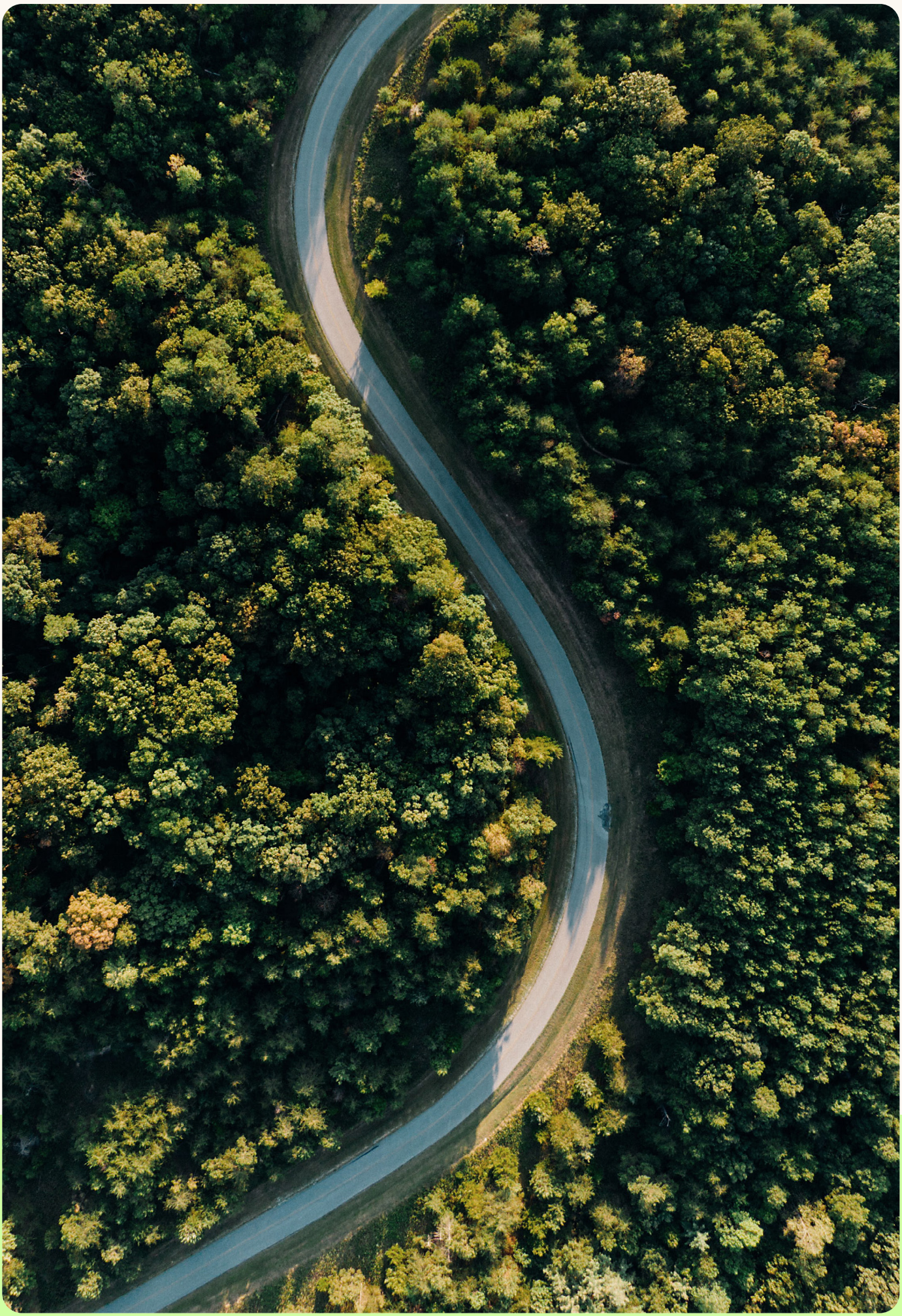
We believe this is even more reason for companies to formulate hypotheses for their own specific situation and use them to guide their business decisions. Since production cycles in manufacturing are often several years long, it is imperative to test how robust an investment is under different scenarios before major financial commitments are made.

Obviously, reality is far more complex than this example. Companies need to consider hundreds or thousands of different parts, there are often far more than two sourcing options and changes to products or production lines will also affect their respective cost and emission levels.

Given these challenges, it is not feasible to rely on slow and isolated cost and GHG calculations. Companies need to have the right tools that allow them to perform these types of analyses on the spot to continuously test their assumptions.

