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CHEMICAL PRODUCTS AND FOSSIL FUEL: A LOVE STORY

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Contents

Executive summary

- **A complex sector, difficult to understand**: the immense diversity of products manufactured by the chemical industry makes the environmental impacts of the sector difficult to quantify. This is compounded by the difficulty of accessing the volumes of chemical products manufactured by companies, which scarcely publish them and prevents a comparison of carbon performances based on physical intensity (in tCO2e per ton of products manufactured, for example).

- **An essential industry**: chemistry is often called the "industry of industries" because it lies upstream of all other sectors (agriculture, pharmaceuticals, automotive, etc.): it transforms matter to obtain substances and materials that are indispensable to all sectors of the economy. **The decarbonization of the chemical sector is therefore a prerequisite for the decarbonization of other industrial sectors.**

- **A double dependency**: the specificity of the chemical sector lies in its **heavy use of hydrocarbons (gas, oil), both as a source of energy (as fuel) and as a raw material**. In fact, hydrocarbons are used as the sector's basic materials, far ahead of other raw materials such as water, sulfur, air, phosphates, or materials from biomass.

- The **risks of transition**, due to this double dependency, are particularly strong. They are linked to the increase in the price of hydrocarbons, carbon taxation systems, or regulatory constraints on the manufacture of certain products (such as plastics for example).

- **The upstream scope 3 emissions related to the purchase of raw materials is not yet considered and published in a satisfactory manner**. Companies show a lack of transparency in the carbon reporting methodologies for these emissions, even though this item is critical, particularly for specialty chemicals, which consume large quantities of basic chemicals. **The downstream scope 3 linked to the sales of chemical products** to client industries is very difficult to be accounted for because chemical compounds are used in the composition of thousands of manufactured products used within all economic sectors.

- **Reduction targets related to raw materials purchase are not yet ambitious enough**. Although we observed that the majority of actors are committed to targets for reducing emissions from purchasing, those are not systematically quantified.

- **Transition opportunities**: To decouple its revenues from the consumption of natural resources (and its impact on the environment), the chemical sector has a multitude of

levers that it can use. On the energy supply side, it can play on the energy efficiency of industrial installations, but also on the electrification of operations. In terms of raw materials, it must largely reduce its consumption of hydrocarbons in favor of materials from biomass (which will sometimes raise the question of volumes).

- **Ranking of companies in the sector**: The development of the Carbon Impact Analytics (CIA) methodology for the Chemicals sector enables to distinguish the best players from the laggards who are highly exposed to transition risks.

Ranking	Company Name	Business Type	Country	Overall Rating (over 15)	Forward Looking Performance (over 15)
1	**Novozymes A/S**	Biotechnologies	Denmark	2	1
2	**Air Liquide**	Industrial Gases	France	5	3
3	**Albemarle Corp**	Specialty Chemicals	USA	5	9
Data available to Carbon4 Finance's clients					
13	**Sika AG**	Specialty Chemicals	Switzerland	6	8
14	**Umicore SA**	Specialty Chemicals	Belgium	6	5
15	**Victrex PLC**	Specialty Chemicals	UK	6	9

Figure 1: Top 15 companies

Introduction

Of all industrial sectors, the chemical industry is the largest consumer of hydrocarbons in the world, yet it is only the third largest emitter of greenhouse gases (GHG), after the steel and cement sectors. This paradox can be explained by the particularity of the Chemicals sector: hydrocarbons have the dual role of energy source and raw material. In Europe, raw materials used to manufacture chemical products represent 41% of the fossil fuels consumed by the sector, with the remaining 59% used for energy purposes.

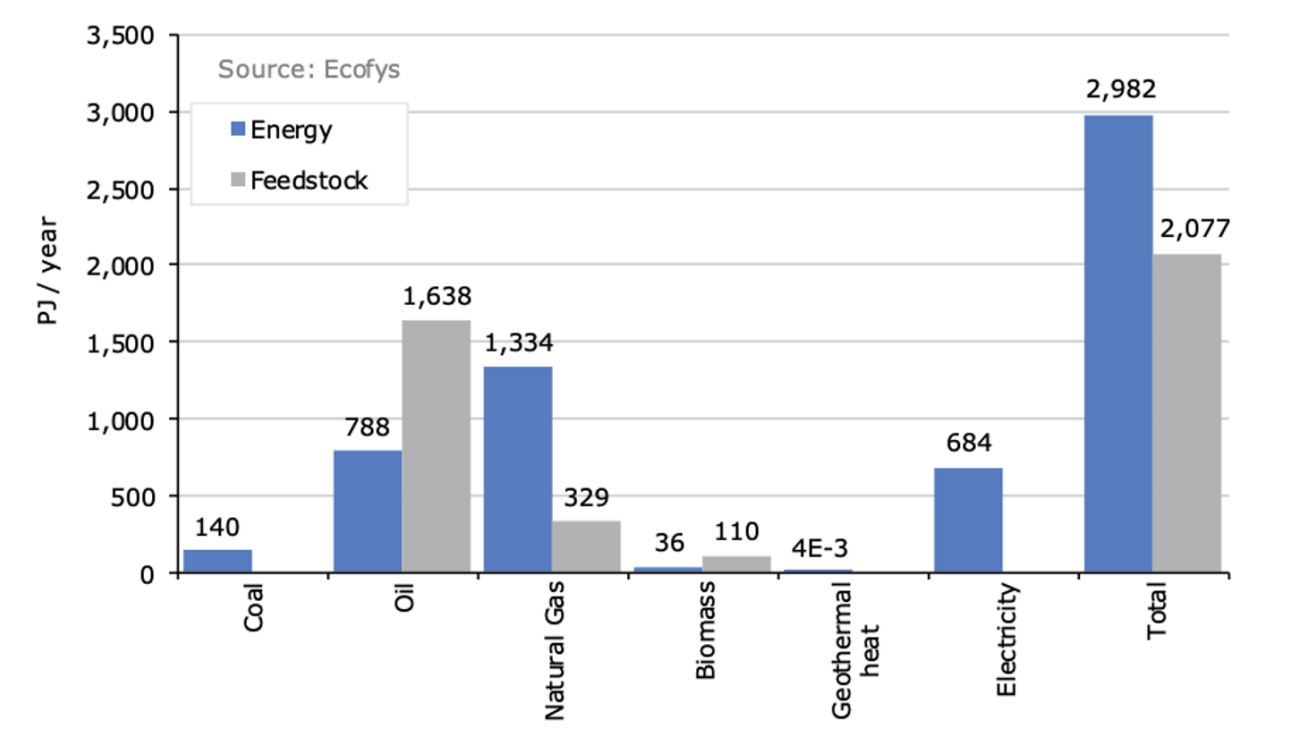


Figure 2: Cefic, European chemistry for growth Unlocking a competitive, low carbon and energy efficient future, 2013

The dual dependency on fossil fuels is a specificity of the chemical sector: the vast majority of the products manufactured are derivatives of oil or gas to a greater or lesser extent, and factories are largely supplied with fossil fuels (the sector is still not largely electrified). Because of this specificity, the International Energy Agency (IEA) describes the sector as a "key blind spot" in the energy debate[1]. Because of this strong dependency, the chemical industry is particularly sensitive to various transition risks (restrictive regulations on products sold, carbon taxation, changes in consumer behavior, etc...). For example, recent changes in gas prices, linked to geopolitical events in 2022, could interrupt gas supplies to European petrochemical facilities and cause a sharp rise in commodity prices throughout the sector. While these events are not directly related to the effects of climate

[1] IEA (2018), The Future of Petrochemicals, IEA, Paris https://www.iea.org/reports/the-future-of-petrochemicals

change, they do foreshadow the potential extent to which the industry's access to hydrocarbons could be limited, and the consequent need to prepare for this.

Nevertheless, the chemical sector is currently performing well economically, and Cefic (*European Chemical Industry Council)* even anticipates a doubling of sales between 2019 and 2030.

