LISBON INVESTMENT SOCIETY | EQUITY RESEARCH

Chemicals Industry

Sustainability Report

February 2026

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Executive Summary

This report provides an in-depth assessment of the chemicals industry through an Environmental, Social, and Governance (ESG) lens. By building up a case study with a focus on five leading companies that work within the industry. The chemicals are essential to almost every value chain, as they supply basic materials, specialty inputs, and performance formulations for sectors ranging from construction and agriculture to healthcare, electronics, and consumer goods.

Given the sector's global footprint and capital intensity, the industry's competitiveness is increasingly shaped by sustainability expectations and regulatory constraints. It is found evidence that key ESG priorities therefore centered on decarbonizing operations and products (Scopes 1–3), improving energy efficiency, and accelerating circularity via recycling, lower-impact materials, and waste minimization, are key for the development of companies towards the net zero targets. Furthermore, across different regions, regulation and stakeholder scrutiny are tightening the requirements for chemical safety, transparency, and sustainability reporting. These factors drive higher expectations on data quality, traceability, and supply-chain performance. Industry initiatives

Finally, the industry is characterized for being one of the most energy- and emissions-intensive in manufacturing, relying on fossil fuels as both feedstock and process energy. With agencies and volunteer programs such as Responsible Care® and Together for Sustainability (TfS) reinforcing these ESG-related trends by promoting common management practices for health, safety, environment, and responsible sourcing, they help companies demonstrate credible governance and continuous improvement. Such that, the report highlights strategic pathways for the companies within the industry, mainly focusing on cooperation, scaling low-carbon technologies, shifting toward renewable and recycled feedstocks, and deploying digitalization to optimize energy, maintenance, and process control. Offering companies the opportunity to long-term growth.

What ESG stands for?

ESG stands for Environmental, Social, and Governance. It represents the core pillars used to assess a company's sustainability practices and ethical impact on its employees, society, and the environment. ESG provides a set of criteria that investors, customers, and other stakeholders use to evaluate a company's performance beyond traditional financial metrics, focusing on its long-term viability, risk management, and overall responsibility. Each component of ESG addresses different dimensions of corporate impact:

- Environmental: Evaluates how a company affects and manages its interaction with the natural environment. Examples: Carbon emissions, energy efficiency, waste management, pollution control, and responsible use of natural resources
- Social: Focuses on how a company manages relationships with employees, suppliers, customers, and the communities in which it operates. Examples: Labor practices, human rights, diversity and inclusion, community engagement, and customer satisfaction.
- Governance: Examines the company's leadership, internal controls, and accountability structures. Examples: Board composition and diversity, executive compensation, shareholder rights, and corporate transparency. By integrating these three pillars, organizations can develop tailored strategies and measurable actions that strengthen sustainability performance and align with stakeholder expectations. (Byrne, 2023)

Industry overview

The chemical industry stands as one of the fundamental pillars of the global economy, supplying the essential materials and compounds that support almost every product and industrial process. It encircles the production and transformation of raw materials, such as oil, natural gas, minerals, and biomass, into thousands of products that are essential to modern life. These products serve as inputs for almost every other sector, from agriculture and energy to healthcare, construction, and consumer goods.

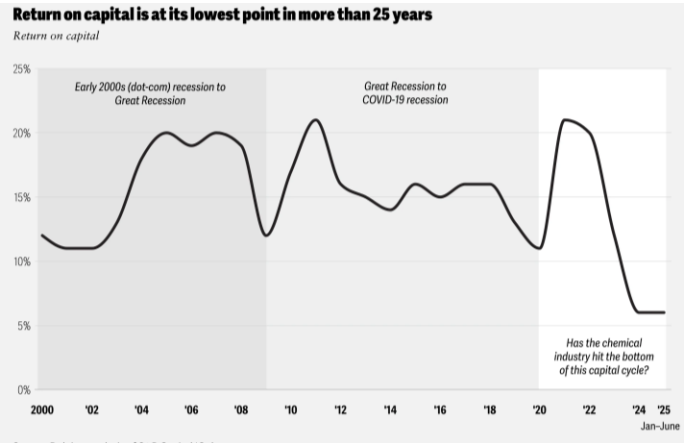
This industry is the foundation for plastics, fertilizers, pharmaceuticals, detergents, and countless other goods. The sector is typically divided into three major segments: (a) basic or commodity chemicals, which provide large-scale inputs, like ammonia, propylene and ethylene; (b) specialty chemicals, designed for specific functions, such as coatings, surfactants, and electronic chemicals; and (c) consumer chemicals, which include personal care, pharmaceutical and cleaning products. Together, these products form the invisible infrastructure of global manufacturing, allowing economies to grow and societies to develop.

Chemical manufacturing is among the most sophisticated industrial activities, combining complex reactions, advanced materials science, and precise process control. Modern plants operate on massive scales, using continuous production lines and catalytic processes that demand high safety standards and environmental stewardship. Increasingly, digitalization, automation, and artificial intelligence are being integrated to optimize yields, reduce waste, and improve energy efficiency, reflecting the industry's shift toward smarter, more sustainable operations.

It is also a highly capital and research-intensive field. Companies invest billions annually in R&D to develop new polymers, advanced composites, and sustainable formulations. While commodity segments remain cyclical and sensitive to energy prices, specialty and life-science chemicals deliver stable, high-margin growth. Long-term structural trends, such as electric mobility, renewable energy, and advanced healthcare, are driving steady demand for innovative chemical solutions.

Presently, the industry's emphasis is on developing products and materials that minimize environmental impact, particularly by reducing carbon emissions. As industries continue to move away from fossil fuels and adopt renewable energy sources.
The sector in this past three years has been lagging the broader market, with growth in the past five years, that has been offset by heavy capital investments and decreasing margins. These downturn cycle highlights structural problems, including short-term effects, including supply chain disruptions and destocking, while long term factors create a sustained supply-demand imbalance. (McKinsey & Company, 2025)

With moderate progress in 2024, the industry filled with cost reducing programs started in 2023, effects were still producing changes in the behaviour of companies in 2025 (Yankovitz et al., 2024).
The market is most concerned with the current problem about the tariffs, and geopolitical tensions that shape the supply chains of the industries and their reach to the end market. With the return of investment capital being at its lowest in the past 25 years. (Graph 1)



Graph 1;Source: Deloitte 2025 report on chemical industry

Furthermore, the overall global picture in 2025 showcased distinct contrasts, as while in Europe is undergoing a severe and sustained contraction, some countries, like India, are seeing growth in this industry that is expected to continue over the next 5 to 10 years.
In Europe these period of closing plants by large petrochemicals made European Commission to present an action plan to strengthen the modernization and competitiveness of the industry. In a way to address key structural problems, as mentioned, mainly high energy costs, weak demand and unfair global competition, such that it established a Critical Chemical Alliance to focus on risks of capacity closures.

One of the key problems on the industry is the overcapacity factor. This appears mainly due to the global overcapacity of ethylene production in Middle East, Asia and North America. (Robinson, 2025) Ethylene is one of the most important organic raw material in the chemical industry by volume, serving as a key element for a vast range of plastics, chemicals and intermediate compounds. (AFPM, 2017) While China's production of chemicals is striving to become more independent in this sector, it fostered a lot of investment in this sense specially in the ethylene production. Such that it was able to affect deeply trade flows and reshaping the industry, fostered also with the tariffs, as the Chinese market has less demand for the other markets due to the domestic market boom. (Robinson, 2025) According to Wood Mackenzie, ethylene capacity has expanded by more than 40 million tons between 2020 and 2025 , owning 70% of this new built capacity to China, while demand only grew around 27 million tons. (Fagg, 2025).

Geographic production

The chemical industry is globally integrated, but production is highly concentrated in Asia-Pacific. Asia now accounts for around 60% of world chemical revenues, driven by large-scale capacity additions and strong demand in China, India, South Korea and other manufacturing hubs (Cefic, 2024; MarketSquare Insights, 2023). China alone represents roughly 45% of global chemical sales, making it the largest producer and consumer and a key price-setter for many bulk chemicals (Allianz Trade, 2023). Europe remains the second-largest producing region with about 18% of global sales, increasingly specializing in higher-value specialty and performance chemicals rather than basic bulk commodities (Cefic, 2024).

North America is another major producer, leveraging competitively priced shale-gas feedstocks to support large export-oriented petrochemical and plastics complexes (American Chemistry Council, 2018). The Middle East, led by the Gulf states, has emerged as a top-five chemicals producer by using low-cost oil and gas to build significant capacity in basic petrochemicals and fertilizers, while gradually moving into more complex downstream products (GPCA, 2022). At the same time, Europe's higher energy and regulatory costs and rising geopolitical tensions are encouraging companies to rebalance supply chains, with new investments concentrating in Asia, North America and selected Middle Eastern hubs as firms seek both cost advantages and greater resilience (S&P Global, 2023; Cefic, 2024; Reuters, 2025).

The 12 major chemical companies include:



Image 1; Logo BASF



Image 2; Logo SINOPEC



Image 3; Logo Dow Inc.



