EUROPEAN UNION CHEMICAL SECTOR TRANSITION

POLICY BRIEF

Climate Bonds Initiative

Prepared by the Climate Bonds Initiative

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List of Acronyms

BAU Business as usual
CBAM Carbon Border Adjustment Mechanism
CCfDs Carbon Contracts for Difference
CCS Carbon Capture and Storage
CCU Carbon Capture and Utilisation
CCUS Carbon Capture, Usage and Storage
CO_2 Carbon dioxide
CO_2e Carbon dioxide equivalents
ESG Environmental, Social, and Governance
ETS Emissions Trading System
EU European Union
GHG Greenhouse Gas Emissions
GWP Global Warming Potential
IEA International Energy Agency
SBTi Science-Based Targets initiative

Key messages summary

1. Chemicals are needed for more than 95% of the world's manufactured goods, and their environmental impact based on a life-cycle approach is much higher than currently reported.

Chemical manufacturing activities, the sourcing of its raw materials (at present, fossil fuels) and the end-of-life treatment of chemical-based production has a significant environmental impact. For example, chemicals production in Germany, the largest chemical producer in the European Union (EU), accounts for 5% of the country's total emissions. Yet these production-related emissions are only a third of the size of the emissions created by the fossil fuels sourced for production, and the end-of-life treatment of those chemical-based products.[1] The successful transition of the chemicals sector is important not only because of its strong interlinkages with the fossil fuel industry, but also in view of the major role that chemicals play in the transition of other industrial sectors and the economy overall.

2. There is a small window of opportunity until 2030 to equip the European chemicals sector with the required green technologies to deliver net zero by 2050.

Approximately 53% of chemicals primary production capacity in the EU27 will need reinvestment by 2030, requiring over EUR1tn of investment in the transition of the EU chemicals industry by 2050.[2] To achieve this, chemicals capital expenditure must increase by 50% over business-as-usual levels.

Many of the necessary elements for the basic chemicals production transition to net zero are available today or at a very advanced stage of development. The use of public budgets to support the efforts of the chemicals industry can accelerate this transition, while positively impacting the competitiveness of this sector.

3. European chemicals and other hard-to-abate sectors require a strong policy framework to enable key decarbonisation levers.

Most chemical emissions (in the wide range from under 60% to over 80%, depending on the source) are scope 3 greenhouse gas (GHG) emissions linked to end-of-life and to fossil feedstocks used for chemical processes. Lack of progress in abating emissions in recent years underlines the urgency for specific action by chemical companies, policymakers, and investors. As plastics and fertilizers represent the majority of overall chemicals production, attention must be paid to finding alternative feedstocks to virgin fossil fuels. This relies on significantly improving circularity, materially increasing the recycling of products at end-of-life, policies to curb demand (especially through reduction and reuse practices), and scaling green chemicals production. Table 1 below provides an overview of the main regulatory initiatives at EU level to decarbonise the EU chemicals sector.

Table 1: Supportive policy framework in the EU for the decarbonisation of the chemicals sector

EU Taxonomy Regulation

CSDDD (Corporate Sustainability Due Diligence Directive)

RED (Renewable Energy Directive)

IED (Industrial Emissions Directive)

CBAM (Carbon Border Adjustment Mechanism)

EU ETS (EU Emissions Trading Scheme)

EU Waste Shipment Regulation

PPWD (Packaging and Packaging Waste Directive)

REACH Regulation (Registration, Evaluation, Authorisation and Restriction of Chemicals)

CSRD (Corporate Sustainability Reporting Directive)

SFDR (Sustainable Finance Disclosure Regulation)

TEN-E Regulation (Trans-European Networks for Energy)

ESPR (Ecodesign for Sustainable Products Regulation)

Introduction

Chemicals are categorised as either: basic chemicals, specialty chemicals or consumer chemicals. Basic chemicals are produced in large volumes and sold to other industries to make a wide variety of industrial and consumer goods, particularly plastics and fertilizers which have large demand at global scale. Thus, chemicals are a key sector of the European economy, and form part of most manufactured goods including pharmaceuticals, electronics, batteries for electric vehicles, and construction materials.

Globally, chemicals production is expected to increase to EUR6.6tn by 2030 (from EUR3.47tn in 2017) and could quadruple by 2050.[3] The EU is a major chemicals producer, second only to China, with 15.6% of global production in 2017, although this is forecast to decline to 10.7% by 2030.[4] The increase in global production presents a challenge when emissions need to decrease to meet the goals of the Paris Agreement.