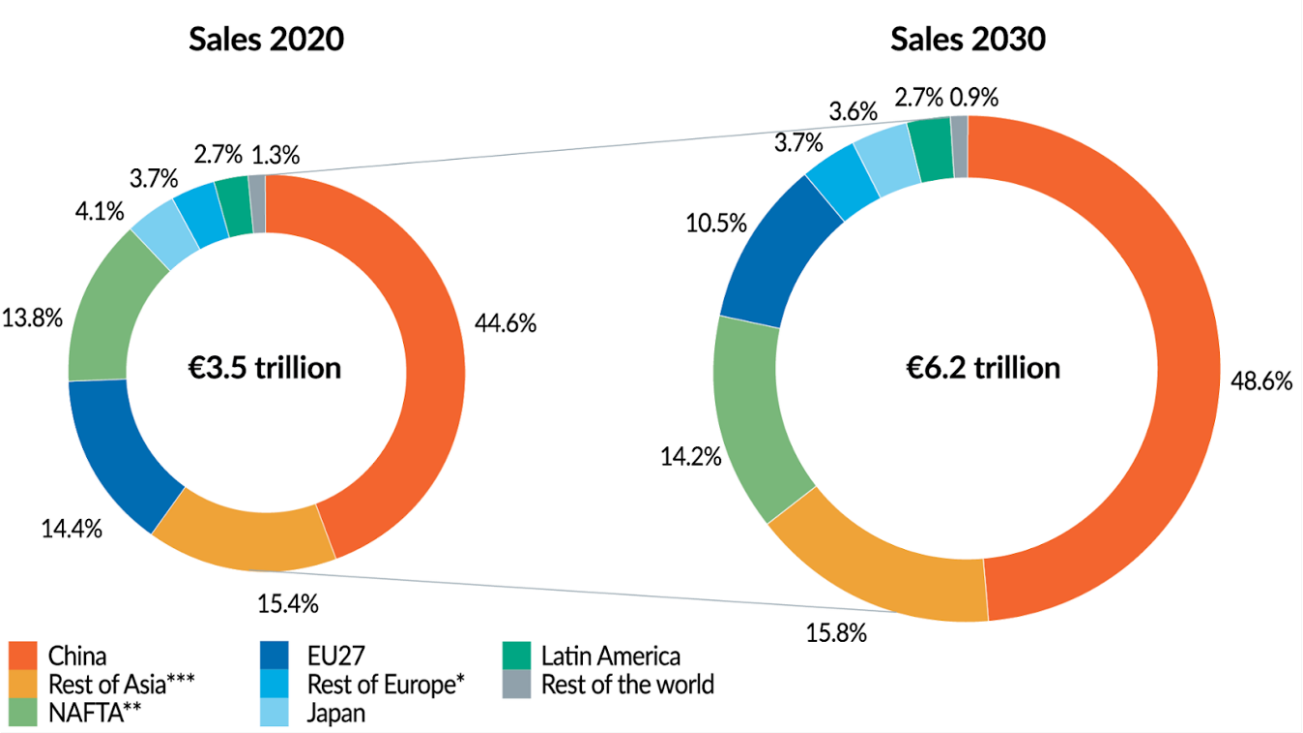


Figure 3: Growth projection for the chemical industry between 2019 and 2030 (in Euro). Source: cefic[2]

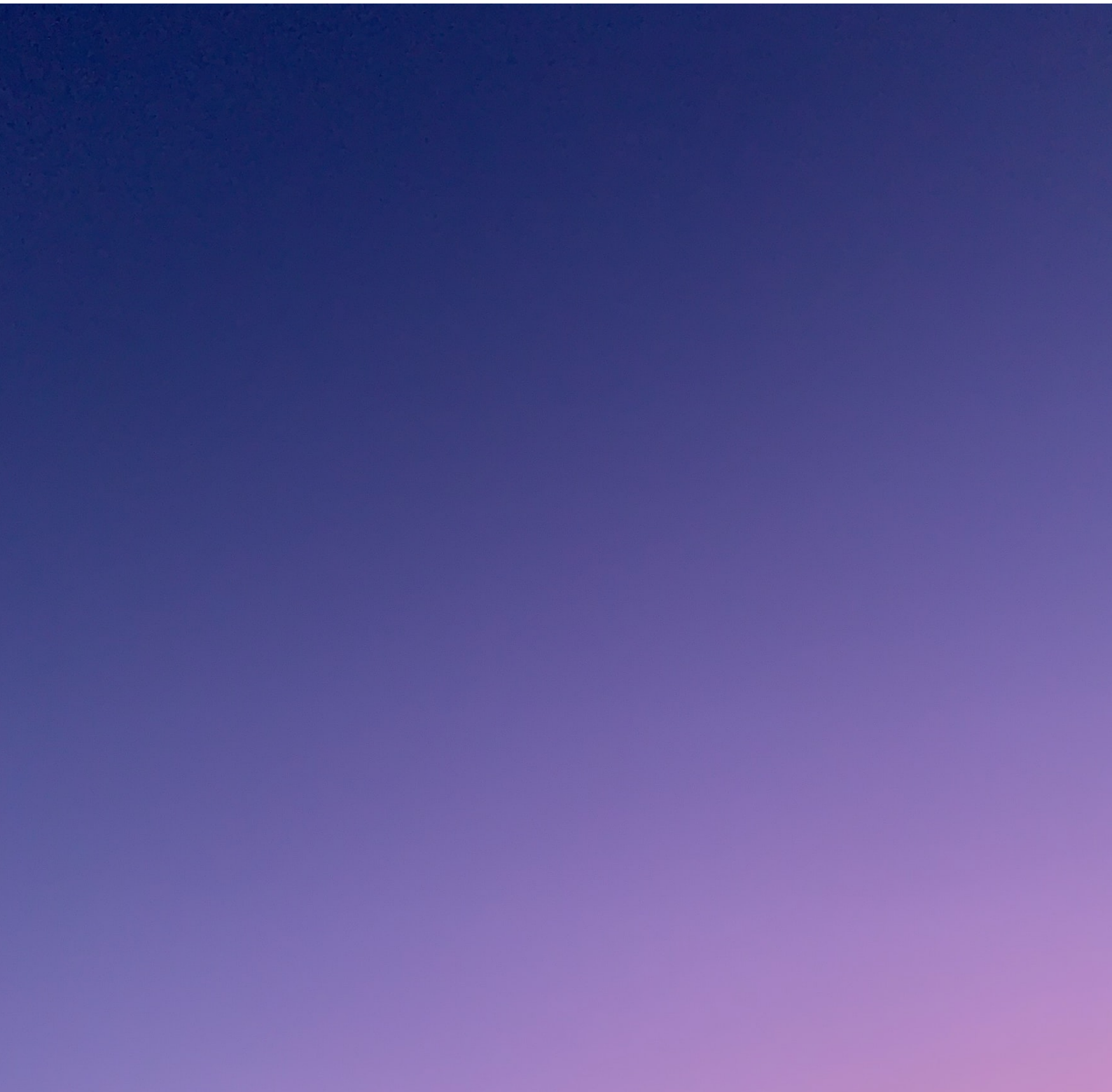
The combination of the sector's high dependency on fossil fuels and its significant economic growth implies a **difficult decoupling[3] with GHG emissions.** Thus, to make a successful transition toward a low-carbon industry, the chemical industry must reduce its fossil fuel consumption by decarbonizing both its raw materials and its energy supplies.

The Carbon Impact Analytics (CIA) methodology, developed by Carbon4 Finance, aims to measure the exposure of companies to transition risk via an overall rating (from A+ to E-) and via various sectoral indicators. In 2021, in line with our ambition to develop reliable and relevant climate indicators for financial players, we have developed a methodology for the Chemicals industry, which considers the specificities of the sector (typology of

[2] Cefic 2022: Growth And Competitiveness
[3] www.carbone4.com/publication-decouplageCarbon 4, Decoupling and Green Growth, 2021

companies, physical flows, decarbonization issues), and which makes it possible to distinguish firms that have already jumped on the transition bandwagon and those that are still on the platform.

This note summarizes the results of a CIA analysis campaign conducted in 2021 on a sample of more than 80 listed companies in the chemical industry. Thanks to our data, we were able to rank these companies according to their degree of exposure to transition risks, and to assess the strategies they have put in place to align - or not - with the decarbonization objectives of the global economy.



I - Presentation of the sector

a. What is the purpose of chemistry?

The chemical industry is extremely diverse. It is responsible for the synthesis of numerous products and operates in very different fields: agriculture, transport, electronics, cosmetics, etc. In the same way that the Oil & Gas Industry mainly meets the energy needs of economic sectors, the chemical sector meets the raw material needs of other productive sectors. To satisfy the needs of all industries, the chemical industry has created and made available a phenomenal quantity of different products.

To fully understand the dependency of the chemical industry on fossil fuels, it is essential to understand where chemicals come from and what are the major synthesis steps.

In the chemical industry, different sectors can be distinguished which correspond to the "stages" of chemical synthesis. From upstream to downstream, we find the following stages:

- Basic chemicals manufacturing
- The chemistry of intermediates
- Specialty chemicals manufacturing

These different stages constitute the chemical value chain.