Image 4; Logo LG Chem Ltd.



Image 5; Logo PetroChina



Image 6; Logo ExxonMobil Corporation



Image 7; Logo SABIC



Image 8; Logo LyondellBasell Industries NV



Image 9; Logo Formosa Plastics Corp



Image 10; Logo Linde Group



Image 11; Logo INEOS



Image 11; Logo Air Liquide

For comparison terms, we will only consider 5 out this 12 major players, in our analysis.

Demand drivers

- **Energy transition**: Materials for batteries, EVs and renewable power equipment, including polymers, solvents, electrolytes and specialty gases used in cells, motors and grid infrastructure. (Deloitte, 2023)
- **Urbanization & infrastructure:** Construction and transport projects using plastics, coatings and construction chemicals for buildings, roads, bridges and water systems, especially in fast-growing emerging markets.
- **Agriculture & food:** Fertilizers and crop-protection chemicals to raise yields and improve crop quality, as well as newer bio-agrochemicals to support more sustainable farming. (TowardsChem, 2025)
- **Consumer & personal care:** Hygiene, cleaning and beauty products using specialty chemicals such as surfactants, fragrances and conditioning agents, with growing demand for "green" and skin-friendly formulations. (IndustryARC, 2024)
- **Healthcare & pharma:** APIs and high-purity chemicals for drugs, vaccines and medical devices, supported by ageing populations, higher healthcare spending and innovation in biologics. (MarketsandMarkets, 2025)

ESG and chemical sector

The chemical industry is essential to modern economies but also one of the most energy- and carbon-intensive sectors. It relies heavily on fossil fuels as both feedstock and energy source, is estimated to account for about 5–6% of global greenhouse-gas emissions, placing it just behind steel and cement among industrial emitters. Beyond climate, the sector's footprint includes air and water pollution, hazardous substances and persistent plastics, which has led policymakers and stakeholders to treat chemicals as a "hard-to-abate" industry that must transform while continuing to supply materials used in 90%+ of manufactured goods.

Regulation and reporting standards are tightening ESG expectations. In Europe, the Corporate Sustainability Reporting Directive (CSRD) and the associated European Sustainability Reporting Standards (ESRS) require large companies to apply a double materiality lens, disclosing both how sustainability issues affect the business and how the business impacts people and the environment across the value chain. The dedicated CSRD Handbook for the chemical sector shows that over 100 surveyed chemical companies are preparing for these new rules, which cover climate, pollution, water, biodiversity, resource use, circular economy and social topics such as workers in the value chain and affected communities.

Survey results highlight that the sector feels relatively confident about climate disclosures but less confident about pollution (especially microplastics), biodiversity, resource use and certain social topics. Most respondents still rely on spreadsheets to compile ESG data and are only starting to adopt dedicated sustainability data systems. Key obstacles include value-chain complexity, limited internal expertise, particularly in smaller companies, and tight implementation timelines, while perceived benefits range from competitive advantage for smaller firms to risk mitigation and improved stakeholder engagement for larger groups.

Responsible Care®

The International Council of Chemical Associations (ICCA) founded Responsible Care, in Canada in 1984 as a voluntary program, that nowadays includes almost 70 economies uniting more than 60 chemical associations. This program was founded as a way to improve the safe chemicals management and to achieve excellence in environmental, safety, health and security performance of those that belong to it. With over 90 of the world's largest chemical companies being signatories, uniting the commitment of more than 740 CEOs of petrochemical and chemical manufacturers.

Its Members commit, according to the Responsible Care® Global Charter, to enable a corporate leadership culture supporting safe chemicals management, while safeguarding people and the environment focusing on innovation, engaging with business partners. Furthermore, they focus on the promotion of lower resource use and lower CO_2 emissions, safer workplaces and stronger health standards, smarter chemical management across the value chain and transparent engagement with stakeholders. By combining regulatory frameworks such as CSRD/ESRS with Responsible Care® and other voluntary standards, leading chemical companies are increasingly treating ESG not only as a compliance requirement but as a driver of innovation, reputation and long-term resilience.(ICCA, n.d.).



Image 12; Logo Responsible care

Together for Sustainability

Is an initiative, operating globally, that aims to promote the acceleration of the development of sustainable and resilient chemical supply chains. The member of this association are chemical companies. As of April 2023, they had over 50 members representing a combined global annual turnover of over 800 Billion euros and spend exceeding 500 billion euros in the industry.



Image 13; Logo Together for Sustainability

To achieve their goal, they align their principles with UN Global Compact and Responsible Care®. By offering a standardized supplier assessments and auditing that include key areas, like Environment, Health and Safety, Labor and Human Rights, Governance, and Management, they make sure the ESG evolution, such that in 2024 6000 suppliers demonstrated a progress through their process, where innovation is the key step and at the heart of TfS. As the assessment provides opportunities to improve sustainability performance with a Corrective Action Plan (CAPs), that guide the improvements. While also offering training besides innovative tools, they share throughout the industry the best practices too decarbonization and responsible sourcing. (Together for Sustainability, 2026)

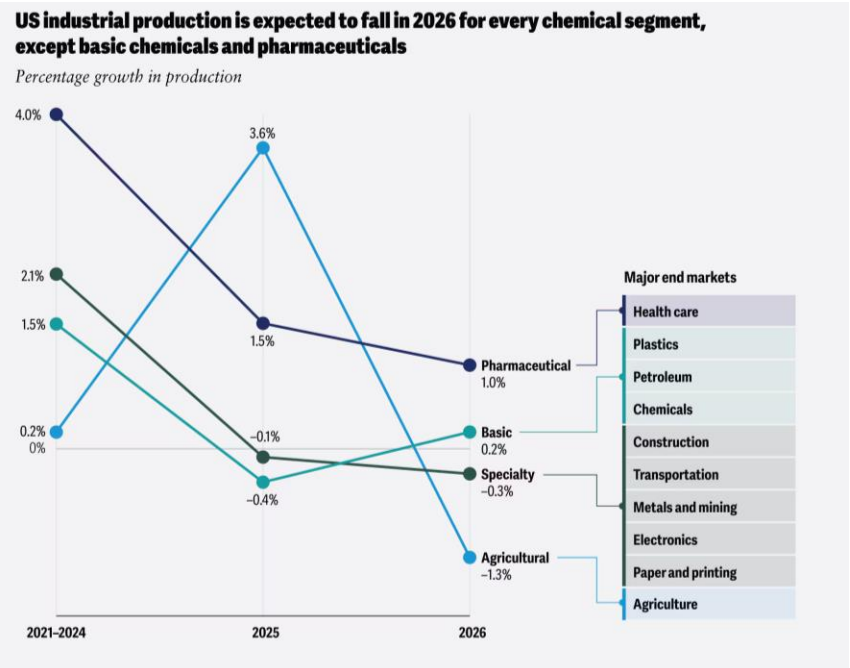
Outlook

As previously mentioned, the industry as been facing a downturn cycle in the past years, with the expectancy of growth in 2025 not happening. The future of the chemicals industry still presents some challenges, highlighting structural problems. In 2026 it is forecasted to continue this trend with an expectant **decrease of 2%,** according to Deloitte report. Despite its resilience through pandemic shocks and inflation, the sector will most likely continue to follow this path as demand will remain uneven between key end markets, with **pressures on operating rates and profit margins** with overcapacity attenuating it.

Although at the same time some levers indicate the industry is turning back to equilibrium. As companies start to apply certain measures to sustain and improve their operation efficiency, with firms that are able to live through this episodes, by being flexible and adaptable that could emerge with more strength to grow.

Key factors englobe the overall **economic growth**, also expecting **key end markets growth**, like the semiconductors sector. This may sustain the demand, although inflation and interest rates could be a negative indicator for it. Additionally, although the tariffs and oil and natural gas prices might influence the costs for the company, the **use of digital AI** to improve cost efficiency in operation of the supply chain will be key. Furthermore, **capacity is sustained** that fosters the recovery to meet the demand more rapidly, while working capital might also be a positive sign as the **pace of receivables** collection and the one at which the companies pay high-interest debt, which foster cash generation more rapidly and increases investor confidence.

