Methodology to Assess Green House Gas Emissions and Emission-related Risks for Companies

Michael Has

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Abstract

To prevent average atmospheric temperatures from rising the emissions of Green House Gases need to be restricted. For that most of the industrialized nations implemented measures to limit such emissions plus develop implementable measures to reduce them. To enforce that an annual percentage of reduction is often legally required. In order to develop fitting strategies for reduction at a given company it is initially required to numerically know the Green House Gas (GHG) emissions within a defined period of time - especially also their main contributions. Consequently, methods are required to assess emissions and develop emission-factor-related strategies for reduction.

The article introduces to a method to assess the Green House Gas Protocol (GHP) Scope 1-, 2 -, and 3 -Emissions and gives examples for main contributors. Related to the emissions and the increasing likelihood of court cases, penalties and negative publicity partly severe risks come into existence for each individual company. Such risks are introduced, structured and examples are given.

1 Motivation/Introduction

All Industries are concerned about global warming. The key measure to restrict global warming is to limit consumption or, a slightly softer measure, to restrict of the GHG emissions. While the relationship between global warming and Greenhouse Gas emissions has been known for a considerable time, the implementation of countermeasures to emissions takes place particularly retarded. This again leads to a considerable pressure to reduce emissions timely before changes become irreversible or fatal on a global scale (1).

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In order to reduce emissions, politics set targets for reduction and, in order to motivate execution of targets, prices for GHG emissions. On a global scale the political target is rather clear: reduction of emissions to the state of what was emitted in 1990 by 2040. Translating this target to a meaningful per-company-number is not trivial. However, independent of which approach to choose in order to determine the absolute reduction individually required, it is necessary to know what was emitted in the first place.

The article is organized as follows:
In the first section (Chapter 2) the relationship between Green House Gas Emissions and Carbon Footprints (also called CO2 Footprints) are sketched. Then (Chapter 3) a means to group the emissions to practically organize them is laid out. Chapter 4 provides two examples (a printing company and a company producing plastic parts) are given to display what the core of a Carbon Footprint reporting may look like. Subsequently the risks going along with these emissions are defined and, for some of the risks defined in the resulting raster, applied to the example of a printing company (Chapter 5). The article offers conclusions (Chapter 6).

It is not intended to
- lay out what a reasonable footprint per company or per industry segment may be. For this we refer to the ongoing scientific discussion within the science based target initiative (2).
- describe specific actions to be taken by a company as those actions are - most often – dependent on the local situation and the value and supply chains under view.

2 What´s a GHG emission footprint and how does it relate to a CO_2 Footprint?

Green House Gases (GHGs) are a class of substances known, if emitted into the atmosphere, to cause rising temperatures on earth. The main GHGes are carbon dioxide, methane, nitrous oxide, sulfur oxide, and the fluorinated gases (including hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride). Carbon dioxide makes up for 64.3% of GHGes. In order to have only one number to deal with and to scale the effect individual gases have on climate their contributing factor is translated into the mass of CO_2 that, if emitted into the atmosphere, has a comparable effect. That number is called "CO_2 Footprint" or "Carbon Footprint" (1) – both terms are used synonymously below. It is noteworthy that some of those gases are known to, once emitted, stay in the atmosphere for hundreds of years and remain to have a climate-related effect during that time.

There are many legislations to limit GHG emissions e.g 'Climate Change Act' (2). Recently the EU has decided to legally bind annual emission quantities with a reduction target of "at least 55 %" by 2030 for all member states of the EU (3). The GHG as emission indicator is based on the National Inventory Submissions 2019 (4). A CO_2- or Carbon Footprint (the terms are used synonymously) caused by an

individual, event, organization, service, industry segment or product summarizes the emissions of GHG. The term was popularised by a $250 million ad campaign by the oil and gas company BP in an attempt to move public attention away from restricting the activities of fossil fuel companies and onto individual responsibility for solving climate change (5).

The CO_2-Footprint is not an abstract number, it needs to be expressed in terms of tons per a certain reference - very often per year. The term relates to a concrete situation which determines the boundary conditions of what (not) to look at. Often and amongst other Footprints the CO_2 Footprint is assessed in the context of a Life Cycle Assessment (see ISO 140040 for Products).