b. A value chain highly dependent on fossils

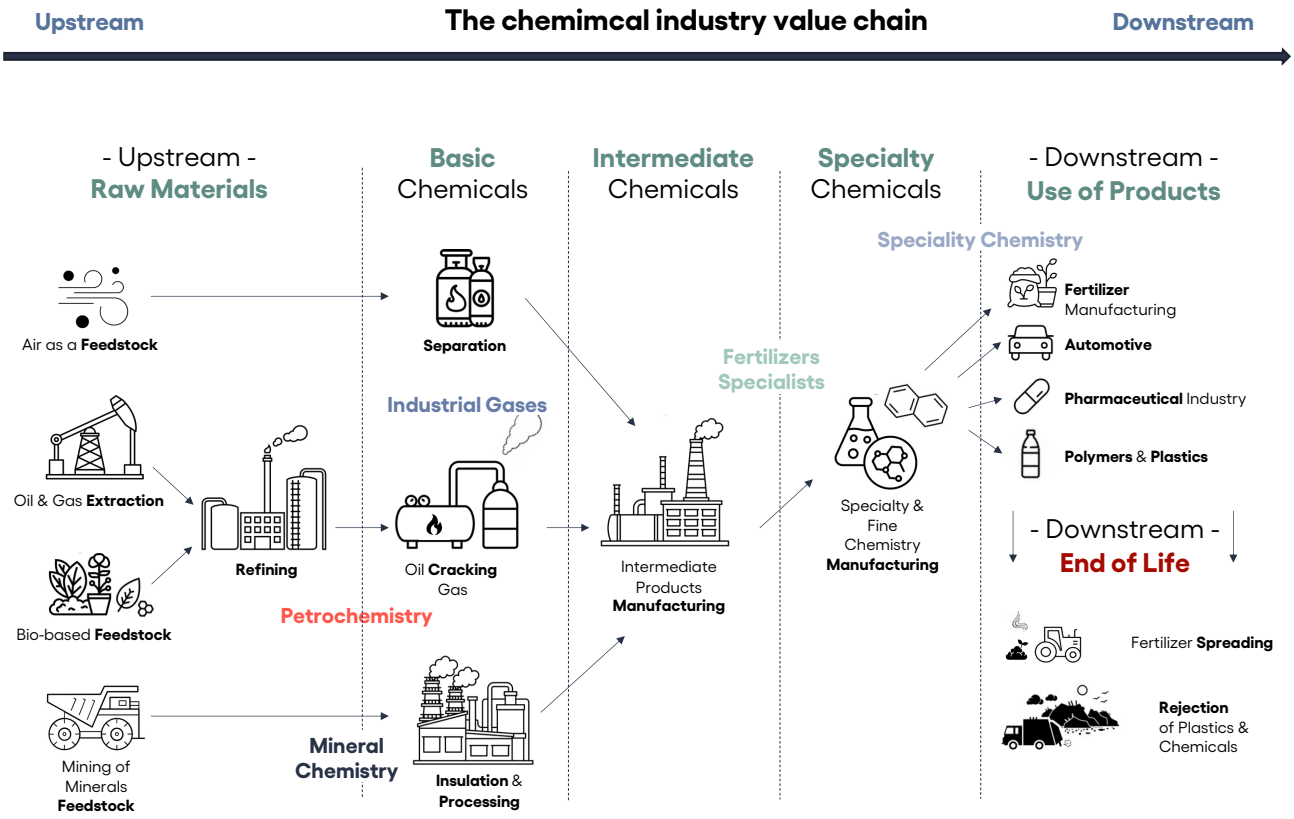


Figure 4: Diagram of the chemical value chain

b.1. Upstream of the chemical value chain

The chemical industry uses a wide variety of raw materials: natural gas, petroleum derivatives, coal, other gases extracted from air, resources from agriculture (plant and animal materials) and a large number of metals and minerals.

However, products from the fossil fuel industry account for 90% of raw materials used by the chemical industry[4]. The petrochemical industry, which is often integrated into large oil groups, then carries out the first transformations into "building blocks".
These "building blocks", which are characteristic of basic chemistry, are the raw materials used in the synthesis of all the chemical products in the sector. Three major products can be distinguished:

[4] IEA (2018), The Future of Petrochemicals, IEA, Paris https://www.iea.org/reports/the-future-of-petrochemicals

- **High Value Chemicals:** derived from oil, which are used in the manufacturing of plastics.
- **Methanol**, which is mainly derived from natural gas, is used in the manufacturing of other products such as plastics, resins, paints, etc.
- Finally, **ammonia**, derived from dihydrogen (itself extracted from natural gas), is mainly used in the manufacturing of fertilizers.

These 3 products account for 2/3 of the sector's total energy consumption (oil / gas / electricity).

b.2. Downstream of the chemical value chain

At the end of the value chain, we find the production of **specialty chemicals**, which represent a very large group of companies whose business is to provide chemical products to numerous client industries.

These include plastics for the automotive industry, fertilizers for agriculture, paint manufacturing for aviation, explosives for mining and a wide variety of highly specialized chemicals for the pharmaceutical industry.

These industries, located at the end of the value chain, are major consumers of resources that are already highly transformed and therefore very dependent on fossil fuels.

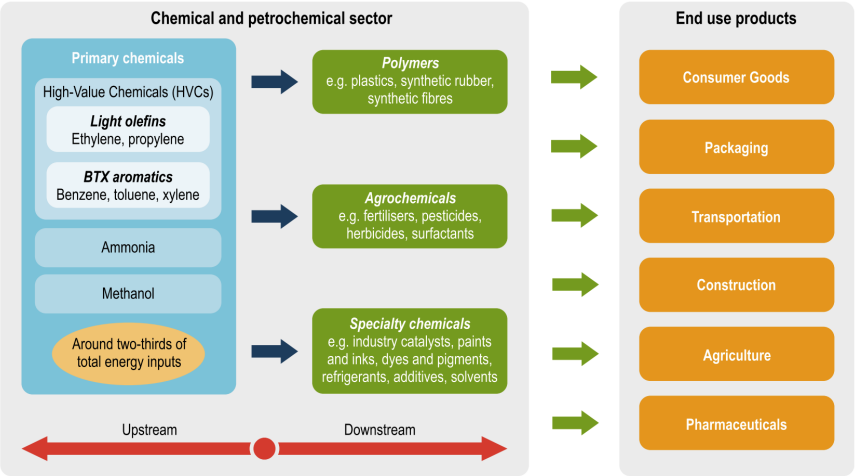


Figure 5: Primary chemicals in context, IEA (2018), The Future of Petrochemicals

To remember: Basic chemicals represent most of the energy and materials consumed by the sector. Downstream activities, such as specialty chemicals and client industries, are highly dependent on emissions emitted upstream of the chemical value chain.

c. Climate context

With a significant demand for energy, the chemical sector nevertheless emits relatively few CO2 emissions, since the sector is the source of 16% of the overall industry emissions[5]. In 2016, the sector accounted for 5.8% of global CO2 emissions[6]. About 63% of these emissions are directly related to the combustion of fossil fuels and the rest is emitted as co-products during chemical reactions.

The sector represents 10% of the world's final energy consumption. The sector's hydrocarbon requirements are such that they account for 85% of the energy consumption of chemical companies (only 15% of energy requirements are therefore met by electricity). The chemical sector alone requires 14% of the world's oil demand and 8% of the world's gas demand[7].

d. Economic context & scope of the study

The chemical sector accounts for 3% of global financial market capitalization[8]. Our study covers more than 80 companies in the sector and focuses on the most highly capitalized companies in the developed country indices (Europe, US & Japan). **Our sample represents 41% of the chemical sector's market capitalization**.

But even more important than the financial weight of the sector, chemicals are essential for all other industries. Indeed, the world's industrial fabric systematically uses chemical products in the production of goods.

[5] IEA, 2020
[6] Hannah Ritchie, Max Roser and Pablo Rosado (2020) - "CO_2 and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions'
[7] IEA, 2020
[8] Source: Internal analysis based on Factset data and on all listed products. The RBICS sectoral breakdown was used.

II - Transition risks in the chemical sector

a. Definition

For a company, transition risks refer to all potential risks of a transition toward a low-carbon economy. The disorderly the transition, the higher the risks. These transition risks range from legislative risks to reputational risks, as illustrated in Figure 6.

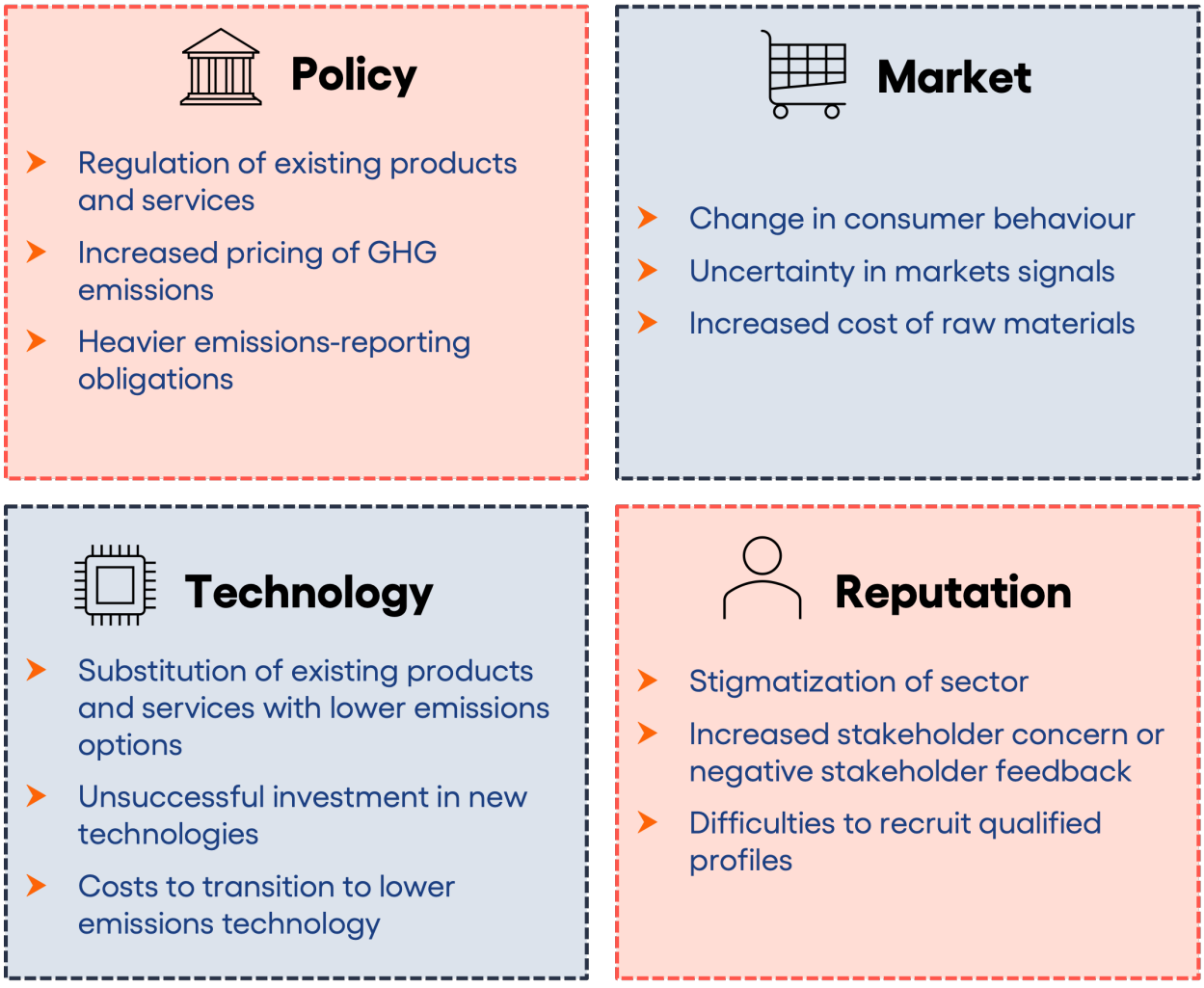


Figure 6: The different risks of transitions

b. Description of the risks:

In the chemical industry, the most immediate risk of transition lies in the high dependency of manufactured products on fossil fuels. This dependency is twofold because it is both a dependence on raw materials and a dependence on energy consumption.
All companies in the chemical sector are heavily dependent on fossil fuels. The question is then to locate this dependency in the value chain: is it a direct dependence? That is, the company directly buys and uses a large quantity of fossil fuels. Is it an indirect dependence? Meaning that the company uses chemical raw materials that are already highly processed.