In the US, industrial production is expected to fall in 2026, in every chemical segment except for basic chemical and pharmaceuticals. (Deloitte, 2026)



Graph 2; Source: Deloitte 2025 report on chemical industry

Key Trends

To remain relevant the companies must consider their strategies according to key trends of the industry, these include the following:

- Profit prioritization: with average net profit margins decreasing in the past years, it is expected that firms turn their focus into a cash generation increase; in order to sustain itself in this downturn cycle, cash preservation should be a focus. To help maintain liquidity can ensure operational continuity and influence investor perception.
- Supply chain resilience: tariffs impose a significant risk within this industry, although the introduction of new preferential trade agreements has offered some clarity, the future remains uncertain. So, we should expect some operational adjustments, with rerouting production flows, and changes in transferences of pricing, with AI position being important to optimize supply chains in line with the newest trade policies. Furthermore, inventory increase strategies, should be expected as many importers front-loaded orders increased in 2025, such that US chemical imports spiked and then returned. This overall led to supply reshuffling and is expected to continue to happen, with emergent markets appearing to fill the gap.
- End-market demand: chemical demand is expected to remain soft fuelled by downturns in key markets that foster the industry, like the construction, automotive and consumer goods, although semiconductor industry could provide new opportunities.
- AI adoption: to provide the increase in efficiency the introduction of machine learning and data analytics is going to be expects, in order to boost innovation, resilience and strengthen future competitiveness.
- Investment in R&D: although cash generation is at key, investment is also key, so that it can provide cost minimization and also to build resilience, drive growth and adopting to changing markets. With sustainability being an important driver within this trend. With a study finding evidence that the industry will require US$ 1 trillion in capital investment in order to meet this needs until 2080. (Deloitte, 2026)

Legal drivers shaping the industry by region

United States

Chemical safety regulation (TSCA update): EPA can require testing and restrict/phase out "high-priority" chemicals found to pose unreasonable risk, raising compliance and product-stewardship costs. (U.S. EPA, 2024).

Product and hazard disclosure: California's Proposition 65 "clear and reasonable warnings" regime continues to drive labelling and reformulation; recent amendments make short-form warnings more informative by requiring at least one chemical name (with transition timing set by the regulation). (OEHHA, 2024).

Climate disclosure expectations: The SEC adopted climate-related disclosure rules in March 2024, but the rule has been stayed during litigation and, in 2025, the SEC voted to end its defence of the rule—creating uncertainty while climate-risk disclosure expectations remain elevated for large issuers. (SEC, 2024–2025).

East Asia

China (MEE Order 12): "China REACH" requires registration/filing of substances not on the IECSC before manufacture/import; inventory updates force continuous compliance monitoring. (Intertek, 2024).

Japan: Japan's Chemical Substances Control Law (CSCL) continues to tighten controls on substances of concern; in Dec 2025, METI announced a Cabinet Decision amending the CSCL enforcement order to classify PFHxS-related compounds as Class I Specified Chemical Substances and expand related restrictions (including certain import controls). (METI, 2025).

South Korea: South Korea's K-REACH (Act on Registration and Evaluation of Chemicals) requires manufacturers/importers to register new chemicals and progressively register priority existing substances, raising data and supply-chain compliance demands. The law was amended in Feb 2024 and took effect in Aug 2025, replacing the old "toxic substances" concept with new hazard categories and tightening classification and SDS obligations. (KTR, 2025).

India: India is using mandatory standards to shape chemical market access—2024 QCOs for certain intermediates, and a 2025 rollback for 14 petrochemicals to ease imports/compliance. (DCPC, 2024–2025; ICIS, 2025).

Europe

REACH & CLP: REACH remains the EU's main chemicals law (registration, authorization and restriction), while CLP governs classification, labelling and packaging; together they shape product design, substitution decisions and compliance costs. (European Commission, 2006/2007; ECHA, 2024).

PFAS restrictions: EU restrictions and broader PFAS work are reshaping product portfolios and requiring reformulation. (European Commission, 2025; ECHA, 2025).

CSRD / ESRS reporting: CSRD makes sustainability reporting mandatory for in-scope companies using ESRS, expanding disclosure expectations across climate, pollution, water, biodiversity, resource use and social/governance topics—directly affecting chemical producers and their value chains. (European Commission, 2023–2024).

Analysis

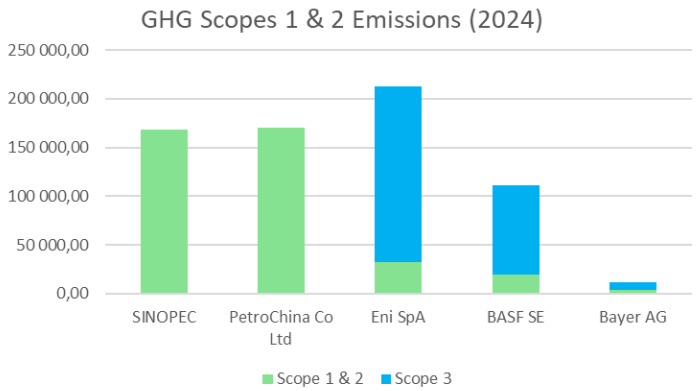
Environmental

Greenhouse gases emissions

Chemical production contributes significantly to global carbon emissions due to its highly energy- and feedstock-intensive processes. The industry relies heavily on fossil fuels both as an energy source and as raw material for producing essential products such as plastics, fertilizers, and solvents. These emissions are categorized into three scopes:

- **Scope 1** covers greenhouse gas emissions released directly from sources a company owns or controls, such as fuel burned in a chemical plant's boilers or furnaces.
- **Scope 2** includes indirect emissions from the generation of purchased electricity, steam, or heat that the company uses to power its operations.
- **Scope 3** encompasses all other indirect emissions across the value chain, including those from the production of raw materials, transportation, product use, and disposal.

An analysis of the largest companies in the industry by 2024 revenue, focusing on those that disclose Scope 3 data, indicates that the majority of their total emissions originate from Scope 3 sources across their value chains. With 75-90% of total GHG driven by scope 3 emissions. (van der Linde, 2025)



Graph 3; Source: Own analysis and Bloomberg.

In the chemicals industry, **Scope 1 emissions** include CO_2 from energy generation, **nitrous oxide (N_2O)** from fertilizer and nitric acid production, and **high-GWP gases** such as HFCs, PFCs, and SF_6 from specialty chemical and polymer manufacturing. Although Scope 1 emissions represent a smaller share of the sector's total carbon footprint, typically around 25–35%, they have a **disproportionately high global warming impact** due to the potency of these gases and the energy intensity of core chemical processes. Reducing Scope 1 emissions therefore focuses on decarbonizing heat and power generation, optimizing processes, and adopting carbon capture and utilization technologies.
By contrast, **Scope 3 emissions** account for the **largest portion of total emissions**, often exceeding 60%. These stem primarily from **upstream activities** such as the extraction, refining, and transportation of fossil-based feedstocks like naphtha and natural gas, as well as **downstream impacts** from the use and end-of-life treatment of chemical products (e.g., plastic incineration or solvent degradation). **Scope 2 emissions**, linked to purchased electricity and steam, make up a smaller share, typically 5–15%, but remain important for energy-intensive operations. Collectively, this profile highlights that achieving deep decarbonization in the chemicals sector requires tackling not only on-site emissions but also the **embedded carbon in feedstocks** and the **broader value-chain impacts**.

Energy Consumption

The chemicals industry is one of the most energy-intensive sectors, accounting for approximately **7.5% of global final energy consumption**, according to the International Energy Agency. This high demand is driven by continuous, capital-intensive production processes that operate around the clock. Energy use is concentrated in a few core process areas that underpin large-scale chemical manufacturing:

- **Process heating and steam generation:** High-temperature reactions, distillation, and separation processes require substantial thermal energy, making steam systems a major energy consumer.
- **Mechanical and electrical operations:** Compressors, pumps, and electrochemical processes consume significant electricity to maintain reaction conditions and enable large-volume material flows.

Industry's main energy sources

Fossil fuels

≈ 85 to 90% of total energy use. Responsible for large parts of Scope 1, 2 & 3 Emissions.

Renewable

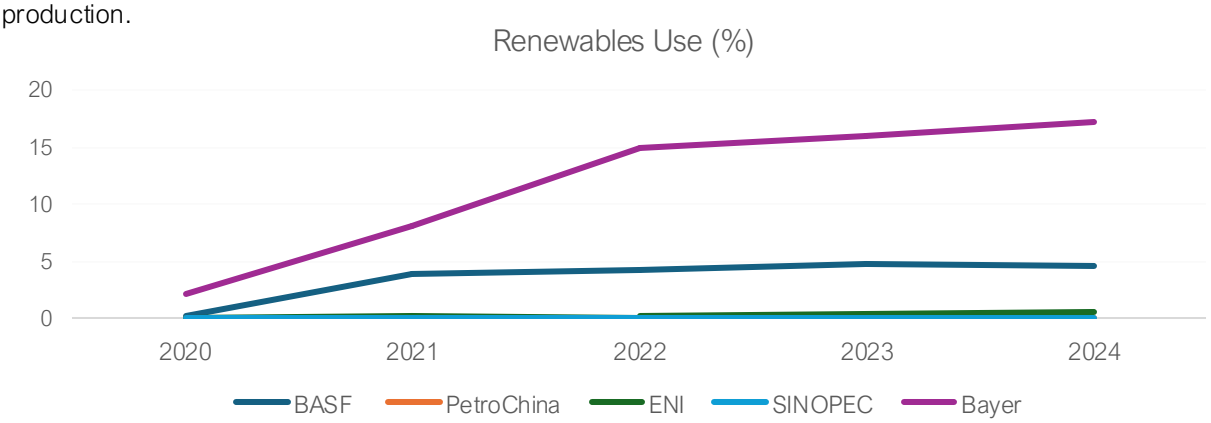
≈ 6-8% of total energy use. Hydropower, wind, solar & bioenergy
Help reduce indirect (Scope 2) emissions as the grid decarbonizes.