3 GHP Scope 1,2 and 3 Emissions

To structure the CO_2-Footprint and to make it easier to analyse and draw conclusions for strategies and related actions the CO_2 emissions need to be structured. Every industry has its unique assessment and modelling techniques, allocation procedures, mitigation methods and labelling strategies for its carbon emissions (1). For allocating risks and defining appropriate stakeholder strategies we found it helpful to structure based on the pattern offered by GHG Scope 1, 2 and 3 emissions. To display that approach, we first need to look into the Green House Gas Protocol (GHP) (2). The GHG Protocol defines the basic principles of relevance, completeness, consistency, transparency and accuracy and is based on financial accounting. In addition, there are efforts by the standardization institutions DIN and ISO to establish related standards.

The GHP defines so called Scopes to permit to separating the internal (and easy to assess) emissions - Scope 1 and 2 – from the emissions caused by inbound and outbound processes - Scope 3 – which often are very difficult to assess:

Scope 1 - direct emissions - internal

> Scope 1 emissions relate to emissions released to the atmosphere as a direct result of activities. As indicated they may refer to a given firm, product, sector within a company. Scope 1 emissions are direct emissions from a given company, company owned or company-controlled resource and of immobile sources.

Scope 2: indirect emissions - internal

> Scope 2 emissions relate to emissions released to the atmosphere from the generation of purchased energy from a utility provider. In other words, from the consumption of purchased electricity, steam, heat and cooling including mobile consumption.

Scope 3: indirect emissions – external

Scope 3 covers the energy consumed in the upstream and downstream value chain including during transmission and distribution.
Scope 3 emissions are all indirect emissions – if not included in the other scopes – that occur in the value chain both upstream and downstream of the reporting company or product. In other words, emissions that are linked to the company's operations. According to GHG protocol, scope 3 emissions are separated into 15 categories.

Upstream activities include several categories such as business travel, employee commuting, waste generated and disposal, purchased goods (raw materials and intermediate products) and services, logistics upstream and capital goods.

Downstream activities include investments, franchises, leased assets, downstream logistics, use of sold products, recycling, make ready for re-use, waste and disposal.

Of course for a specific case not all but rather a selection of criteria needs to be assessed. Still the careful analysis of the given situation is crucial. Under practical conditions it is often not obvious to decide which step in the value chain belongs where. Analysis and resulting strategies require expertise. To illustrate that in an example:

To pick an example:

When producing a printed product, the CO_2 Footprint of the inbound value chain - especially paper - and the production of the printed product have to be considered. The situation is less clear if the outbound value chain and the recycling situation is considered: One can attribute the responsibility for paper to

- the print product put in the waste-paper-bin

or

- the print product the recycled paper is used for.

While this differentiation appears to be of academic character it actually can be of severe financial impact e.g. for a newspaper. As a rule of thumb about 10-20% of the mass of the paper entering a recycling chain at the waste paper bin is wasted during the recycling process. This fraction is burned after being separated from the to be processed material. If this mass is being burned it leads to emissions. If one assumes that one ton of paper translates to 1.15t of CO_2 this weight needs to be attributed and paid for by one of the responsible products. As we will see below the price per ton of CO_2 Footprint varies between 30 and 180 € (in 2019 and in Sweden 140 €/ t CO_2 Footprint) – see Chapter 5.

Note that there is a scientific argument ongoing as to whether burning wood is CO_2-neutral or not. The argument goes as CO_2 has been bound out of the

atmosphere earlier it is only released by burning afterwards. Plus, if at least as many trees are planted as were cut down, the carbon removed and then added into the atmosphere will all balance out in the end. On the other hand, there is worry that, unless the industry is heavily regulated, it will have a negative impact on carbon storage (3) and, additionally, on biodiversity.

4 Examples and Accuracy

To illustrate the above, two examples are given. The examples represent actual numbers assessed in two different companies located in the EU and the Middle East. Both companies wanted to understand their Footprints better in order to prepare themselves for possible emission-related payments.