	Upstream risks	Direct risks	Downstream risks
Description	Purchase and **consumption of petroleum-based chemicals that have required numerous energy-intensive transformations**. Most of products purchased by chemical companies are **chemical intermediates.** Their manufacturing represents 2/3 of the sector's energy consumption.	Direct **consumption of fossil fuels**. As a **raw material** for the manufacturing of chemical intermediates. As an **energy vector** used in chemical reactions.	**Environmental Pollution**: A large quantity of chemicals are released into nature at the end of the product's life cycle (plastics, plant protection products, etc.). **Climate Pollution:** In France 40% of plastics are burned and thus releases the carbon contained in the material.
Materiality, for whom?	• Specialty Chemistry • Fine Chemicals • Fertilizer manufacturers	• Petrochemicals • Industrial Gases • Fertilizer manufacturer	• All
Potential Risks	Increase in the price of basic commodities following the increase in carbon prices (tax or scarcity of raw materials). Price volatility.	Increase in carbon prices. Scarcity of cheap fossil fuels.	Risk of changes in regulations on the end of life of chemical products.
Potential opportunities	Electrification & decarbonization of processes. Circular economy and waste recycling. Better control of emissions related to chemical purchases and selection of suppliers based on environmental criteria.	Use of bio-sourced raw materials. Use of recycled raw materials. Low-carbon hydrogen production (water electrolysis). Capture and storage of CO2 in the most emissive processes.	Waste recycling. Better control of the end of life of products.
CIA Coverage	Covered for all	Covered for all	Covered for N2O emissions after nitrogen fertilization.
Case studies	The specialty plastics company **SIKA** consumes and processes a large quantity of primary plastics. The emissions linked to their purchase represent 87% of the company's emissions.	55% of **Air Liquide**'s industrial gas emissions come from the combustion of natural gas.	**Nutrien Ltd** manufactures and markets a wide variety of chemical fertilizers. 85% of the company's emissions are released during fertilizer application.

III – What solutions to decarbonize the sector?

As it plays such an important role in our daily lives, it is essential to decarbonize the chemical industry. In a context where the sector anticipates a significant increase in demand for chemicals in the coming decades (e.g., mainly fertilizers and plastics, etc.), it is crucial to building solid decarbonization strategies.

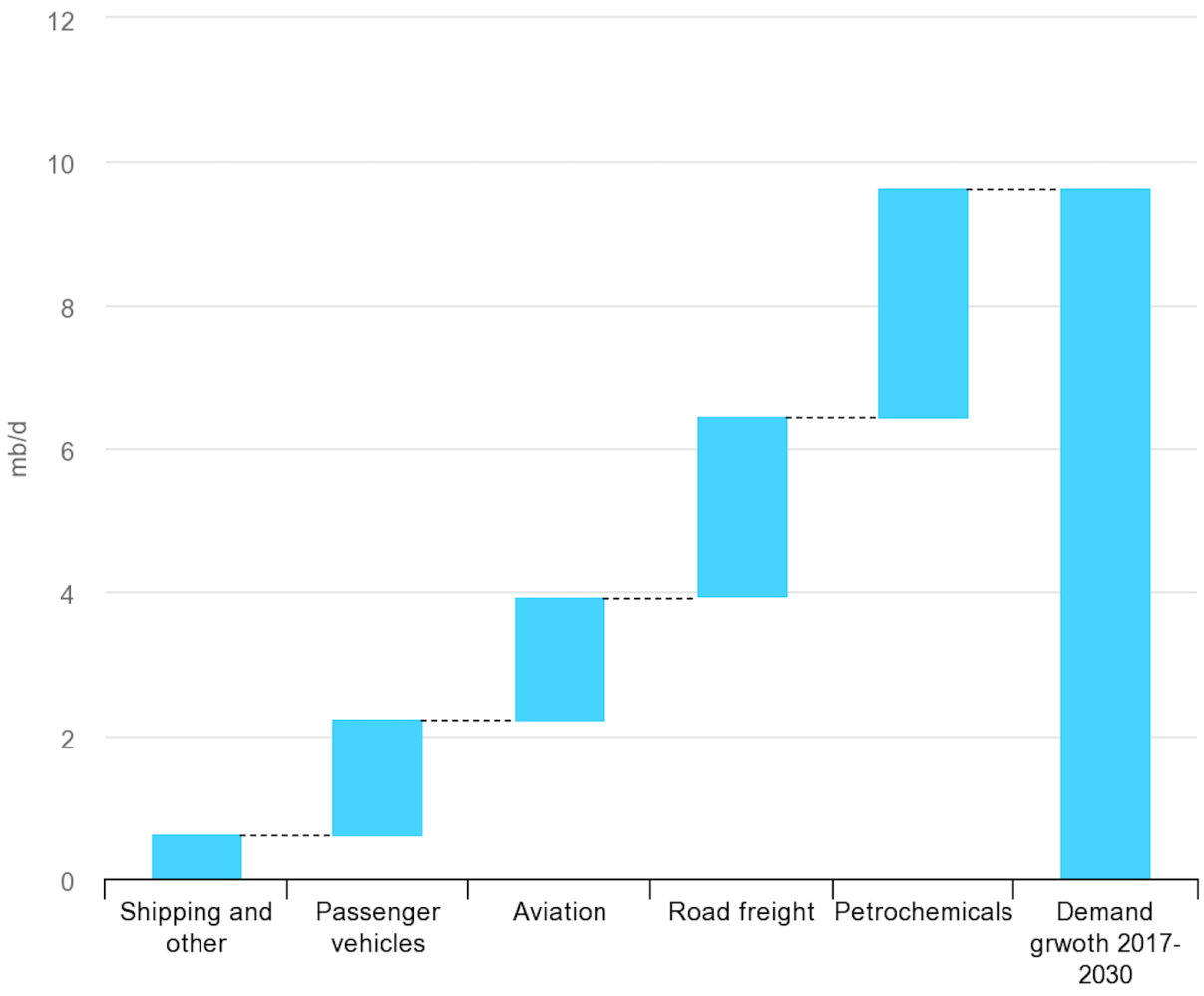


Figure 7: Hydrocarbon demand growth by sector, IEA (2018), The Future of Petrochemicals

a. What Strategies?

Climate change mitigation strategies for the sector are diverse. Three key levers have been identified by the think tank The Shift Project[9] :

- **A sobriety effort** on key products: this involves a reduction in the final consumption of chemical products, first targeting the production of virgin plastics and then the consumption of chemical fertilizers, which are the two main areas of consumption of chemical products.

- **Disruptive changes in processes**: on one hand, by sustaining efforts in energy efficiency and, on the other hand, by relying on cutting-edge technologies, such as biotechnologies, natural-based raw materials, low-carbon hydrogen, or CO2 capture and storage technologies.

- Stronger carbon emissions regulations: In Europe, the **EU-ETS (emission trading system)** is currently reviewed. This revision consists of ending free carbon allowances and an obligation to declare the carbon content of imported products (and then be subject to payment of emission rights). This revision will go with the introduction of a tax at the border system (Carbon Border Adjustment Mechanism) to counterbalance the rising price of basic chemicals.

As far as disruptive technologies are concerned, most of them are in their infancy, and it remains to be seen whether they will ever be widely available, as they are generally not very energy efficient. Only a few tens of millions of tons of CO2 are currently being captured and stored (a thousand times less than global emissions). Similarly, low-carbon hydrogen and the electrification of chemical processes are currently very limited.

b. Regulatory Framework

The evolution of the regulatory framework on the carbon impact of the sector would also allow an acceleration of its decarbonization. The example of the European market and CO2 quotas (EU ETS - European Emission Trading System) is representative of what the sector could undergo.

[9] Shift Project: PTEF, Decarbonising Chemicals, Final Report.

Phase 4 of the EU-ETS (2021-2030) will increase the carbon constraint on industrial infrastructures. Thus, the 'free' emission allowances introduced in previous phases are set to decrease progressively (-2.2% per year) until they disappear. In the same way, taxes on emissions have so far been limited to upstream and intermediate chemicals, but this scope could be extended to other chemical players. In France, around 70% of the chemical industry is already subject to a CO2 quota[10].