Nuclear Power

≈ of total energy use. Contributes low-emission baseload power, lowering the carbon intensity of purchased electricity for chemical producers.

Transition to Renewables

To address the high levels of energy consumed, companies in the sector have been engaging in short- and long-term goals such as 100% renewable energy use and net-zero GHG emissions by 2040 or 2050. Moreover, initiatives such as the *GENESIS* program in Europe develop more energy-efficient semiconductor manufacturing processes and accelerate the industry's transition toward greener production.

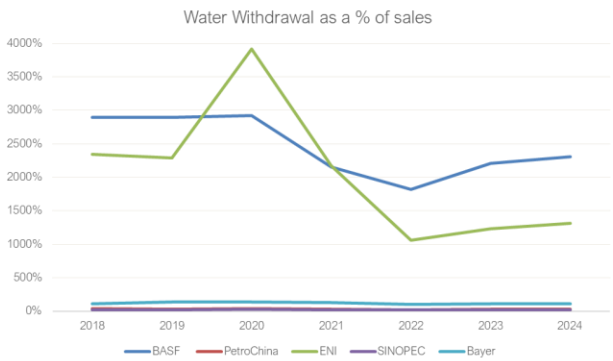


Graph 4; Source: Own analysis and Bloomberg

The calculated renewable energy share of these five players demonstrated an overall increase and a clear upward trend in renewable adoption for most of the evaluated firms from 2018 to 2024, indicating progress toward climate goals.

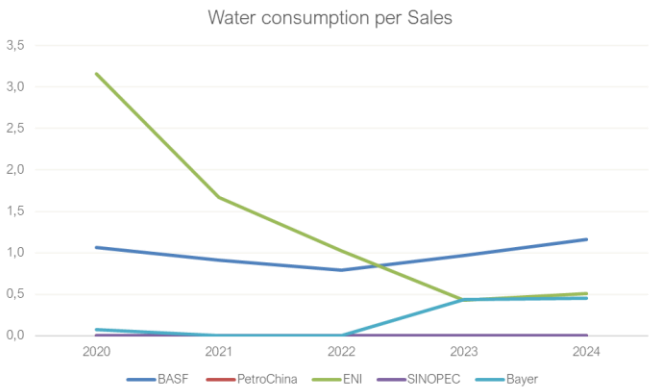
Water consumption

Companies within the chemical industry rely significantly on water for manufacturing purposes, like distillation, refining, and product rinsing, as well as for cooling mechanisms. This water contains many substances that can be hazardous to both the environment and the population, which can sometimes be highly resilient to water treatment procedures, like pesticides and PFAS ("forever chemicals"- class of synthetic substances that do not break down). The introduction of machine learning is a huge step in the treatment of these waters; it has contributed to the detection and classification of these persistent chemicals.
In order to minimize water consumption, companies aim to focus on the high efficiency of their cooling tower systems, using machine learning to allow the cooling process to be done with less water. Other than that, by investing in more closed-loop manufacturing systems, which is a trend in the industry, water can be reused for different purposes (Nexocode, 2023).



Graph 5; Source: Own analysis and Bloomberg.

Regarding the companies selected, it should be noted that PetroChina and SINOPEC do not provide comprehensive data on their water consumption. Looking at water withdrawal figures, BASF and ENI show significantly higher water usage relative to sales compared to SINOPEC, Bayer, and PetroChina. Notably, in 2020, ENI's water withdrawal reached 3915% of its sales; however, ENI's presence in the energy sector heavily influences these figures compared to the other companies. While most of these firms have shown a clear trend of reducing water usage per sales volume over the past four years, BASF remains an exception.



Graph 6; Source: Own analysis and Bloomberg.

In terms of water management implementation, BASF has set goals for 2030 to introduce sustainable water management across all its Verbund sites and production facilities in water-stressed areas, which account for approximately 90% of their total water abstraction. The company also monitors water usage throughout its entire value chain. To maintain water protection, BASF performs effective due diligence in its upstream value chain to identify mandatory standards, while downstream, it collaborates with customers on R&D for water-related solutions to support the green transformation. As of 2024, 83% of the water used in their cooling processes, which represents 88% of their total abstraction, was recycled (BASF SE, 2025).

PetroChina's goals in this area focus on improving water-use efficiency and sustainable use across its operations, including refining, petrochemicals, and chemical production. The company has set clear targets to reduce freshwater consumption per unit of output while following similar ideas to BASF, such as increasing recycling rates and moving toward a more circular economy (PetroChina Company Limited, 2025.)

At **SINOPEC**, the target of over 60% wastewater reuse is a key part of the company's medium-term sustainability plan through 2028. They aim to reduce total industrial freshwater withdrawal by at least 1% annually and have already established water conservation planning. Similar to other industry leaders, they are adopting smart resource monitoring, using AI to more efficiently optimize water management (SINOPEC, 2025).

Bayer is committed to better water management, with a target to ensure all relevant production sites in water-scarce areas have robust systems in place by 2030. This involves assessing risks and implementing mitigation strategies. Additionally, by 2030, Bayer aims to reduce water withdrawals by focusing on closed-loop cooling circuits and efficiency. They are also factoring supplier performance into their strategy, increasingly including sustainability and water criteria in their evaluations (Bayer, n.d.).

ENI's goals also focus on responsible and efficient water use, including the protection of water resources and a reduction in freshwater withdrawals. Like PetroChina, they are reducing dependency on freshwater by seeking secondary sources such as treated wastewater, rainwater, and desalinated water. They have set targets to reduce impact at 30% of their high-withdrawal sites in water-stressed areas by 2035, and all operated sites by 2050, aligning with the Net Positive Water Impact framework. ENI is prioritizing water circularity and expanding treatment solutions, such as their "Blue Water" technology, which treats and reuses production water from oil and gas extraction rather than disposing of it. In 2024, their reinjection of produced water rose to 42% from the previous year (Eni S.p.A., 2025).

Waste Management

The chemical industry, by its nature, involves a high volume of processes that result in the production of diverse types of waste. This waste is generally categorized into three main types: solid, liquid, or gaseous. Each type presents different challenges and requires specific management to mitigate environmental impacts.

Firstly, **solid waste** includes materials like spent catalysts, packaging, sludge, and chemical containers. These are often hazardous, containing substances that may be toxic, flammable, or reactive. Even non-hazardous waste requires proper segregation and disposal to avoid negative environmental effects.

Secondly, **liquid waste** is a byproduct of chemical reactions, cleaning operations, and general manufacturing. Effective management involves neutralizing these liquids, treating them, or recycling them depending on the specific contaminants involved. If not handled correctly, these liquids pose a significant risk of water pollution.

Finally, **gaseous waste** consists of emissions from combustion, chemical reactions, and other industrial activities. These emissions include volatile organic compounds (VOCs), sulfur dioxide, nitrogen oxides, and carbon monoxide. Much like solid waste, these can be hazardous, contributing to air pollution and adverse health effects. To prevent them from entering the atmosphere, techniques such as scrubbing, filtering, and emission control technologies are used to minimize their spread.

Furthermore, **product circularity** is becoming increasingly important in the industry through the recovery and reuse of acids, solvents, and bases via closed-loop processing systems (van der Linde, 2025). By adopting **strict measurement controls** during production or using **alternative raw materials**, companies are investing in the better management of hazardous waste (DiverseDaily, n.d.).

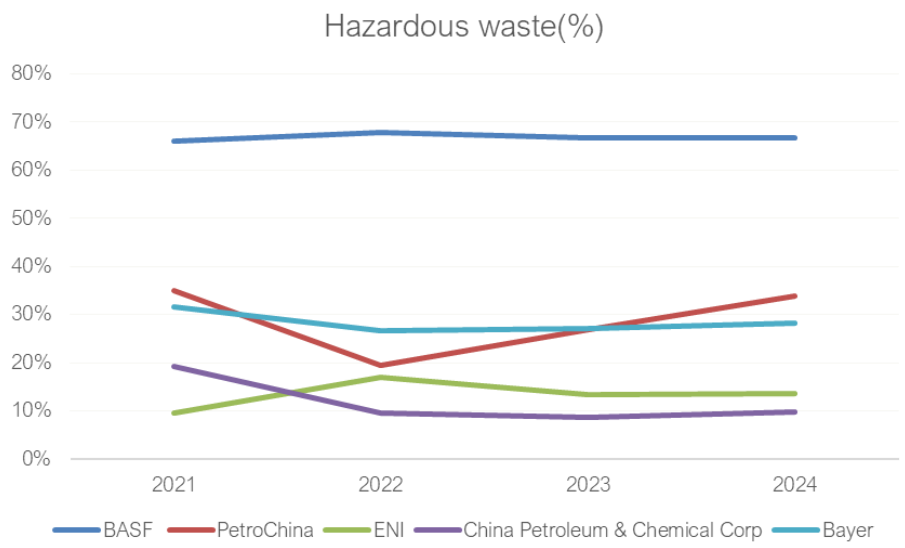
In **BASF**, in this topic their main focus is the minimization waste generation at source through more efficient products, closing loops in the production Verbund for example. Furthermore, they take more in account the increase of use of recycled and renewable raw materials in production, while also using technologies to recover valuable materials, creating circular value chains.