Scope 1 (~0.5%)			
Category	**Absolute CO2 Footprint in t CO_2 p.a. (rounded)**		**Remarks**
Stationary combustion	123		Mainly Gas Diesel for power emergency negligible
	emissions fluorinated gases		Chiller operates with R134a
Scope 2 (~2,8%)			
Indirect emissions	purchased electricity	1880	
Scope 3 (inbound, 81%)			
Purchased products and services	Paper:	40 000	
	Offset ink	1 801	
	Liquids Plates	- 430	Ration raw versus recycled material unknown
	Water	10	
	Tools and machines Press	 350	Annual consumption assuming a certain lifetime of the presses – not knowing whether this lifetime can be achieved
	Facility Management	20	
	Loss caused by electricity transportation	150	
	Inbound transport - paper	1250	
	Inbound transport - goods	10	Estimation assuming an average distance of transport of 400 km
	Non-print-related waste Not assessed		No records available
	Business travel	2	4 intern. Flights
	Commute	610	
Scope 3 (outbound; 16%)			
Outbound logistics		150	Assuming that readers are located within an average circle of 150 km
Total p.a.	~ 45 000 t CO_2		

Table 1: *CO_2 Footprint of a Newspaper Print Shop (rounded numbers) located in Germany and producing mainly for the German market. Part of the printed products are distributed under different brands. The paper originated from different plants located in different parts of Europe.*

Scope 1 (~ 0.5 %)		
Category	Absolute CO_2 Footprint in t CO_2 p.a. (rounded)	Remarks
Stationary combustion	Mainly Gas 10	
	emissions fluorinated gases R134a 0.2	
	Process-related use Propane Gas 10	
Scope 2 (~ 41 %)		
Indirect emissions	Electricity 1510	
	Petrol 30	
Scope 3 (inbound, ~ 43 %)		
Purchased products and services	Liquid (solvents) 1	
	Raw materials 1060	
	Water 240	
	Tools and machines Not assessed -	Tools and Machines partly aged and still in use. No documentation on system Footprints or lifetime available..
	Facility Management 20	
	General Transport 170	
	General waste 45	
	Business travel 15	42 intern. Flights
	Commute 35	
Scope 3 (outbound; ~ 16 %)		
Outbound logistics	600	
Total rounded	~ 3 760 t CO_2 p.a.	

Table 2: *Rounded CO_2 Footprint of a production facility for Plastic parts located in the middle east for products sold into the German market. The parts produced have to be transported to Europe using fast ships to meet tight deadlines. The raw materials originate from factories outside of the country of production. Local electricity is manufactured with Diesel engines.*

4.1 Newspaper.

4.2 A company producing plastic parts in the Middle East

Discussion of examples – Accuracy required:

The general observation is that, for both examples 4-5 categories provide most of the emissions. Once knowing those it becomes clear that spending too high an effort to assess the other emissions with a high accuracy will not contribute to a substantial reduction of CO_2 Emissions. Hence, when looking for strategies it is advisable to look for "the big numbers" and the "low hanging fruits" in parallel.

When comparing the two examples of course the absolute numbers are the first visible striking difference – this size, however only reflects the sizes of the companies – the one with about 40 and the other with some 400 employees.

The next difference is not only product–related: the electricity produced in the EU (in this case mostly wind- and water-powered) has a significantly lower CO_2

Footprint than the diesel driven generators used for electricity-production in the middle east.
In both cases the inbound logistics contributes significantly to the CO_2 Footprint while the outbound logistics is small for the print shop under view while large for the producer. The difference is due to the business model used: Both companies operate under tight timelines but while the one company is located close to its customers the other is located several 1000 km away. Both require transport of the product to the customer but given the tight delivery schedules for the parts-producing company it´s required to use fast ships which again are characterized by very high emissions.

The raw material access for both products also differs considerably: Plastic is raw material for parts under view and easily to be acquired, buying large quantities. Paper on the other hand is becoming more and more difficult to access over the recent years – also due to the changed environmental awareness of the public. That again reflects the distances to be passed for raw materials.

As discussed above from a business management perspective, the key questions at stake are

- What is the product/company-related Carbon Footprint?
- What are strategies to reduce it so that the operation under view operates under legal conditions?
- What are the risks going along with the emissions if the company acts/ does not act?

Of course, it is not intended to discuss/suggest strategies possible out of the numbers presented or their ratio – discussing these questions is too company-related and provides almost no value add for the audience. However, what is of interest are the risks going along with non-sustainable acting – that is: no focus on reduction of CO_2 footprints.

5 Risks

Sustainability-related risks have been discussed in literature. An overview of the related risks has been generated in form of a fact sheet by the Federal Banking Supervisory Authority (BAFIN) in Germany recently (see references). In the following individual risks are discussed.

5.1 Risk types

On a high level risks can be organized by types – here we suggest grouping them

into physical, transistional (or transfer), and reputational risks:

5.1.1 Physical risks (1)

Physical risks are understood to refer to the direct and indirect consequences from both individual extreme weather events and long-term changes in climatic and ecological conditions.