# The impact of CBAM

**The carbon price is a key tool for reducing emissions. By putting a price on carbon, governments can encourage businesses and individuals to switch to cleaner energy sources and reduce their emissions.**



# The impact of CBAM

## Empowering supply chains for a carbon-neutral future: The role of CBAM

The Carbon Border Adjustment Mechanism (CBAM) is a policy under development by the European Union that aims to put a price on carbon emissions from goods imported from countries that do not have a carbon pricing system in place. This is intended to level the playing field for European businesses and encourage the transition to a low-carbon economy.

The automotive industry is one of the sectors that is likely to be most affected by CBAM. This is because the industry is a major emitter of greenhouse gases, and it relies heavily on imports of raw materials, such as steel and aluminum, that are produced with high carbon emissions.

The introduction of CBAM is likely to have a number of impacts on the automotive industry, including:

**Increased costs**

Companies will be required to pay a carbon price on the imported goods they use, which will increase their costs. This could put pressure on profit margins and make it more difficult for companies to compete.

**Supply chain disruptions**

The introduction of CBAM could lead to disruptions in the supply chain as companies seek to source more sustainable materials and products. This could lead to shortages and higher prices for consumers.

**Accelerated innovation**

The need to comply with CBAM could accelerate innovation in the automotive industry as companies look for ways to reduce their carbon emissions. This could lead to the development of new technologies and products that are more sustainable.

In order to optimize their CBAM compliance and reduce their cost/$CO_2$ challenges, automotive companies can take a number of steps, including:

## Identifying and reducing emissions

Companies should undertake a comprehensive assessment of their emissions across their entire value chain, from raw material sourcing to manufacturing and end-of-life disposal. This will help them identify opportunities to reduce emissions and improve their compliance with CBAM.

## Transitioning to low-carbon materials

Companies should seek to source low-carbon materials, such as recycled materials or materials produced with renewable energy. This will help them reduce their emissions and meet CBAM requirements.

Investing in carbon capture and storage: Companies can invest in carbon capture and storage technologies to capture and store their emissions from manufacturing processes. This can help them reduce their overall emissions and meet CBAM requirements.

Optimizing supply chains: Companies should work with their suppliers to develop more sustainable supply chains. This could include sourcing materials from companies that have already reduced their emissions or switching to suppliers that are located closer to their manufacturing facilities.

Implementing a carbon price internally: Companies should consider implementing an internal carbon price to internalize the cost of carbon emissions into their decision-making processes. This can help them incentivize the development of more sustainable products and processes.

By taking these steps, automotive companies can mitigate the impact of CBAM and position themselves for success in the transition to a low-carbon economy.

Interesting facts & figures that will showcase the big impact, especially on the automotive industry.

**The CBAM is expected[41]:**

**01** To cover approximately 40% of EU imports

**02** To raise €5 billion per year in revenue

**03** To reduce carbon emissions by 25% by 2030

**04** To create 20,000 jobs in the EU

The CBAM is a complex policy with the potential to have a significant impact on the global economy. It is important for businesses to understand the CBAM and to take steps to comply with it.

## What can companies do to prepare for CBAM?

First, companies should check whether and to what extent affected goods are imported from countries subject to reporting requirements. In doing so, it is important to quantify the emissions in the upstream value chain. Companies must therefore become experts not only on their own sustainability, but also on that of their suppliers. To do this, they must obtain as many details as possible about the actual emissions of the business partners along the value chain. In addition, they need to work out how the relevant data will be collected, analysed, reported and stored in the future. This may require additional consulting and software.

## How can a software provide support here?

Tset advises and supports companies in obtaining detailed information on the emissions of their value chain. Using a bottom-up approach, we include all relevant aspects with the help of our cloud-based and intuitive software. Using intelligent algorithms, we finally create meaningful analyses of product costs and $CO_2$ emissions. In contrast to common top-down methods such as the cost-per-kilo method, our approach comes much closer to the actual $CO_2$ values - and this already in the early phase of product development. By combining extensive master data, recognised calculation methodology, the use of intelligent, extensively validated algorithms and a high level of consulting expertise, we help you to better assess potential and existing suppliers and ultimately identify more sustainable alternatives.

# About Tset

**Our software platform "Tset" is a proven solution for automotive companies to create comprehensive and accurate total cost of ownership (TCO) calculations, including $CO_2$ emissions.**

Tsetinis Software GmbH – Tset for short – is a leading expert in product cost and carbon analysis. Based in Vienna and Kuchl, the scaleup was founded by Andreas Tsetinis and Sasan Hashemi in 2018. Tset's holistic cost management software enables the manufacturing industry to maximise cost and carbon efficiency when developing, manufacturing and procuring products. Since costs and carbon emissions are always calculated together, customers can very specifically demonstrate the benefit of their particular products and carbon avoidance strategies.