For **PetroChina** also follow steps like BASF, with waste minimization while emphasizing reuse and recycling through production and distribution, using waste reduction technologies to take care mostly of the solid waste management. While focusing on treatment technologies, either physical, chemical and biological ones, to treat waste streams for a safe environmental discharge and enable the reuse of the waste. With recycling technologies including pyrolysis extraction, and regeneration to recycle solid wastes and recover useful materials from by-products. Furthermore, by including technologies that can detect leakages and system optimization, while taking into account pollution prevention measures, such that surface water contamination does not happen. (PetroChina Company Limited, 2025)

In **SINOPEC**, has settled goals in order to be 100% compliant disposal of hazardous waste, and targeting a high utilization rate for industrial solid waste, >92% , by effectively using waste tracking following strict compliance measures, that ensure hazardous and general industrial waste are tracked . Focusing also on recovery and recycling, also implementing advanced treatment technologies, hazard free recycling facilities, and fostering a circular economy integration. (SINOPEC, 2025).«

Bayer tries to minimize material consumption and though integrated waste management practices, decrease the waste disposal, fostering recycling, promoting safe and environmental sound according to their imposed good practices. With each site maintaining a waste register, and also focusing on waste separation at source, with safe disposal channels and recycling processes, including a circular mindset. (Bayer, n.d.)

ENI, again focus also on circularity and recovery of waste, through the Eni Rewinds that manages and plans and executes waste treatment and safe disposal, with 2024 measures, around 76% of recoverable waste was sent for recovery. Investing in chemical recycling, through Versalis “Hoop” technology to convert mixed plastics waste into high-quality feedstock for new products, supporting feedstock demand in its chemical operations. (Eni S.p.A., 2025)



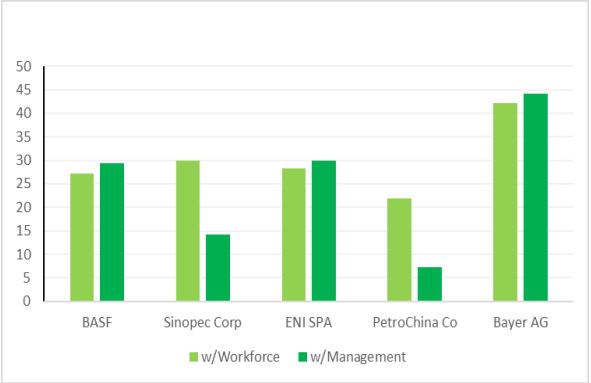
Graph 7; Source: Own analysis and Bloomberg.

Social

The chemical industry's social sustainability footprint is highly significant, given its large global workforce and the inherent risks and responsibilities tied to its operations. Social factors in this sector encompass workforce safety, fair labour practices, diversity and inclusion, and ethical supply chains. This industry employs millions worldwide, from Germany's **BASF** (~112,000 employees) to India's **Reliance Industries** (~347,000), making worker welfare a central concern. The handling of **hazardous chemicals** and **heavy machinery** means occupational health and safety is paramount, as even a single lapse can endanger workers and surrounding communities. Moreover, like many STEM-based fields, the chemical sector has struggled with talent pipeline and diversity issues, an aging workforce in Western countries and underrepresentation of women in technical roles. At the same time, chemical companies' source raw materials and contract manufacturing from around the world, creating complex global supply chains. Ensuring humane working conditions and respect for human rights at every supplier and site has thus become a critical expectation from regulators, investors, and civil society. In summary, ESG's Social dimension for chemical firms spans the well-being and development of employees, the fairness and safety of operations, and the sector's broader impact on communities and supply-chain workers.

Workforce demographics and Diversity Trends

The sector faces a dual challenge: an aging workforce in developed markets and a shortage of new technical talent. In the U.S., nearly 25% of chemical workers will reach retirement age within five years, prompting companies to invest in upskilling and talent retention. In emerging markets like India, Reliance has recruited over 171,000 employees in a single year, with more than half under age 30.



Graph 8; Source: Bloomberg

Diversity remains a work in progress. Women comprise about 27% of BASF's global workforce and only 21% at Reliance. ENI reports 28.3% women overall but only 18.7% in management. In contrast, Bayer achieved 43.6% female leadership, driven by internal D&I targets. Initiatives such as unconscious bias training, employee resource groups, and STEM outreach are helping improve representation across gender, ethnicity, and ability. Still, cultural inclusion in frontline operations remains an industry-wide challenge.

Health and Safety Performance

Workplace Hazards and Safety Culture: The chemical industry's operations involve handling dangerous substances and complex processes, so **protecting worker health and safety is a foundational priority**. In large chemical plants and refineries, employees and contractors routinely face hazards such as exposure to toxic chemicals, extreme heat or pressure, heavy equipment, and the risk of fires or explosions. Past industrial disasters [from **Seveso (1976) to Bhopal (1984)**] revealed the catastrophic potential of chemical accidents for both workers and nearby communities, driving major improvements in safety regulation and culture. Today, strict safety protocols govern everything from the use of personal protective equipment to process controls. For example, the **EU's Seveso III Directive (2012/18/EU)** was enacted explicitly to prevent major chemical accidents and limit their impacts on human health and the environment.

This directive (and corresponding **COMAH regulations** in the U.K.) imposes rigorous requirements on facilities handling large volumes of dangerous substances – including emergency response plans, regular safety audits, and community notification systems. As a result, the frequency of major accidents in Europe has declined to under 22 per year across ~11,000 high-risk installations, with generally lower severity of incidents. Similarly, in the United States, OSHA and EPA regulations (e.g. the Process Safety Management standard and Risk Management Plan rule) enforce comprehensive safeguards. **Global chemical firms often apply uniform safety standards** that meet or exceed these regulations wherever they operate, seeking to cultivate an ingrained safety culture. Industry initiatives like **Responsible Care,** as previously mentioned also commit companies to continual improvement in safety metrics.

Safety Performance and Initiatives: In recent years, leading chemical companies have reported steady improvements in key safety indicators, reflecting their investment in training, technology, and risk management. Many firms now achieve **zero fatalities among direct employees in a given year and** treat any serious injury as unacceptable. For instance, BASF recorded **no employee fatalities from work-related injuries or ill health in 2024**. (However, two contractor deaths occurred in separate incidents that year, prompting renewed emphasis on contractor safety management.) **Injury frequency rates** have likewise declined or remained low. BASF's total recordable work-related injury rate stands around 3.78 per million working hours, and the company has set ambitious targets to further reduce the most serious incidents. Specifically, BASF aims to cut its High-Severity Injury rate to **no more than 0.05 per 200,000 hours by 2030**, a goal that aligns with best-in-class performance. In 2023, it had already achieved a low rate of **0.02 high-severity injuries per 200,000 hours globally**, demonstrating the feasibility of near-zero outcomes. Other players report similar progress: Bayer and Dow have publicly reported declining Lost-Time Injury rates and frequent safety drills, while PetroChina and Reliance emphasize a "zero accident" vision in line with national safety campaigns. The **continuous improvement** approach means not just tracking metrics but also identifying root causes and preventative measures for every incident or near-miss.

Chemical companies place strong emphasis on **worker training and process safety**, ensuring employees are prepared to handle hazardous materials and complex equipment. Reliance, for example, trained over **97%** of its permanent workforce in safety and skills development. New regulations, such as India's **OSHWC Code (2020),**further strengthen safety standards by requiring certified training, safety committees, accident reporting, and medical checks for high-risk roles. Similar tightening of safety oversight is occurring in China, where companies are adopting **advanced monitoring technologies** like IoT sensors and AI systems.

Across the industry, the shift is toward a **proactive, prevention-focused safety culture**, encouraging hazard reporting, stop-work authority, and behaviour-based safety programs. Safety metrics are increasingly embedded in management KPIs and compensation, reinforcing safety as a core operational value. By investing in rigorous training and complying with evolving regulations, chemical companies not only protect workers but also reduce operational risks and maintain their **license to operate** with regulators and communities.

Human rights in supply chains

Chemical production depends on global raw materials and feedstocks often sourced from high-risk regions. This exposes companies to potential human rights violations, such as forced or child labour in upstream tiers. In response, countries like Germany have enacted due diligence laws (e.g., LkSG), while the EU's Forced Labour Regulation will soon ban any product linked to forced labour at any point in its supply chain.

To comply, companies are ramping up ESG-based supplier monitoring. Initiatives like "Together for Sustainability" (TfS) enable companies such as BASF and Bayer to audit shared suppliers using standardized ESG criteria. Firms also conduct risk-based mapping and require adherence to human rights codes. Nonetheless, deep-tier visibility remains a challenge, especially for raw materials with opaque sourcing routes.