According to the Shift Project, the implementation of a Carbon Border Adjustment Mechanism (CBAM), approved in 2022 within the European Commission, is particularly promising, given the characteristics of the sector: high dependency on fossil fuels, high international competition, and the considerable costs of the transition to low-carbon processes. This directive would initially concern the manufacture of fertilizers and would make European low-carbon fertilizers more competitive.

Examples of carbon taxation developed here relate only to European industrial infrastructure. However, as the carbon constraint increases around the world, taxation schemes will continue to develop and will probably resemble the European schemes.

c. In concrete terms, what levers are available to these industries?

Our methodology identifies and integrates six low-carbon products and activities, in line with the IEA Technology Roadmap (IEA, 2020). These include:

1. The use of recycled raw materials
2. The use of plant or plant-derived materials without inducing deforestation
3. Contribution to low-carbon hydrogen production
4. The development of products for the electrification of our economy (solar panels, batteries, fuel cells, etc.)
5. The development of new catalytic processes
6. The use of biotechnological processes

[10]Advancy: The chemical industry in France in 2030: prospects and actions.

d. A sector in need of transparency

In general, chemical industry companies provide little detailed information on their activities: neither the volumes of products manufactured nor the turnover per type of product sold are generally published. This is due to the diversity and complexity of the products manufactured, which limits the visibility of physical flows.

In addition, reporting segments are very broad and encompass markets (end-users) rather than products. This makes it difficult to compare companies based on energy efficiency.
Beyond their operations, players are not very transparent about their supply and related upstream risks. We have identified that rising commodity prices (due to rising fossil fuel prices, or carbon prices) are key drivers. However, companies scarcely report upstream Scope 3 emissions, which are linked to the raw materials used in their process. The lack of transparency on this point demonstrates a partial identification of the most significant risks for the sector. **Out of 80 companies analyzed, 58% reported Scope 3 upstream related to the purchase of raw materials.**

e. The role of investors in the commitment of companies to the transition

In view of this lack of environmental information, investors could demand more transparency from the chemical industry. In this document, we describe various indicators relevant to the sector. It is on these indicators that transparency efforts should be focused.

In particular, we emphasize on:

- The importance of the upstream scope 3 related to the purchase of raw materials, which, for the majority of specialty chemists, is a central indicator of dependency on highly carbon intensive products.

- The importance of considering the viability of a product type in a low carbon economy. For example, the total quantities of chemical fertilizers or plastics will decrease in the long term (due to the scarcity of cheap energy but also due to the strengthening of the regulatory framework). Companies need to confront these developments and plan their business accordingly.

- The importance of quantifying decarbonization initiatives. What is the share of Capex that allows a reduction in emissions? How much CO2 will the replacement of equipment avoid? The implementation of a more virtuous process?

- Finally, companies must declare the emissions related to the manufacture of a product (by ton, for instance). The implementation of a policy to reduce emissions requires precise carbon accounting for the best-seller products of the company. At present, very few companies carry out life cycle analyses of chemical products, although this is a key point if chemical suppliers are to be compared with each other.

IV - Results

a. Our methodological approach

The CIA (Carbon Impact Analytics) rating represents both the company's transition risk and the more or less negative contribution of the company's activity on climate change. The methodology is adapted to the specificities of the sector.

This score is broken down into 3 sub-scores that allow us to estimate the company's decarbonization dynamics:

- The past performance is based on the company's scope 1&2 emissions evolution over the last 5 years.

- The current performance is composed of three indicators:
  - Scope 1&2 carbon intensity
  - The amount of CO2 equivalent embodied in sold products (scope 1,2&3)
  - Decarbonization opportunities implemented by the company

- The future performance examines the company's decarbonization strategy:
  - Ability to identify climate change risks and opportunities
  - Decarbonization strategy: ambition, quantification, and planning of targets
  - Investments that will help reduce GHG emissions
  - The entity's GHG emissions reduction target for scopes 1&2 and scope 3
  - Governance structure that oversees climate risks within the entity

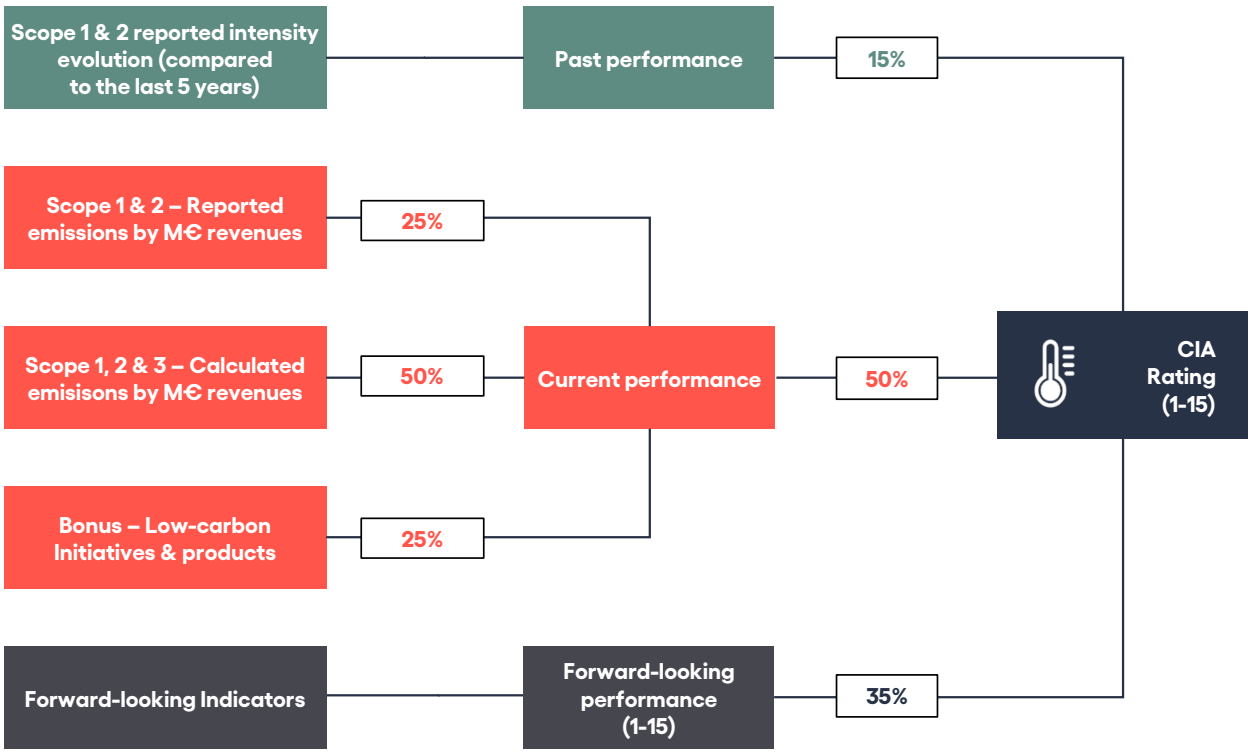


Figure 8: Rating system for companies in the chemical industry

For more details on the rating methodology for the chemical sector, please refer to section *5. CIA methodology*.

For more details on the CIA (Carbon Impact Analytics) methodology in general, please refer to the methodology guide available here.

The reporting of CO2 emissions by companies is also subject to an in-depth analysis. First, the quality of the **scope 1&2** reported by the company is validated. These reported emissions are then compared to sector averages or to the energy consumption reported by the company.

In the same vein, **scope 3** is systematically calculated: indeed, there is such a disparity in calculation methodologies within the same sector that we prefer to perform the calculations based on the types of products sold and on our internal emissions factors to ensure comparability and better reliability of these emissions between companies.

Finally, **avoided emissions**, i.e., emissions linked to the selling of a technology that avoids emissions during its use phase (such as insulating plastic materials or bicycle batteries) could not be quantified for the chemical sector. Products manufactured are too varied and it is extremely difficult to recover the volumes of products sold by companies for such emissions to be properly quantified. However, the CIA rating does include transition opportunities in the "Low carbon initiative & products" criterion.

b. Comparison of companies within the sector

The following graph shows the distribution of scores by performance indicator for the 43 largest listed companies in our sample with a market capitalization of over 7 billion Euros. Companies with the best score (on the top of the graph) have a lower transition risk due to their lower carbon intensity as well as their better contribution to a transition economy.

The companies with the worst scores (on the bottom of the graph) have both a negative impact on the climate and in addition, have a significant risk of losing profitability if transition risks materialize (carbon prices rise, regulations tighten, etc.).