Unlike conventional blanket assessments, Tset's software can produce highly comprehensive and precise analyses based on large amounts of existing secondary data and given only a small amount of additional primary data. Our solution is also cloud-based and available as an SaaS product, so the system is ready to use and doesn't incur any internal IT costs for customers. It is used by decision-makers in the white goods, yellow goods, automotive, medical technology and electrical engineering sectors – and more. More than eighty mathematicians, software developers and manufacturing experts are currently working at Tset's Kuchl and Vienna sites to constantly expand and optimise our product range.

**Contact tset**
info@tset.com

# Endnotes


1 2018 “Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C approved by governments.” IPCC. Accessed 18 Jan. 2024. https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/.

2 Woetzel et al. 2020. Climate risk and response: Physical hazards and socioeconomic impacts. McKinsey Global Institute.

3 CDP. Accessed 20 Jan. 2024. https://www.cdp.net/.

4 Seiwert, Martin. 2019. “VW verantwortet weltweit zwei Prozent der CO2-Emissionen.” Wirtschafts-Woche. Accessed 18 Jan. 2024. https://www.wiwo.de/unternehmen/auto/volkswagen-konzern-vw-weltweit-fuer-zwei-prozent-der-co2-emissionen-verantwortlich/24155948.html.

5 European Union. 2023. “GHG emissions of all world countries.” WirtschaftsWoche. Accessed 18 Jan. 2024. https://edgar.jrc.ec.europa.eu/report_2023/GHG_emissions_of_all_world_countries_booklet_2023report.pdf

6 Patterson, Jane. 2018. Understanding the life cycle GHG emissions for different vehicle types and powertrain technologies. LowCVP, written by Ricardo.

7 2020. “Wie klimafreundlich sind Elektroautos?” Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit. Accessed 11 March 2024. https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Verkehr/emob_klimabilanz_bf.pdf.

8 “How Volkswagen makes the ID3 carbon neutral.” Volkswagen. Accessed 11 March 2024. https://www.volkswagenag.com/en/news/stories/2019/11/how-volkswagen-makes-the-id-3-carbon-neutral.html.

9 Frahm, Christian. 2019. “Wie Autohersteller das Null-CO2-Auto bauen wollen.” Spiegel. Accessed 8 Feb. 2024. https://www.spiegel.de/auto/aktuell/vw-mercedes-volvo-wie-die-hersteller-nachhaltig-werden-wollen-a-1293674.html.

10 Greenhouse Gas Protocol. Accessed 26 Jan. 2024. http://ghgprotocol.org/.

11 Eccles, Robert G. and Svetlana Klimenko. 2019. “The Investor Revolution.” Harvard Business Review May–June 2019: 106–116)

12 2015. “Second-best solutions.” The Economist. Accessed 28 Jan. 2024. https://www.economist.com/news/special-report/21678959-if-best-method-tackling-climate-change-not-offer-try-something.

13 2013. “Report of the Conference of the Parties on its nineteenth session.” United Nations Framework Convention on Climate Change. Accessed 29 Jan. 2024. http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf.

14 World Bank. (2023). State and Trends of Carbon Pricing 2023. Accessed 12 Feb. 2024. https://openknowledge.worldbank.org/entities/publication/58f2a409-9bb7-4ee6-899d-be47835c838f

15 Astheimer, Sven. 2020. “Ich wünsche mir eine höhere CO2-Steuer.” FAZ. Accessed 29 Jan. 2020. https://www.faz.net/aktuell/wirtschaft/welt-wirtschaftsforum/vw-chef-diess-ich-wuensche-mir-eine-hoehere-co2-steuer-16597195.html.

16 1991. “A Discussion Paper on Global Warming Response Options.” Imperial Oil.

17 Ahluwalia, Manjyot Bhan. 2017. “The Business of Pricing Carbon: How companies are pricing carbon to mitigate risks and prepare for a low-carbon future.” Center for Climate and Energy Solutions. https://www.c2es.org/site/assets/uploads/2017/09/business-pricing-carbon.pdf.

18 2010. “Global investor statement on climate change.” INEP FI. Accessed 28 Jan. 2020. http://www.unepfi.org/fileadmin/documents/GlobalInvestorStatementOnClimateChange.pdf.

19 Miremadi, Mehdi, Musso, Christopher and Ulrich Weihe. 2012. “How much will consumers pay to go green?” McKinsey & Company. Accessed 10 Jun. 2020. https://www.mckinsey.com/business-functions/sustainability/our-insights/how-much-will-consumers-pay-to-go-green.

20 Allonby et al. 2015. “The Price of Climate Change: Global Warming’s Impact on Portfolios.” BlackRock Investment Institute. Accessed 28 Jan. 2020. https://www.blackrock.com/corporate/literature/whitepaper/bii-pricing-climate-risk-us.pdf.