Community Engagement

Local Communities and Social License:

Chemical facilities significantly shape the social and economic fabric of surrounding communities, providing jobs and tax revenue but also raising concerns such as pollution, noise, and safety risks. As a result, strong community engagement is essential to maintaining a "social license to operate." Leading firms use dedicated community-relations teams and tools like Community Advisory Panels (CAPs), such as those at BASF, to maintain transparent dialogue with residents, share operational updates, and address concerns early. Public consultation is often legally required for major projects, and companies with strong engagement records typically experience smoother permitting processes and better community trust.

Community Development and Outreach:

Beyond communication, chemical companies invest heavily in social programs that address local needs. BASF's long-term initiatives, like "Kids' Lab" and TECH Academy, promote STEM learning and career readiness, while firms also support schools, health programs, and vocational training to strengthen local talent. In developing regions, companies like Reliance play a major development role, with CSR efforts reaching over 50,000 villages across India. These initiatives both improve community well-being and reinforce a positive, mutually beneficial relationship between companies and society.

Environmental Stewardship and Broader Impact:

Environmental responsibility is increasingly tied to community expectations. Many firms engage in local environmental projects and publish accessible emissions and emergency-response information to build transparency and trust. Frameworks like Responsible Care formalize these commitments, while ESG investors increasingly factor community relations into assessments. Companies also mobilize employee volunteers for initiatives such as emergency responder training and science mentoring. Together, these efforts help companies act as responsible neighbours, address social concerns, and strengthen long-term community support for their operations.

Governance

In the context of the chemicals industry, due to its high complexity and being high-hazard linked, governance is about who decides what, how risks are identified and controlled, especially those related to process safety and environmental impacts, how laws and standards are complied with, and how performance is monitored and reported.

Furthermore, the governance structure centred on the Board of Directors, plays a crucial role in preventing catastrophic accidents. Primarily as the Board is responsible for fostering a strong corporate culture and providing visible leadership to reduce both the frequency and the severity of process safety incidents. It makes the key strategic decisions that influence the safety outcomes and sets the tone, vision and culture for the entire organization. Research done on past accidents repeatedly highlight inadequate leadership and weak organizational culture as recurring factors, often connected to failures in recognizing loss of control situations or to a lack of competence at different levels of the organization. Although major accidents are relatively rare, their potential consequences are very severe on the community, environment and reputation of the company. Such that leaders must treat them as a central governance concern.

To work effectively towards this goal, the Board must, among other things, systematically analyse and learn from past incidents, not only within the company but across the wider industry.

- Well-governed assets and processes can deliver significant benefits, including:
- Reduced downtime and higher plant availability
- Maintenance budgets that are more predictable and easier to forecast
- Longer lifespans for plants and equipment
- Improved operational efficiency and flexibility
- Stronger relationships with employees, stakeholders and regulators
- Improved access to capital and insurance on more favourable terms (OECD, 2012)

In the Industry board governance is organized having core committees and high-hazard specific committees' the following table we have a usual representation of the committed in our player comparison.

	eni	PetroChina	BAYER	BASF We create chemistry	SINOPEC
Audit/Control & Risk	✓	✓	✓	✓	✓
Nomination	✓	✓	✓	✓	✓
Remuneration/ Compensation	✓	✓	✓	✓	✓
Strategy/ Investment	Done by full board	✓	Done by full board	✓	✓
ESG/ Sustainability	✓	✓	✓	Part of Supervisory Board and Audit committee	✓
Health, Safety & Environment	Covered by Control & Risk plus management committees	✓	Part of ESG & Audit oversight	Within Audit Committee	Covered by Sustainable Development Committee and board
Legal / Risk-specific	✓	-	✓	Via Audit & Strategy committees	-
Other unique committees	-	-	✓	-	-

Table 1; Source: Own analysis and Bloomberg.

On Table 2 an overview of our player comparison in terms of governance. Highlighting that most boards of the companies have a track field in the company and know the industry very well. Establishing a good governance structure.

	eni	PetroChina	BAYER	BASF We create chemistry	SINOPEC
Nº in BoD	9	12	6	8	12
ESG linked compensation	✓	✓	✓	✓	✓
Average Age	61.1	58.8	57.5	57.1	59.1
Female Presence	44.4%	8.3%	16.7%	25%	8.3%
Average tenure (y)	3.0%	2.9	5.2	5.3	2.2
% of independence of BoD	77.8%	41.7%	45%	50%	33.3%

Table 2; Source: BoD overview.

ESG-related compensation

The integration of Environmental, Social, and Governance (ESG) performance targets into executive compensation schemes has become a cornerstone of modern corporate governance in the chemicals industry, directly linking management's financial incentives to long-term sustainability strategy. This practice is widespread, with most major global firms adopting ESG metrics into either **Short-Term Incentives (STI) or Long-Term Incentives (LTI)**.

Examples of STIs and LTIs of the analysed players:

1. **STIs**: Bayer has a one-year cash bonus linked to group sales growth, core EPS, FCF and individual strategy factor. PetroChina other than the basic annual salary has a variable short-term bonus related to performance dependent on profitability indicators. Eni Spa KPI's for the CEO. Eni Spa, links its annual cash incentive STI, mainly driven by metrics like, EBT, leverage, GHG emissions and safety. BASF SE based on financial and non-financial targets for the group. Nonfinancial including employee engagement and satisfaction, occupational and process safety, strategic projects and a sustainability share.
2. **LTIs**: BAYER four-year performance share plan tied mainly to relative total shareholder return and sustainability with a 250% cap and strict share-ownership rules. PetroChina capped at no more than 30% of the leader's total salary over the multi year period, linked to also key profitability ratios. Eni Spa splits between market objectives, financial and balance sheet objectives and environmental & energy transition objectives with a high potential multiple of fixed salary for the CEO. BASF SE with a 4-year performance period related to growth, with ROCE premium on cost of capital, profitability and sustainability

Players Comparison

ESG Scores

	Range	BASF	PetroChina	ENI	SINOPEC	BAYER
Morningstar	0 - 100 (lower = lower risk)	43	51,45	24,91	54,16	20,23
MSCI ESG Ratings	AAA (leader) - CCC (laggard)	BBB	BBB	A	A	AA
S&P Global CSA	0 - 100	28	53	40	40	37
Bloomberg ESG Score	0 - 10	4,83	4,39	7,09	4,79	5,77

Table 3: ESG Ratings.

Morningstar: Provides ESG risk ratings that measure a company's exposure to industry-specific ESG risks and how well they are managed.

MSCI ESG Ratings: Evaluates companies' ESG performance relative to its peers.

S&P Global CSA (Corporate Sustainability Assessment): Assesses companies' ESG practices through detailed questionnaires, used to determine inclusion in the Dow Jones Sustainability Index.

Bloomberg ESG Score: Offers ESG scores based on publicly available data.

Outlook

For the chemicals industry, to reach the goals of net zero in the next 30 years, there is a lot of innovation that is needed across all-value chain segments. Companies must follow strict defined paths in reducing their own emissions by investing in innovation, developing new processes that allows this adaptation. While within the scope 2 they will need to leverage more sustainable energy sources, and most importantly scope 3, that must be reduced by fostering strong and reliant relationship by sourcing more sustainable raw materials by considering this upstream value chain segments.

Furthermore, this overall development will need large sums of investments, for this ESG- driven innovation which has to be aligned with the brands identity, by setting specific teams to build disruptive technologies such that they are able to meet consumers needs. While sourcing investment within the public sector and private sector that are willing to promote this ESG innovation, through Joint Ventures, Venture Capital. (Strategy&, no date) With non-compliance might causing market access restrictions, while alignment many times causing increase in investor demand.

The future of waste management in the industry is highly aligned with the improvement of technological innovations that continue to re shape the chemical manufacturing. With the expectancy of the introduction of AI progressively, real-time monitoring, and predictive analytics will further enhance waste reduction strategies. Future development could include and enhanced data sharing protocols across production sites that allows for thee increased in transparency , and also it could be expected a greater integration of blockchain technology to secure and verify data. Which aligns with the overall trend that companies are trying to follow in the overall market. (DataCalculus, no date)

Market Trends

Sustainability has become a defining theme in the chemical industry, has mentioned before, with key trends within the ESG, like the following:

- Innovation beyond regulatory requirements: by following the ESG standards lines companies gain an advantage through this early preparation but having in mind that innovation with the introduction of AI and machine learning is the key for efficiency to be improved in the industry. (Strategy& no date) Implementing digital tools to track the sustainable product credentials (Yankovitz et al., 2024)
- Aligning ESG-driven innovation with identity of the business: by following defining goals that deliver a definition of a clearer path taking into consideration the innovation operating model and KPI's.
- Built an ecosystem of innovation alongside external partners: by sharing risks, instead of carrying only in-house R&D, through this global voluntary programs, like Responsible Care, fosters investment, as it requires large financing, however returns being very uncertain and might only be seen in the future.
- Adjustments in the hybrid corporate-business unit operating models for this wave of innovation: companies need to think long-term, with a need of investment in research that is crucial for the achievement of long-term goals, with incremental innovation that suits customers needs, while having teams engaging in more research into disruptive technologies.
- Leveraging external funding opportunities for innovation: full ESG compliance in all dimensions will need large investments so leveraging governmental support to see this development will be imperative in this industry reducing the company's risk.
- Adoption of innovation impact metrics: a new set of metrics is needed to determine the real evolution and adaptation of this sector (Strategy& no date).
- Substitution of hazardous substances with safer or bio-based alternatives (van der Linde, 2025)

Although sustainability measures will vary by region, influenced by local regulations, incentives and market needs. (Deloitte, 2026)

Roadmap & Recommendations

Companies in the following years need to :

Focus on the core: by fostering sustainability in-house, by focusing on the root of the problem, for example in investment of closed production processes such that, gaseous waste can be reused. (DiverseDaily, n.d.)