In detail, these are:

i) Operational risk
   Example: A given company or their suppliers are affected by an environmental disaster.
ii) Underwriting risk
   Example: In the area of damage-related insurance, losses increase as a result of storms, flooding, forest fires or hail. Likewise, losses in business interruption insurance may increase. A new type of intensity and/or frequency of such events is not (yet) adequately reflected by underwriting reserves or in the measurement of premium risk.
iii) Legal risk
   Example: Risks for environmental damage or partners in the companies supply chain that neglect sustainability risks being held responsible in court for the consequences and changing their business practices in this context.

This type of risk will not be dealt with below - even though changes in the supply chain, for example, could conceivably cause problems for the plant under view.

5.1.2 Transition risks (Transfer risks)

Transition or transformation risks are understood as risks for business models resulting from decarbonization and the transition to carbon-free economic structures. The term was introduced by the UK Financial Services Authority in 2015 (2). For example, the coal phase-out and a carbon tax are leading to new challenges and investments across sectors.

i) Credit risk/default risk
   Example: An expected or unexpected change in market sentiment (e.g., due to pricing in expected regulatory actions) leads to devaluations or disruption of supply chains and loans cannot be serviced as a result.
ii) Market (price) risk
   Example: A print company invests/participates in companies in the paper or energy sector or paper chemicals and these companies demonstrably do not operate sustainably nor are the invested funds used for sustainability transition.
iii) Liquidity risk

Example: After an environmental disaster, credit institutions themselves get into difficulties and, consequently, the customer company as well.

iv) Strategic risk
Example: A strategic purchasing partner of a company loses its business base due to manufacturing processes becoming more expensive as a result of environmental requirements.

v) Stranded assets, i.e. assets (e.g. company shares, technical equipment or (raw material) inventories) whose earning power or market value unexpectedly drops drastically to the point of becoming worthless.

There are interdependencies between risks, in particular between physical risks and transition risks. For example, an energy transition that proceeds too slowly can cause more frequent and more severe damage and subsequently necessitate a much more abrupt change in the economy, which increases transition risks.

5.1.3 Reputational risks

In addition to the effect of sustainability risks on net assets, financial position and results of operations, there are also reputational risks. In this context, the effect can arise as a result of events and behaviours that have occurred or as a result of business relationships with companies (external) or internal structures within the company with high sustainability risks.

Examples:
Internal/external

- The environment or people are harmed due to insufficient internal specifications regarding environmental standards. The case is reported in the media, with the companies being named.
- Involvement in and own "greenwashing" strategies (at a company and its suppliers) can, if they become known and are eye-washed, also represent a reputational risk. Worth mentioning here are compensation payments without own measures, the cooperation with unchecked compensation payment partners or also false calculations with the aim to minimize the own footprint.

5.2 Types of Risks considered

In the following, the currently discernible material risks are to be described and, as far as possible, assessed in monetary terms.

For a risk assessment, it is necessary to evaluate the probability of occurrence of the various risks or build scenario like best or worst case specifically for a product or a plant including the associated value chains and at least the most important/strategic partners. A detailed analysis including scenario can only be carried out in the light

of a given company/product (see ISO 3100, Risk Management). Hence, below only a few of the risks will be named and briefly described and generally evaluated and

	Physical risks	+/-	Transitional risks	+/-	**Reputational risks**	+/-
1	operational risk	-	credit risk/default risk	+	intern	-
2	underwriting risk	-	market(price) risk	+	extern	+
3	legal risk	-	liquidity risk	-		
4			strategic risk	+		
5			stranded assets	-		

Table 3: *Risks considered (+) and not considered (-). For a specific company and sustainability-related questions also risks not considered here may be decisive. They have not been considered in more detail as the corresponding task would be beyond the scope of the study - especially reputational risk can be a critical issue to manage.*

the analysis only offers best and worst case scenario for the quantifiable risks of an example given above.
Below a more detailed analysis of the risks considered partly using the example of a given newspaper print company used above:

5.3 Market Price Risk / Price Development CO_2 Levy

5.3.1 Risk

5.3.1.1 Status

Following the decision to reform emissions trading in April 2018, the price of emissions allowances tripled from an average of 5 euros per ton of CO_2 in 2017 to 15 euros in 2018 (1). In December 2019, the German federal and state governments agreed to initially set the CO_2 price at 25 euros per ton starting in January 2021 (2). In early December 2020, the certificate price freely traded climbed to over 31 euros, reaching a new all-time high (3). A price corridor of at least 55 and at most 65 euros is to apply for 2026. The corresponding amendment to the law came into force after approval by the Deutsche Bundestag and will apply from January 2021 (4). At the same time, the European Union announced that it would raise its climate target for 2030 from 40 percent to 55 percent compared to 1990. Greenhouse gas emissions are thus to be reduced much more drastically in the coming years than previously planned. Higher prices are therefore a distinct possibility - because the prices for emitting a ton of CO_2 equivalent vary widely around the world. In April 2018, they reached as high as € 122 per ton of CO2 €, 2020 and in Sweden: € 140 (5).

A special report published in 2019 by the Berlin-based climate research institute MCC and the Potsdam Institute for Climate Impact Research (PIK) recommended that fixed CO_2 prices start at €50 per ton of CO_2 in 2020, then gradually increase to €130 in 2030. In 2020, “the Federal Environment Agency ... in an expert report proposed to set the price per ton of CO_2 emissions at 180 euros. To limit global warming to 1.5 degrees Celsius, the CO_2 price would have to be much higher,

according to PIK estimates." (6,7)

5.3.1.2 Development of CO_2 emissions

According to the Paris Climate Agreement and the UN Gap Report, global emissions must decrease by about 3% and 8% annually by 2030 to limit climate change well below 2 and 1.5 degrees, respectively. This reduction is consistent with projected emissions declines (8). According to the German Federal Ministry of Economics, CO_2 emissions fell to 35.7% in 2019 compared to 1990 (9) - the target is 55% by 2030, as mentioned above. Total CO_2 emissions-from fossil CO_2 and from land use-were about 39 billion metric tons of CO_2 in 2020, still at levels similar to about 2012 despite the decline (10). In December 2020, emissions from road and air transport were between 10% and 40% lower than 2019 levels, respectively, due to corona-related restrictions (11).

5.3.1.3 Legal boundary conditions (12)

In 2014, the European Council decided that GHG emissions in the EU must be reduced by at least 40% by 2030 compared to 1990 levels. That has been corrected to a reduction of 55% by 2030 in late 2020. The given target of a GHG reduction is concretized by two sub-targets:

- 43% reduction compared to 2005 for sectors in the emissions trading system (ETS) in particularly energy-intensive industries (including paper manufacturers)

and

- Reduction of 30% compared to 2005 for all other sectors (12).

The EU will carry out compliance checks from 2027 for emissions made from 2021 onwards (12).

5.3.2 Valuation - Monetary estimate – Options for Action

According to the above-mentioned benchmarks and assuming that on a wold-wide scale all countries work on their targets immediately, Germany must reduce GHG emissions by 2-3% per year (compared to the previous year) to reach the target emissions in 2030. The most important tool to make that happen is to oblige companies to pay levers. Two approaches would be plausible for this - between which mixed forms could also exist

1. levy on total emissions with reference to a starting year: recording of total emissions and calculation of emission reductions.
2. Levy if the targeted reduction is not achieved in accordance with the shortfall.
3. Probably the variant most likely: mixed form, in which a basic amount is paid on the total emission and a penalty levy on failure to meet the emission targets.

Each of these approaches assumes that emissions are recorded continuously and in a reproducible manner. Based on the above and a production site within the EU, a complex estimate results for a plant, depending on the assumptions:

1. it can be assumed that, due to the legal situation, the authorities, at least in the case of large companies will request
   - Evidence of continuous recording of GHG emissions
   - evidence of the strategies pursued and their implementation or emission reductions.

2. The target for emission reduction should, as of today, be 2-4% reduction per year compared to 2019.

3. Legislators have no choice but to impose penalties to enforce targets. Since the compliance checks for industries not subject to the ETS (including printing plants) will not be carried out until 2027, the corresponding penalties are not to be expected until 2027 in the current state of the law.

Note: Paper manufacturers as suppliers are already part of the emissions trading system (ETS) and must therefore act earlier. Since the emissions generated during paper production are added to the printed product, it is necessary to ask the paper manufacturers about corresponding strategies and the expected cost developments and as part of one's own strategy or to change the supplier.