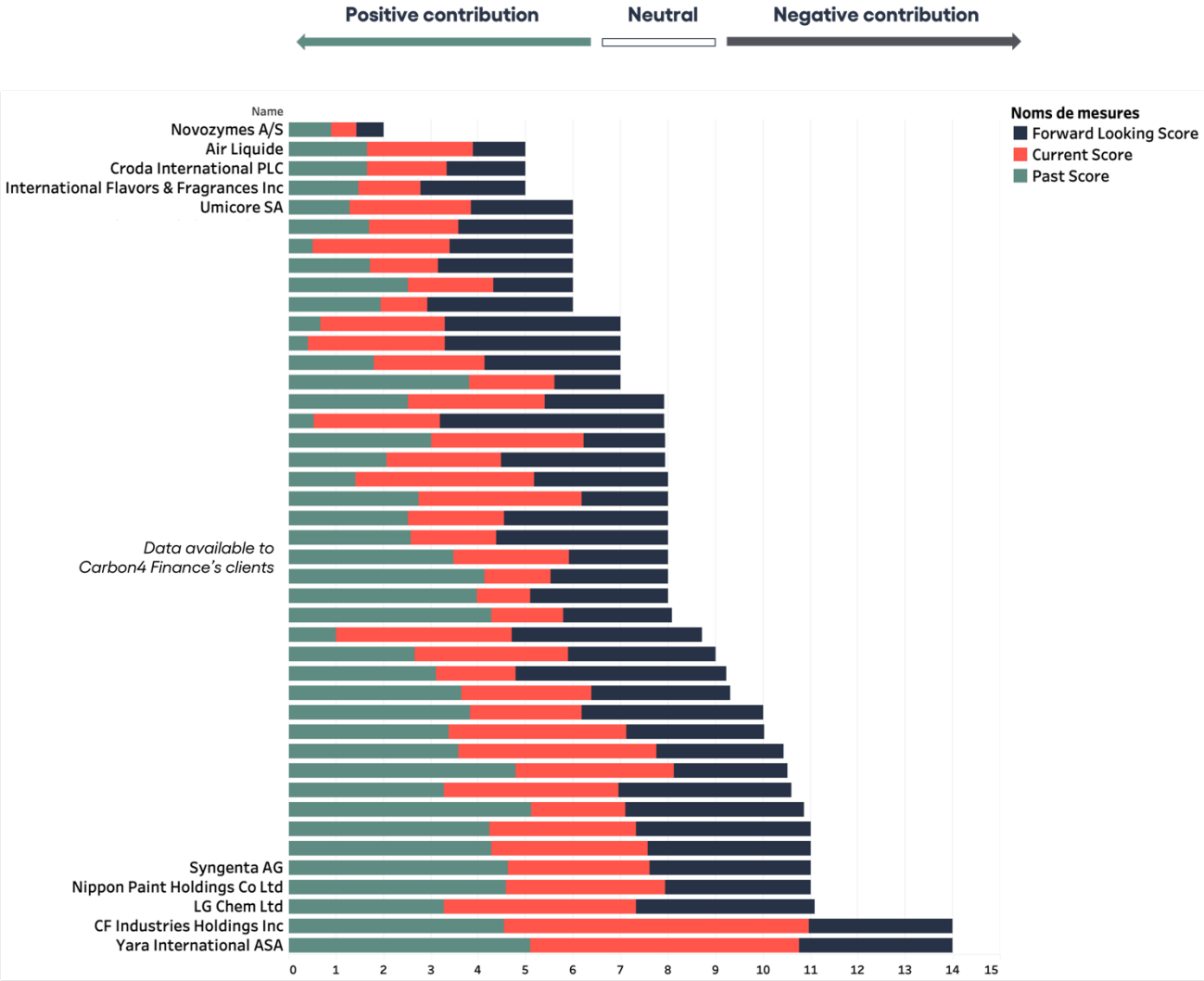


Figure 9: Distribution of scores in the sector

c. Top 5 current performances

The current performance of a company is based on **3 indicators**:

- Scope 1&2 carbon intensity / EURm turnover
- Carbon intensity of scope 1,2&3 / EURm of turnover (carbon intensity of manufactured products)
- The quantity and quality of transition initiatives put in place by the company

For more details on the meaning of these indicators, please refer to section 5.b. 2.

The following graph shows the five companies with the best current performances of the chemical sector. Most of these companies are active in low-energy intensive activities based on biochemistry or have a high potential for decarbonization (electrification).

Company Name	Current Score /15	sc 1&2 intensity tCO2e/M€	Sc 1&2 Score /15	Sc 3 upstream intensity tCO2/M€	Sc 3 Score /15	Low carbon initiatives Descrpition	Low Carbon Score /15
Novozymes A/S	1,8	236	2	1 060	8	o 95% of raw materials used are bio-based (natural)	1
Chr Hansen Holding A/S	3,2	51	1	1 940	5	o The majority of raw materials used are bio-based (natural) but remains unquantified.	3
Albemarle Corp	3,2	282	3	2 506	7	o Strong lithium segment serving the electrification of the economy o Developpement of new catalysts serving the manufacturing of biofuels	1
International Flavors & Fragrances Inc	3,9	63	1	2 062	5	o Significant and quantified investments for the implementation of more efficient manufacturing processes o Few products are now produced from natural raw materials.	3
Sika AG	4,3	30	1	1 130	3	o There are a few initiatives in the use of recycled materials as input. However, this remains very marginal.	13

Figure 10: Top 5 current performances and their composition

d. Top 5 Forward Looking Performances

The transition strategy of a company is based on **5 indicators**:

- The entity's strategy for the transition to a low-carbon economy
- R&D investments and expenditures that will contribute to reducing GHG emissions
- The entity's objectives for reducing its GHG emissions, both direct and indirect
- The governance structure that oversees climate risks within the entity

For more details on the meaning of these indicators, please refer to section 5.b.3.

The following graph develops the first 4 indicators for the 5 companies in the sector with the best decarbonization strategy. This analysis is done from a qualitative point of view on the one hand: what are the investments? How is the company positioned in a low-carbon world? But also, from a quantitative point of view: are the reduction objectives in line with the scenarios provided by the International Energy Agency?

Company Name	Forward Looking Score /5	Thge decarbonation strategy is focused on :	Strategy Score /5	Low carbon investments are focused on :	Investment Score /5	Targets concerning the reduction of direct emissions (scope 1&2) :	Scope 1&2 reduction target score /5	Targets concerning the reductionof the impact the purchase of raw materials :	Scope 3 upstream reduction target score /5
Croda International PLC	**1,6**	o An ambitious direct emissions reduction target o Selling products which benefits to a low carbon economy	**2**	o Renewables and energy efficiency o Investment are quantified and reprensent about a third of total investments	**1**	o The company plans to reduce by 25% its scope 1&2 between 2018 and 2024 (or -4.68% a year) o Target in line with a **"Beyond 2°C scenario"** (B2DS)*	**1**	o By 2030 over 75% of raw-materials will be bio-based o The company also disclose a **target in intensity (tCO2/tProdcuts) but it is not considered relevant** as it does not directly implies the reduction of emissions in absolute.	**3**
Solvay SA	**1,7**	o Selling products which benefits to a low carbon economy o Increase by 5% the share of bio based & recylced raw materials	**2**	o Identified growth platforms as batteries and hydrogen related technologies o Investments are quantified	**1**	o The company plans to reduce by 26% its scope 1&2 between 2018 and 2030 (or -2.48% a year) o Target in line with a **"Beyond 2°C scenario"** (B2DS)*	**1**	o **Double the amount of recycled and bio-sourced feedstock** up to 10% by 2030	**3**
Symrise AG	**1,7**	o Two serious and quantified targets for the reduction of direct and indirect emissions o Use more bio based raw matierials to produce synthetic materials	**1**	o The refurbishement of industrial processes with a focus on heat management	**1**	o The company plans to reduce by 18% its scope 1&2 between 2016 and 2030 (or -1.41% a year) o Target in line with a **"2°C scenario"** (2DS)*	**2**	o The company plans to reduce by 15% its scope 3 upstream emissions by 2030 compared to 2019 levels (or -1.47% a year) o Target in line with a **"2°C scenario"** (2DS)*	**2**
Evonik Industries AG	**1,7**	o Two serious and quantified targets for the reduction of direct and indirect emissions o Selling products which benefits to a low carbon economy with a focus on catalyst and biochemicals	**1**	o In two highly efficient gas and steam turbine plants for the production of polymers	**2**	o The company plans to reduce by 22% its scope 1&2 between 2020 and 2025 (or -4.85% a year) o Target in line with a **"Beyond 2°C scenario"** (B2DS)*	**1**	o The company plans to reduce by -15% its scope 3 upstream emissions by 2025 compared to 2020 levels (or -3.20% a year) o Target in line with a **"Beyond 2°C scenario"** (B2DS)*	**1**
Givaudan SA	**1,8**	o Two serious and quantified targets for the reduction of direct and indirect emissions o Use more bio based raw matierials to produce synthetic fragnance & flavors	**1**	o Renewables and in energy efficiency o Investments are quantified but remain marginal	**3**	o The company plans to reduce by 70% its scope 1&2 between 2015 and 2030 (or -7.71% a year) o Target in line with a **"Beyond 2°C scenario"** (B2DS)*	**1**	o The company plans to reduce by 20% its scope 3 upstream emissions by 2030 compared to 2015 levels (or -1.48% a year) o Target in line with a **"2°C scenario"** (2DS)*	**2**
						* as defined by the IEA's 2017 ETP report		* as defined by the IEA's 2017 ETP report	

Figure 11: Top 5 future gra:des and their composition (focusing on 4 of the 5 forward-looking indicators)

e. By type of activity

The following graph shows the distribution of CIA overall ratings, as well as the type of the companies' main activities, in order to facilitate a comparison of similar companies.