Presence of AI, Business Intelligence and Data Analytics such that it enables the companies to monitor process variations in real-time. Which allows for early detection of anomalies and timely interventions to mitigate waste production and water management. (DataCalculus, no date)

Acquire capabilities: will also be important is to foster acquisition of Intellectual property for them to improve sustainable offerings while strengthening market position.

Create ecosystems: foster the engagement with the supply chain which can strengthen the company's market position while also giving the company higher control with the production inputs to ensure sustainability in the value chain.

Design the operating model: all the structures of the company must be aligned towards the same goals to successfully make this transition. (Ernst & Young (EY), 2024)

Conclusion

In conclusion, the chemicals industry remains essential to the global economy, supplying critical inputs to agriculture, construction, healthcare, manufacturing and consumer goods. At the same time, it faces increasing ESG scrutiny because production is energy-intensive and closely linked to emissions, resource use and pollution risks, which makes sustainability performance a core factor for long-term competitiveness.

Environmental priorities are therefore centered on decarbonization, energy efficiency and circularity, particularly the shift toward recycling, renewable/recycled feedstocks and lower-impact product design. Social priorities focus on health and safety, given the sector's operational risk profile, alongside responsible supply-chain practices and transparent engagement with workers and local communities.
Governance and compliance pressures are also rising across regions. In Europe, frameworks such as REACH/CLP and PFAS restrictions, combined with CSRD/ESRS reporting requirements, are increasing transparency expectations and accelerating product substitution and portfolio review. In parallel, industry initiatives such as Responsible Care® reinforce common standards for product stewardship, continuous improvement and disclosure.

By our case study, of BAYER, BASF SE, SINOPEC, PetroChina and Eni Spa, it is grasped the sense of movement towards this goals, with increase in measures to foster, circularity either in waste management or in water management. Companies should continue to focus on this development, considering the cooperation for the research and development process, as it is going to be vital in the next few years for leaders to continue leaser. While also fostering, ties with public governments to support the risk sharing.

Ultimately, ESG is no longer an add-on for chemical companies: it directly influences market access, investment decisions and reputation. Companies that integrate ESG into strategy and operations, while demonstrating credible progress through measurable targets and clear reporting, are better positioned to manage risk and capture growth opportunities in transition-enabling chemical solutions.

Webgraphy

- Allianz Trade (2025) Chemicals (Sector Report) [Online]. Available at: https://www.allianz-trade.com/en_global/economic-research/sector-reports/chemicals.html (Accessed: 27 December 2025)
- American Chemistry Council (ACC) (n.d.) Energy & Greenhouse Gas Emissions [Online]. Available at: https://www.americanchemistry.com/chemistry-in-america/data-industry-statistics/economic-elements-of-chemistry/energy-greenhouse-gas-emissions (Accessed: 27 December 2025)
- American Fuel & Petrochemical Manufacturers (AFPM) (2017) *Ethylene: The "World's Most Important Chemical"*. Available at: https://www.afpm.org/newsroom/blog/ethylene-worlds-most-important-chemical (Accessed: 20 January 2026)
- BASF Greater China (2021) Community Advisory Panels (CAPs) [online].
- Available at: https://www.basf.com/cn/en/media/GC-report/GC-report-2021/basf-in-greater-china/employees-and-society/social-engagement(Accessed: 5 January 2026)
- BASF SE (2023) Community Outreach and Engagement [online].
- Available at: https://www.basf.com/us/en/who-we-are/community/community-outreach (Accessed: 5 January 2026)
- BASF SE (2024) Employees – Diversity and Leadership [online].
- Available at: https://www.basf.com/global/en/investors/calendar-and-publications/factbook/basf-group/strategy/employees (Accessed: 5 January 2026)
- BASF SE (2024) Occupational Safety – Facts and Figures [online].
- Available at: https://www.basf.com/nz/en/who-we-are/sustainability/responsibility-for-society-and-nature/efficient-safe-responsible-production/occupational-safety/facts-and-figures (Accessed: 5 January 2026)
- BASF SE (2024) Safety Metrics – Fatalities and Injury Rates [online].
- Available at: https://report.basf.com/2024/en/combined-managements-report/consolidated-sustainability-statement/social/s1-own-workforce/metrics.html (Accessed: 5 January 2026)
- BASF SE (2025) *E3 Water — BASF Group 2024 Sustainability Report: Water*. Available at: https://report.basf.com/2024/en/combined-managements-report/consolidated-sustainability-statement/environment/e3-water.html (Accessed: 20 January 2026)
- Bayer (n.d.) *Waste and packaging*. Available at: https://www.bayer.com/en/sustainability/wasteandpackaging (Accessed: 20 January 2026)
- Bayer (n.d.) *Water stewardship*. Available at: https://www.bayer.com/en/sustainability/water-stewardship (Accessed: 20 January 2026)
- Bayer AG (2023) Annual Report 2023 – Workforce Gender Diversity [online].
- Available at: https://www.bayer.com/sites/default/files/2024-03/bayer-annual-report-2023.pdf (Accessed: 5 January 2026)
- Business Standard (2024) Over half of Reliance employees under 30; women make up 21% of workforce [online].
- Available at: https://www.business-standard.com/companies/news/over-half-of-reliance-employees-under-30-women-make-up-21-of-workforce-124080701002_1.html (Accessed: 2 January 2026)
- Cefic (European Chemical Industry Council) (2025) Corporate Sustainability Reporting Directive (CSRD) handbook for the chemical sector [Online]. Available at: https://cefic.org/app/uploads/2025/03/Corporate-Sustainability-Reporting-Directive-CSRD-handbook-for-the-chemical-sector.pdf (Accessed: 27 December 2025)
- DataCalculus (no date) *Waste reduction and management for chemical engineers*. Available at: https://datacalculus.com/en/blog/wholesale-chemical-and-allied-products/chemical-engineer/waste-reduction-and-management-for-chemical-engineers (Accessed: 21 January 2026)

- Deloitte (2023) 2024 Chemical Industry Outlook [Online]. Available at: https://www.deloitte.com/us/en/insights/industry/chemicals-and-specialty-materials/chemical-industry-outlook/2024.html (Accessed: 27 December 2025)
- Diverse Daily (n.d.) Waste Management in Chemical Engineering: Approaches to Minimizing and Managing Waste in Chemical Processes to Comply with Environmental Regulations [Online]. Available at: https://diversedaily.com/waste-management-in-chemical-engineering-approaches-to-minimizing-and-managing-waste-in-chemical-processes-to-comply-with-environmental-regulations/ (Accessed: 21 January 2026)
- Eni S.p.A. (2024) Diversity & Inclusion – Workforce and Management Composition [online].
- Available at: https://www.eni.com/en-IT/company/diversity-inclusion.html (Accessed: 5 January 2026)
- Eni S.p.A. (2025) *Annual Report 2024*. Available at: https://report.eni.com/annual-report-2024/en/ (Accessed: 20 January 2026)
- Ernst & Young (EY) (2024) *How to be profitable and sustainable in the chemicals industry*. Available at: https://www.ey.com/en_us/insights/strategy/achieving-sustainability-in-the-chemicals-industry (Accessed: 28 January 2026)
- European Chemicals Agency (ECHA) (n.d.) Per- and polyfluoroalkyl chemicals (PFAS) – Hot topics [Online]. Available at: https://echa.europa.eu/hot-topics/perfluoroalkyl-chemicals-pfas (Accessed: 10 January 2026)
- European Commission (n.d.) Industrial Accidents – Seveso III Directive [online].
- Available at: https://environment.ec.europa.eu/topics/industrial-emissions-and-safety/industrial-accidents_en (Accessed: 5 January 2026)
- European Commission (2025) Commission adopts “quick fix” for companies already conducting corporate sustainability reporting [Online]. Available at: https://finance.ec.europa.eu/publications/commission-adopts-quick-fix-companies-already-conducting-corporate-sustainability-reporting_en (Accessed: 10 January 2026)
- European Union (2006) Regulation (EC) No 1907/2006 (REACH) [Online]. Available at: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32006R1907 (Accessed: 10 January 2026)
- European Union (2024) EU Forced Labour Regulation – Summary [online].
- Available at: (official portal URLs vary) (Accessed: 5 January 2026)
- European Union (2025) Commission Regulation (EU) 2025/1988 … as regards PFAS in firefighting foams [Online]. Available at: https://eur-lex.europa.eu/eli/reg/2025/1988/oj/eng (Accessed: 10 January 2026)
- Fagg, L.A. (2025) *Petrochemicals in peril: oversupply crisis and energy transition threaten industry survival*. Wood Mackenzie. Available at: https://www.woodmac.com/news/opinion/petrochemicals-in-peril-oversupply-crisis-and-energy-transition-threaten-industry-survival/ (Accessed: 20 January 2026)
- Germany Trade & Invest (GTAI) (2024) The German Chemical Industry 2024 [Online]. Available at: https://www.gtai.de/resource/blob/1877158/32e5ee2e141d2c63acd05db200bf4b93/2024_10_29_The%20German%20Chemical%20Industry%202024_GTAI_Bug.pdf (Accessed: 27 December 2025)
- Government of India, Department of Chemicals and Petrochemicals (2024) Gazette Notification: Quality Control Orders (H Acid; K Acid; Vinyl Sulphone) [Online]. Available at: https://chemicals.gov.in/sites/default/files/notification/Gazette_Notification%20%281%29.pdf (Accessed: 10 January 2026)
- Government of India, Department of Chemicals and Petrochemicals (2025) Rescind the Fourteen notifications (QCO withdrawal for selected petrochemicals) [Online]. Available at: https://chemicals.gov.in/sites/default/files/notification/Rescind-the-Fourteen-notifications.pdf (Accessed: 10 January 2026)
- Gulf Petrochemicals and Chemicals Association (GPCA) (2022) Facts and Figures 2022 [Online]. Available at: https://www.gpcachem.org/wp-content/uploads/2022/12/Facts-and-Figures-2022.pdf (Accessed: 27 December 2025)