4. it is reasonable to assume that the costs for corresponding penalties will be minimally in line with the costs for CO2 emissions - i.e. today 30 €, in 2025 at a minimum of 55 - 65 € / t CO2 equivalent, but rather higher - currently a maximum of 180 € / t CO2 equivalent.

To what extent dates and prices are constant cannot be estimated at present - these are political targets. For example, the EU has changed its decision on tightened emission targets in December 2020 within 2 weeks from originally 40% first to 50% and then to 55% reduction in 2030 in each case compared to 1990.

An example:

A print shop is currently involved in two value chins: a newspaper printed for the publisher it´s related to and newspapers for other publishers. For the production of these print products 45 000 t CO_2 p.a. emissions can be calculated (see Table 1).

The CO_2 footprint of the

- newspaper published by the mother company – the publisher is equivalent to some 40% of the print volume
- other printed product are equivalent the remaining fraction – some 60

Thus, as of today, the plausible idea for a legally enforceable development of emissions (and costs) could be handled as follows:

Year	2021	2025
Total Emissions (CO_2 eq. t/a) including all print products Target: 3% reduction p.a. Self – published produc (Example 40%) Partner products (Example 60%)	45 000 18 000 27 000	39 800 15920 23880
	360	199
Total Scope 2 Partly-addressable by the print shop	1260	1115
Total Scope 3 inbound – only addressable by partners in supply chain	36450	32240
Total Scope 3 outbound - mostly in responsibility of partners (means of transport) and depending on location of own customers (assuming 100% recycling of paper)	7200	63670
Minimal Price per t CO_2 emission in €	*~ 30*	*~ 55(65)*
Worst Case cost per t CO_2 emission in €	180 €/t	180 €/t
Total cost for emission in Mio € Min Max	 1.35 8.1	 2.2 (2.6) 7.2

Table 4: *Development of emissions and related costs. Note that it is reasonable to attribute costs to its originator – these are, for the Scope 1 and Scope 2 emissions, mostly the internal processes and the energy suppliers and for Scope 3 emissions the companies participating in the up and down stream value chain. Prices will rise due to this effect also for customers.*

At the end of the day, however, it is in the interest of all companies to reduce pricing in order not to run the financial risk of discontinuing products or significantly reducing profits made.

It is obvious that Scope 3 inbound (paper and, to a lesser degree paper transport) is crucial. Any means to reduce that number will result into highest reduction of monetary risks.

The calculations were made under the assumption that 100% of the newspaper printed is recycled. Note that should recycling not take place to that degree the CO2 price for the non-recycled part will have to be added to the calculation above.

Actions required to address this risk:

1) Strategies are needed to reduce emissions by the same 3%. The reduction of 3% is to be understood as an example.

2) For all kinds of resulting actions the cooperation of the purchasing and partner management is essential, especially for the reduction of Scope 2 and Scope 3 emissions, because these emissions cannot be realized alone. The comparison of the respective line items sets the targets to reach.

3) It can safely be assumed that the partners for whom is currently produced want to see strategies for emissions reduction on the part the print shop.

The preparation of risk analyses such as this one with the appropriate figures tailored to the partner therefore becomes necessary.

4) The costs involved will be accommodated in purchasing prices and will result into reduced profit or increased price per product. The current legal situation needs review to ensure that the date, from which emissions will be audited (and direct costs will occur) are well understood.

5.4 Strategic risk

5.4.1 Risk

A print companies´ carbon footprint is dominated by energy (gas and electricity) and raw materials (paper and consumables). This is as the paper industry is known for its high level of emissions and is therefore part of the ETS – accordingly. It is not unlikely that changing environmental requirements will have consequences on both the price (increase) and the availability (reduction) of paper as a raw material. Already today, paper for newsprint is seen by paper manufacturers as a less lucrative production commodity than, for example, (corrugated) board. For some suppliers, this may mean that focusing on production areas other than newsprint will lead to more lucrative business conditions and thus change supply chains.

5.4.2 Assessment and options for action

Even if these risks cannot be assessed in monetary terms, it is recommended that appropriate audits be carried out.

5.5 Credit risk - Counterparty default risk

5.5.1 Risk

A print shop operates in association with a paper supplier/supplies itself with paper. Due to the technology used, the paper supply chain is subject to high emissions. These emissions are priced. The price development has been estimated above. Customers have to bear the corresponding costs for the products printed for them. The risk is that the costs develop in a way that makes the continuation of the print product no longer lucrative for the customer, which in turn leads to the printing order being cancelled. The same risk naturally applies to the entire value chain. The risk corresponds to the explanations given above under 2.2.