21 CDP. Accessed 4 Jan. 2024. https://www.cdp.net/en/climate/carbon-pricing/carbon-pricing-connect

22 Flauger, Jürgen and Kathrin Witsch. 2024. “Warum RWE sogar an steigenden CO2-Preisen verdient.” Handelsblatt. Accessed 4 Jan. 2024. https://www.handelsblatt.com/technik/thespark/energiekon-

zern-milliardengeschaeft-kohle-warum-rwe-sogar-an-steigenden-co2-preisen-verdient/27617624.html.

23 "Nachhaltigkeit wird BlackRocks neuer Investmentstandard." BlackRock. Accessed 4 Jan. 2024. https://www.blackrock.com/ch/privatanleger/de/blackrock-client-letter

24 Abramskiehn, Dario, Wang, David and Buchner, Barbara. 2015. "The Landscape of Climate Exposure for Investors" Climate Policy Initiative.

26 DiCaprio, Tamara (2013): The Microsoft carbon fee: theory & practice, Microsoft Corporation.

26 2019. "Global Supply Chain Report 2019." CDP, written by Carbon Trust. Accessed 20 Jan. 2020. https://www.cdp.net/en/research/global-reports/global-supply-chain-report-2019.

28 Villena, Verónica H. and Dennis A. Gioia. 2018. "On the riskiness of lower-tier suppliers: Managing sustainability in supply networks." Journal of Operations Management 64: 65–87. https://doi.org/10.1016/j.jom.2018.09.004.

28 "The state of sustainable supply chains: Building responsible and resilient supply chains." EY. Accessed 20 Jan. 2020. https://www.ey.com/Publication/vwLUAssets/EY-building-responsible-and-resilient-supply-chains/$FILE/EY-building-responsible-and-resilient-supply-chains.pdf.

30 Kumar, Divesh and Zillur Rahman. 2015. "Sustainability adoption through buyer supplier relationship across supply chain: A literature review and conceptual framework." International Strategic Management Review 3 (2015): 110–127. https://doi.org/10.1016/j.ism.2015.04.002.

30 2017. "Loi relative au devoir de vigilance des sociétés mères et des entreprises donneuses d'ordre." Légifrance. Accessed 28 Jun. 2020. https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000034290626&categorieLien=id.

31 Vohra, Rohit, Kamath, Pundalik and Karthik Iyer. 2018. "Don't Give Up on Strategic Supplier Management." Boston Consulting Group. Accessed 13 Feb. 2020. https://www.bcg.com/publications/2018/do-not-give-up-on-strategic-supplier-management.aspx.

32 Gocke et al. 2011. "Supplier Development: Bonanza or Bust?" Boston Consulting Group.

33 Drive Sustainability. Accessed 25. Jan 2024. https://drivesustainability.org/.

35 Wagner, Gernot. 2020. "Why Oil Giants Figured Out Carbon Costs First: Gernot Wagner." Bloomberg. Accessed 3 Feb. 2020. https://www.bloomberg.com/news/articles/2020-01-22/why-oil-giants-figured-out-carbon-costs-first-gernot-wagner.

35 Smith, Brad. 2020. "We're increasing our carbon fee as we double down on sustainability." Microsoft. Accessed 21 Jan. 2020. https://blogs.microsoft.com/on-the-issues/2019/04/15/were-increasing-our-carbon-fee-as-we-double-down-on-sustainability/.

36 2020. "Grundlage für CO2-Preis steht". Bundesregierung. Accessed 9 Apr. 2020. https://www.bundesregierung.de/breg-de/themen/klimaschutz/nationaler-emissionshandel-1684508.

37 2019. "Calling for a price on carbon." BP. Accessed 21 Jan. 2020. https://www.bp.com/en/global/corporate/sustainability/climate-change/our-role-in-advancing-the-energy-transition/carbon-pricing.html.

39 2020. "Report of the High-Level Commission on Carbon Prices." Carbon Pricing Leadership Coalition. Accessed 21 Jan. 2020. https://www.carbonpricingleadership.org/report-of-the-highlevel-commission-on-carbon-prices.

39 2020. "Sweden's carbon tax." Government Offices of Sweden. Accessed 25 Feb. 2020. https://www.government.se/government-policy/taxes-and-tariffs/swedens-carbon-tax/.

41 2019. "Gesellschaftliche Kosten von Umweltbelastungen." Umweltbundesamt. Accessed 21 Jan. 2020. https://www.umweltbundesamt.de/daten/umwelt-wirtschaft/gesellschaftliche-kosten-von-umweltbelastungen.

41 European Commission. 2024. Carbon Border Adjustment Mechanism. Accessed 11 March 2024. https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en#cbam-definitive-regime-from-2026

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