- Gulf Petrochemicals and Chemicals Association (GPCA) (2022) Facts and Figures 2022 [Online]. Available at: https://www.gpcachem.org/wp-content/uploads/2022/12/Facts-and-Figures-2022.pdf (Accessed: 27 December 2025)
- IndustryARC (n.d.) Personal Care and Cleaning Chemicals Market (Report 18836) [Online]. Available at: https://www.industryarc.com/Report/18836/personal-care-and-cleaning-chemicals-market (Accessed: 27 December 2025)
- Intertek Assuris (2024) China New Chemical Substance Registration (China REACH / MEE Order No. 12) – brochure [Online]. Available at: https://www.intertek.com/siteassets/assuris/brochures/china-new-chemical-substance-registration-china---assuris---04.19.24.pdf (Accessed: 10 January 2026)
- International Council of Chemical Associations (ICCA), *n.d. Responsible Care*. Available at: https://icca-chem.org/focus/responsible-care/ (Accessed: 27 January 2026).
- Korea Testing & Research Institute (KTR) (2025) K-REACH update (Ministry of Environment Announcement No. 2025-49) [Online]. Available at: https://reach.ktr.or.kr/en/selectBbsNttView.do?bbsNo=5&integrDeptCode=&key=134&nttNo=3494 (Accessed: 10 January 2026)
- MarketsandMarkets (2025) Chemical Industry Outlook [Online]. Available at: https://www.marketsandmarkets.com/Market-Reports/global-chemical-industry-outlook-89294716.html (Accessed: 27 December 2025)
- MarketSquare Insights (n.d.) Global Chemical Market [Online]. Available at: https://marketsquareinsights.com/global-chemical-market/ (Accessed: 27 December 2025)
- Mayer Brown LLP (2023) The German Supply Chain Due Diligence Act and the Chemical Industry [online].
- Available at: https://www.mayerbrown.com/en/insights/publications/2023/03/the-german-supply-chain-due-diligence-act-and-the-chemical-industry (Accessed: 2 January 2026)
- Ministry of Economy, Trade and Industry (METI) (2025) Cabinet Decision on partial revision of the Order for Enforcement of the Chemical Substances Control Law (CSCL) [Online]. Available at: https://www.meti.go.jp/english/press/2025/1212_001.html (Accessed: 10 January 2026)
- Nexocode, 2023. Waste management in chemical industry: Reduce chemical manufacturing waste with AI. Available at: https://nexocode.com/blog/posts/waste-management-in-chemical-industry-reduce-chemical-manufacturing-waste-with-ai/#chemical-waste-management [Accessed 21 January 2026].
- Office of Environmental Health Hazard Assessment (OEHHA) (n.d.) Proposition 65 [Online]. Available at: https://oehha.ca.gov/proposition-65 (Accessed: 6 February 2026)
- Organisation for Economic Co-operation and Development (OECD) (2012) *Corporate Governance for Process Safety: Guidance for Senior Leaders in High Hazard Industries* [online]. Available at: https://www.oecd.org/en/publications/corporate-governance-for-process-safety_9789264274846-en.html (Accessed: 30 December 2025)
- PetroChina Company Limited (2025) *2024 Environmental, Social and Governance Report*. Available at: https://www.petrochina.com.cn/ptr/gsgg/202503/c7f46bff3c8548ecad122a1626d64831/files/cd0d49615ba241ea81c20860434cee66.pdf (Accessed: 20 January 2026)
- Press Information Bureau (Government of India) (2025) OSHWC Code – Reforms and Provisions [online].
- Available at: https://www.pib.gov.in/PressReleasePage.aspx?PRID=2194640 (Accessed: 5 January 2026)
- Reliance Industries Ltd. (2022) We Care – CSR Initiatives [online].
- Available at: https://www.ril.com/ (Accessed: 5 January 2026)
- Robinson, J. (2025) *Chemicals industry roundup 2025*. *Chemistry World*. Available at: https://www.chemistryworld.com/news/chemicals-industry-roundup-2025/4022541.article (Accessed: 20 January 2026)
- S&P Global (2023) No recovery in sight in 2024 for Europe's crisis-ridden chemical industry [Online]. Available at: https://www.spglobal.com/energy/en/news-research/latest-news/chemicals/122923-no-recovery-in-sight-in-2024-for-europes-crisis-ridden-chemical-industry (Accessed: 27 December 2025)

- Strategy& (no date) *ESG-driven innovation in the chemical industry*. Available at: https://www.strategyand.pwc.com/gx/en/industries/chemicals/esg-innovation-chemicals.html (Accessed: 28 January 2026)
- Together for Sustainability (TfS) (n.d.) Industry Collaboration for ESG Supplier Monitoring [online].
- Available at: https://en.wikipedia.org/wiki/Together_for_Sustainability (Accessed: 5 January 2026)
- Towards Chem and Materials (2025) Chemical Industry Market [Online]. Available at: https://www.towardschemandmaterials.com/insights/chemical-industry-market (Accessed: 27 December 2025)
- U.S. Census Bureau & Deloitte (n.d.) Transformational Changes and Challenges for the Chemical Industry [online]. /(Accessed: 2 February 2026)
- Available at: https://www.netatwork.com/transformational-changes-and-challenges-for-the-chemical-industry-x3-insider/(Accessed: 2 February 2026)
- U.S. Environmental Protection Agency (EPA) (2025) Assessing and Managing Chemicals under TSCA [Online]. Available at: https://www.epa.gov/assessing-and-managing-chemicals-under-tsca (Accessed: 6 February 2026)
- U.S. Securities and Exchange Commission (SEC) (2024) The Enhancement and Standardization of Climate-Related Disclosures for Investors (File No. S7-10-22) [Online]. Available at: https://www.sec.gov/rules-regulations/2024/03/s7-10-22 (Accessed: 6 February 2026)
- U.S. Securities and Exchange Commission (SEC) (2024) SEC Adopts Rules to Enhance and Standardize Climate-Related Disclosures for Investors [Online]. Available at: https://www.sec.gov/newsroom/press-releases/2024-31 (Accessed: 6 February 2026)
- U.S. Securities and Exchange Commission (SEC) (2025) SEC Votes to End Defense of Climate Disclosure Rules [Online]. Available at: https://www.sec.gov/newsroom/press-releases/2025-58 (Accessed: 6 February 2026)
- van der Linde, E., 2025. *ESG trends transforming the chemicals industry*. Nexio Projects, 18 December. Available at: https://nexioprojects.com/esg-trends-transforming-the-chemicals-industry/ [Accessed 29 January 2026]
- **中国石油化工股份有限公司** (2025) *2024**年可持续发展报告**.* ***九方智投*** (9Fzt.com). Available at: https://www.9fzt.com/detail/sh_600028_2_4796059612687.html (Accessed: 20 January 2026)

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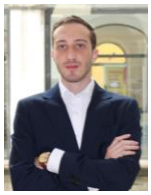
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Mafalda Bento
Co-Head of Equity Research



Lourenço Brilha
Equity Research Analyst



Yuri Andrade
Equity Research Analyst

CONTACT US

You can reach us at **lis@iseg.ulisboa.pt**
Subject line: Sustainability Report - Chemicals Industry
Visit us at: **www.lisiseg.com**

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