5.5.2 Evaluation - Monetary estimation for customers of the printing company

It is in the logic of the above approach that the printing customers of a print company also incur increased costs. These are easiest to calculate per ton of paper.

It is unclear here - as it is for a print company- whether the levies are already priced in by the suppliers (in particular the water, gas and electricity suppliers as well as the paper suppliers, as these should all already be committed to the ETS today) and pass through the increased prices.

Year	2021	2025
Total Emissions (CO_2 eq. t/a) including products printed for partners (Example 60%) Target: 3% reduction p.a.		23880
Minimal Price per t CO_2 emission in €	*~30*	*~55(65)*
Worst Case cost per t CO_2 emission in €	180 €/t	180 €/t
Total cost for emission in Mio € Min Max	 0.8 4.9	 1.3 (1.6) 4.3

Table 5: *Development of emissions and related costs to be charged to customers of the print shop under view based on data presented in Table 4.*

From a risk-perspective it is important to consider that, given the additional costs some of the customers may not be willing to pay the resulting price. Consequently, they may decide for discontinuation and choosing a different partner with higher margins today/that is able to accommodate for a higher fraction of the resulting costs or is able to utilize a cheaper supply chain.

5.6 Reputational risk

5.6.1 Risk

As mentioned, reputational risks can arise both as a result of sudden events and long-term developments and can have consequences in the internal relationship with employees as well as in the external relationship with partners and customers. A print shop´s energy requirements are currently covered by a company that sets its own emissions to zero by means of certificates. This means that the customer initially saves on emission costs, but in terms of reporting is

- dependent on both the extent to which the supplier's emissions have been reported correctly

as well as

- whether the measure indicated as compensation actually compensates for the announced emission in the long term and whether it would not have taken place anyway without the investment by the customer.

As a company in the media industry, a print company producing a newspaper can be sure of receiving attention for its conduct in this matter. The chance that insufficient attention will go undetected is thus low - i.e. lack of attention and action will be discovered and reported. As a consequence, companies are forced to act proactively.

5.6.2 Strategic options for action

The quantified risks must be reassessed on an annual basis, and the implementation of reduction strategies must be backed up by consistent action. As mentioned above, in the EU audits are to be expected from 2026/2027 and, in order to secure foreseeable costs resulting from non-compliance with the requirements or mismanagement of the risks, loss provisions could be used as an instrument for action.

Some of the risks discussed here are of a medium or long-term nature. One can rather counter the risks at an early stage and proactively or pursue a "wait and see" strategy. In any case, hedging against the risks that are already quantifiable today should be examined. Planning horizons should be extended with a view to informed decision-making, taking sustainability risks and factors into account.

Above, systematic processes for identifying, measuring, managing and reporting sustainability risks were implicitly suggested. Thus, it is recommended to

- critically analyse all risks
- to exclude certain sustainability risks completely, if necessary
- conceptualize the necessary measures.

In this context, it is also advisable to clearly communicate the handling of sustainability risks identified to the company's own management, employees, customers and investors. In particular, any criteria for the exclusion or targeted management of certain risk positions should be presented to the outside world in order to make the company's own actions transparent to stakeholders and to prevent uncertainty among customers.

6 Conclusions

In this study we aimed to investigate a practical access to carbon footprints and risks for companies going along with emissions especially in the light of changed legislation. For grouping and accessing different ways to assess and structure emissions are offered in literature; here we successfully used Scope 1-3 Emissions as defined by the Green House Gas Protocol. For the access of sustainability risks, we suggest regroup the risks named by BAFIN and apply probabilities or scenarios to get a handle on their local relevance.

The examples given indicate that, for a printing company and a high volume print product which, after use is recycled, the most important contributors to the CO2 Footprint are the paper, paper transport, energy, and ink supplies. Given that paper and energy suppliers are - at least in the EU - subject to the emission trading system the price development of emission certificate can be expected to have a significant impact on purchasing prices of paper and energy. Strategies are needed to reduce

emissions by 2 % p.a. plus which cannot be obtained by changing internal processes. Hence the cooperation of all partners in the supply chain is essential.

The most important risks to address are the development of prices of raw materials and energy and the strategic risks for supply chains becoming instable.

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