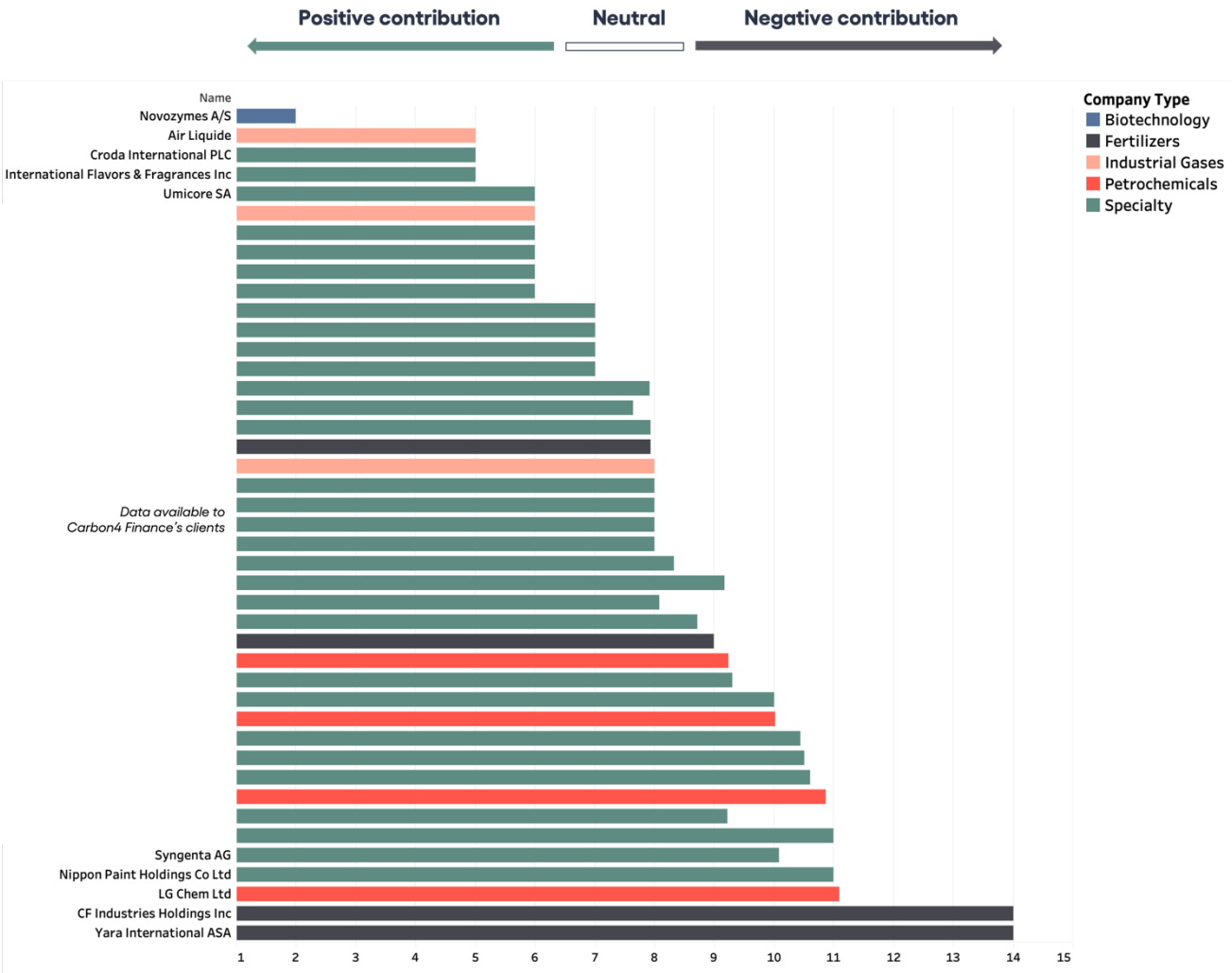


Figure 12: Distribution of CIA overall rating by type of actor

Thus, it can be seen that:

- *Most of the companies analyzed are active in specialty and fine chemicals*.
  As our sample of companies is mainly European and American, we mainly find companies located downstream of the value chain. Indeed, the manufacture of petrochemicals ("building blocks" of the chemical industry) is largely concentrated in the Middle East and the USA, where energy is cheaper and/or more accessible.
- *Within the same activity, companies have different scores*.

Indeed, the main interest of our method is to rank companies from the top performers to the laggards within the same sector of activity.

f. Analysis of the 11 largest market capitalizations in the sector

The graph below presents the results for the largest market capitalizations in the chemical sector. It mainly shows companies in the petrochemicals, fertilizers, and industrial gas chemicals sector, a highly capital-intensive sector with a small number of companies.

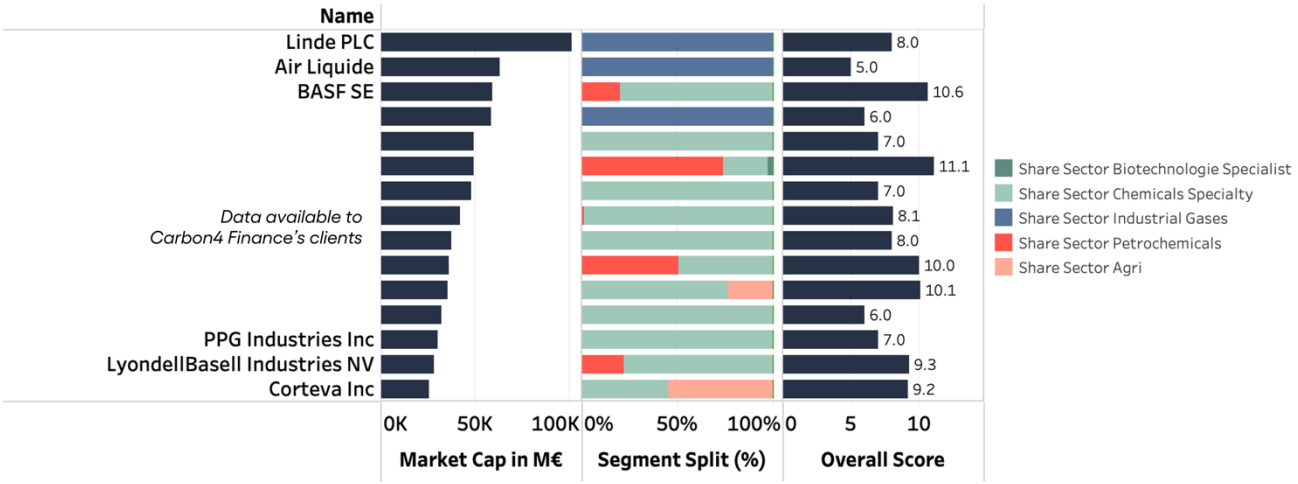


Figure 13: Distribution of scores for the 15 largest market caps in the sector

We note that most polluting activities such as petrochemicals and pesticide manufacturing activities (Syngenta) have a poor impact on the companies' rating. In both cases, products manufactured are highly carbon-intensive and are very dependent on fossil fuels whether it is raw materials or an energy vector for each kilo of product manufactured.

5. CIA methodology

The CIA approach is based on the dependency of companies on fossil fuels along their value chain.

a. Scope 3: a dependency indicator

Scope 3 covers greenhouse gas emissions that are not directly linked to the company's operations, but to other stages of the product's life cycle (production of raw materials, transport, use of sold products, end of life of the product, etc.).

For the chemical sector, the main emissions in the overall carbon footprint are those linked to the production of raw materials used as feedstock (which require a lot of heat for the manufacturing processes). However, it should be remembered that it is difficult to calculate emissions from the products use phase (what are emissions from plastics that end up in a car? Do they have to include some of the car's operating emissions?), and so - by default - there is often no emissions calculated - when it would be questionable to calculate their contribution to product emissions.

As the sector is composed of companies positioned along a transformation chain, companies are directly dependent on each other. Thus, the product of one company will be the raw material of the next, and the direct emissions (scope 1&2) of one company will be part of the upstream scope 3 emissions of another.

In the method, we have considered that the other Scope 3 emissions - notably freight, end-of-life and personal travel - are either negligible (e.g. transport) or too difficult to estimate (e.g. product use emissions - see above - or end-of-life emissions from plastics: all are not incinerated).

Of the 80 companies analyzed, 58% report an upstream scope 3 related to the purchase of raw materials. The reporting of these emissions by companies is still far too low given the importance of these emissions. Moreover, methodologies for calculating upstream scope 3 are rarely transparent, and these emissions often cover only a limited number of suppliers.

b. Our performance indicators

b.1. Past performance indicator

The historical carbon performance of a company is based on the evolution of the scope 1&2 intensity per million euros of turnover over the last 5 years.

The aim here is to look at whether the company has been able to decouple its revenue growth from its direct energy consumption. In other words, it is a first overview of the decarbonization dynamic of a company.

This indicator is limited by the evolution of commodity prices. Indeed, prices of chemical products are particularly volatile, which means that for the production - and therefore emissions - that remains constant, a price increase gives the impression that performance has improved. We therefore assume that for a majority of products, prices are relatively stable over 5 years.

A sign that the carbon assessment exercise is being taken more and more seriously by the industry: in 2015, 21% of the companies analyzed did not report their direct emissions (scope 1&2); in 2020, the figure had dropped to 9%.

b.2. Current performance indicators

To assess the current climate performance of a company we look at **3 indicators**:

1. **Energy performance of activities**

It is based on **a company's carbon intensity**, which is the company's direct emissions divided by its turnover.

This indicator reflects two elements:

- The magnitude of the company's greenhouse gas emissions in relation to the value of the products it produces.

- The location of a company in the overall value chain of the chemical sector, as explained below.

If a company is at the beginning of the value chain, it produces commodities that are cheap per ton but require a lot of energy per ton to be produced. The company's carbon intensity is therefore high. For example, the manufacture of primary plastics or ammonia will be found in this category.

Downstream, there are companies that buy these raw materials and process them, generally using less energy-intensive processes, to make much more expensive products per ton. We will then end up with much lower emissions per euro of turnover.

2. **The amount of carbon embedded in the products sold**

This indicator is based on the mix of products manufactured by the company. For each of them, we estimate the total amount of carbon that was involved in their manufacturing, from the production of the raw materials to their sale.

This life-cycle view of the mix of products sold by the company allows for a better understanding of the amount of carbon contained in the mix. The higher this indicator is, the more energy was used to manufacture the company's production. Among the most carbon-intensive products are pesticides or fibers used in composite materials.

The indicator that supports this "product mix" aspect is the reported scope 1&2 intensity in addition to the upstream 3 calculated according to the product type.

3. **Decarbonization opportunities**

The current performance indicator is enriched by a bonus system applied to each actor. This empirical approach is qualitative and is based on six relevant criteria to measure the company's involvement in establishing a low-carbon production model. The six criteria selected in our methodology are based on the results of the IEA report[11] and on a publication from a global chemical industry trade association[12] .

Among them we can find:

1. **Use of recycled raw materials**: recovery of low-value waste.
2. **Biomass feedstock**: all plant and plant-derived materials, including animal manure, used to produce chemicals.
3. **Low-carbon hydrogen production**: hydrogen produced from water and low-carbon electricity (electrolysis) or from biomass without deforestation.
4. **Chemical products for the energy transition**, in particular electrochemical products (solar panels, batteries, fuel cells, etc.). Any product allowing the

[11] IEA: The Future of Petrochemicals 2018
[12] International Council of Chemical Associations ENABLING THE FUTURE, Chemistry innovations for a low-carbon society

production of low-carbon electricity (solar panels, fuel cells using low-carbon hydrogen, etc.), the storage of electricity (batteries, etc.), or a gain in energy efficiency in an electrochemical system.

5. **Development of new catalytic processes** (extended to any improvement towards more efficient processes). Any process that captures emissions or reduces CO2 emissions, energy consumption, raw material use, and even waste consumption.
6. **Share of biotechnological processes** (enzymes, etc.): Chemical processes can be replaced by biochemical processes (use of biotechnology). These new processes are considered more environmentally friendly and produce less waste.

Bonuses are applied based on two criteria. If a low-carbon activity is precisely reported by the company in terms of share in total production, total revenues or total capacity, the bonus will be awarded according to this quantitative data. If this effort is mentioned by the actor but not quantified, qualitative rating criteria will be used: marginal activity (vaguely mentioned by the actor), minor activity (mentioned by the actor, with underlying avoided emissions), significant activity (less than the majority of products) and finally major activity if the majority of products participate in the low-carbon transition).

b.3 Forward-looking performance indicator

In addition to assessing the current carbon performance of companies in the chemical sector, we assume that decision-makers also need a prospective assessment of climate risks and performance. Therefore, a qualitative analysis of companies is necessary, to assess the future performance of the company.

The "Forward-looking" analysis considers:

- The entity's strategy for the transition to a low-carbon economy
- R&D investments and expenditures that will contribute to reducing GHG emissions
- The entity's objectives for reducing its GHG emissions, both direct and indirect
- The governance structure that oversees climate risks within the entity

Given the diversity of business models within the sector, specific issues are identified for different types of actors. The qualitative analysis is carried out with regard to these differences, using an analysis grid adapted to these issues.

The main difference between types of companies lies in the importance that we attach to scope 3 reduction targets. The petrochemical industries and industrial gas manufacturers are very far up the chemical value chain, so scope 3 related to the production of raw materials is less important for these types of players.

Of the 80 companies analyzed:

- The vast majority of companies have decarbonization objectives for their operations: 83% have reported scope 1&2 direct emissions reduction targets.
- Only 31% also have quantified targets for reducing their upstream scope 3 related to procurement.
- The latter figure is very low. However, many companies make non-quantified commitments and require their suppliers to comply with certain quality charters on emissions reporting or to set their own reduction targets (37% of companies).

All these reduction targets are available in our database.

c. Aggregation of indicators, rating methodology

c.1. How are the indicators aggregated?

The aggregation of indicators represents the importance we believe should be given to each rating criterion.

- Current performance, with 50% of the final score, reflects a company's current dependence on fossil fuels (scope 1&2) or on products that themselves required a lot of fossil energy to be manufactured (which explains the poor ranking on this criterion of fertilizer or pesticide manufacturers).
- The future score (35% of the total) focuses on ambitions: we have chosen to make this the 2nd criterion in terms of materiality.
- The past score is less important (15%), as the evolution of the intensity is significantly dependent on price fluctuations, and it is therefore more difficult to conclude a simple meaning.

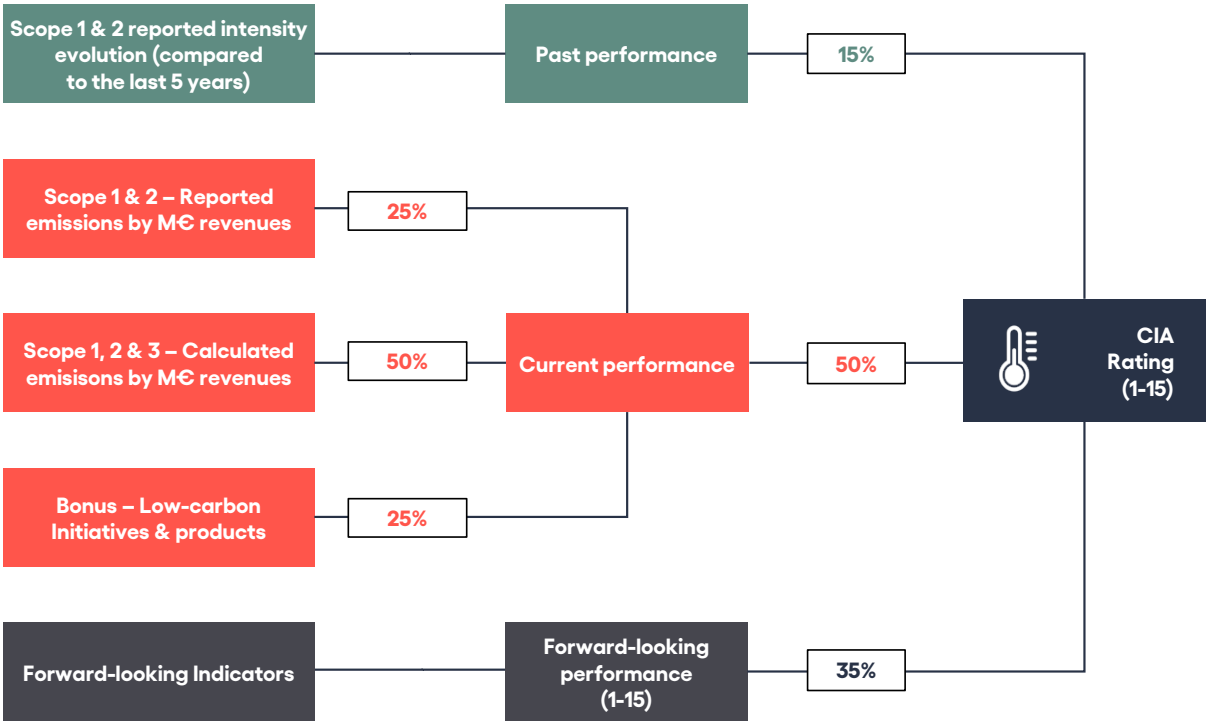


Figure 14: Rating system for companies in the chemical industry

c.2 Caps & Floors of Activity Ratings

Caps & Floors indicate, for each activity, the minimum and maximum possible CIA rating for the main type of actors in the sector. This is in line with our desire to rank sectors according to whether each sector can contribute to the transition (which determines the best possible score), and whether it contributes significantly to current emissions (which determines the worst possible score). These limits are based on the intensity of the activities and their possible role in the decarbonization of our economy.

These limits may change as certain sectors progress. For example, the production of low-carbon hydrogen could lead the industrial gases sector to have an A-range (for the moment, hydrogen is still mainly produced based on natural gas and is highly carbon intensive).

	A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E+	E	E-
Petrochemicals															
Industrial Gases															
Fertilizers Specialists															
Mineral Chemicals															
Specialty															
Biotechnology Specialists															

Figure 15: Cap & Floor for the rating of chemical sub-sectors

d. Limitations and ways forward

Our approach to assessing transition risks is limited by three elements.

- Firstly, the downstream risk, which materializes the vulnerability of the sector that will ultimately buy the chemicals, is not included in the analysis. For example, selling chemicals to a manufacturer of internal combustion engine vehicles is associated with a higher transition risk than selling products to a company that produces electric bicycles. A systemic approach by type of customer sector could be considered.
- The high volatility of chemical prices reduces the accuracy of monetary ratios (in tCO2/EURm of products sold). To overcome this drawback, we plan to update the database of monetary emission factors using a database of industrial commodity prices.
- In the future, more low-carbon initiatives will be considered, such as insulation materials, technologies used in the manufacture of biofuels (additives/catalysts/enzymes) or silicone materials used in the manufacture of solar panels, or more generally used in the electrification of our economy.

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Carbon4 Finance offers a comprehensive set of climate data solutions covering both physical risk (Climate Risk Impact Screening) and transition risk (Carbon Impact Analytics). These proven methodologies allow financial organisations to measure the carbon footprint of their portfolio, assess alignment with a 2°C compatible scenario and measure the level of risk arising from climate change events.

Carbon4 Finance applies a rigorous bottom-up research-based approach, which means that each asset is analysed individually and in a discriminating manner.

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