Between them, the chemicals, cement, and steel sectors account for 70% of industrial CO_2 emissions globally.[5] Although chemicals ranks third after steel and cement in terms of total emissions, it is the largest industrial energy consumer.[6] Basic chemicals are the major focus for decarbonisation as they account for around 60% of energy consumption and 75% of the chemicals industry scope 1 and 2 GHG emissions.[7,8]

Addressing scope 3 emissions presents a further challenge given that most chemical emissions (in the wide range from under 60% to over 80%, depending on the source) are scope 3 GHG emissions linked to end-of-life and to fossil feedstocks used for chemical processes. Chemicals and petrochemicals account for 40% of the EU's industrial fossil gas demand.[9,10]

Therefore, the EU has declared the transition of the chemicals sector essential to achieving carbon neutrality by 2050. Decarbonising a hard-to-abate sector like chemicals production is challenging given the complex technological, economic, and political barriers to reducing emissions. This is further complicated by the absence of guidance and transition pathways for the chemicals industry until very recently, which has hindered the efforts of industry, investors, and policymakers to decarbonise production.

A policy framework for chemicals is therefore critical to facilitate a delivery of the rapid reduction in fossil gas planned by the EU following the May 2022 REPowerEU announcements, which plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition. The policy recommendations in this report can help mobilise the private capital required to fast-track the transition of hard-to-abate industries that will enable a credible transition of the EU chemicals sector.

In January 2023, the European Commission published its transition pathway for the European chemicals industry.[11] With crucial investment decisions needed in the form of strategic long-term capex within the next five years given the expiry of of a significant proportion of European chemicals industry assets by 2030 or earlier, the sector is at a critical juncture. This policy brief provides specific guidance and follows the recent publication of the Climate Bonds Basic Chemicals Criteria. This policy brief will focus on the policy tools at EU level that can drive the decarbonisation of the chemicals sector in line with a 1.5°C transition pathway, which examine both the financing of the chemicals sector transition as a whole as well as the financing of low-carbon chemicals production. It will use the case of basic chemicals decarbonisation, due to its sizeable importance, following the Climate Bonds Basic Chemicals Criteria. Recommendations are based on a review of EU policies, position papers and reports from industry, NGOs, management consultancy companies and international organisations, including other pertinent sources such as the chemical industry pathway developed in the One Earth Climate Model, the Center for Global Commons, and Systemiq.

Noteworthy sources include the European Commission, Agora Industry, the European Chemical Industry Council (Cefic), Plastics Europe, Fertilizers Europe, the International Renewable Energy Agency (IRENA), the Science Based Targets initiative (SBTi), McKinsey, the International Energy Agency (IEA), the Organisation for Economic Co-Operation and Development (OECD), ShareAction, and the United Nations Principles for Responsible Investing (UNPRI) among others.

Climate Bonds Initiative and the net-zero transition

Climate Bonds has embarked on an ambitious transition programme to provide the industrial pathways, sustainable finance standards, policies, and investment guidance required to deliver credible transition in the hard-to-abate sectors.

The Climate Bonds Standard and Certification Scheme is an easy-to-use screening tool that provides a clear signal to investors and intermediaries on the climate integrity of Certified Climate Bonds. A key part of the Standard is a suite of sector-specific eligibility Criteria. Each sector-specific Criteria sets climate change benchmarks for that sector that are used to screen debt instruments, assets and/or entities, so that only those that have climate integrity, either through their contribution to climate mitigation, and/or to adaptation and resilience to climate change, will be certified.

The Basic Chemicals Criteria lay out the requirements that basic chemicals production assets and projects must meet to be eligible for inclusion in a Certified Climate Bond and for companies on a credible transition path to issue transition labelled debt.[12] The Criteria contain Mitigation Requirements, Adaptation & Resilience Requirements and Transition Requirements.

The second key part of the Climate Bonds Standard (CBS) is the overarching Climate Bonds Standard V4.0 which describes the cross-sectoral criteria all certified instruments/ assets/ entities must meet, in addition to meeting the sector specific Criteria. In April 2023, Climate Bonds expanded its Standards and Certification Scheme to the certification of non-financial corporates, assets, and sustainability-linked instruments.

The financial markets must implement the results of this work to support the decarbonisation of the chemicals sector. Financial instruments (bonds and loans) linked to these eligible assets, activities, and entities will be aligned with the Paris Agreement and the goal of keeping global temperature rises to no more than 1.5°C above pre-industrial levels.

2. Decarbonisation levers for the chemicals sector

As mentioned, the chemicals sector ranks third, after cement and steel, in terms of global industrial CO_2 emissions but is the largest industrial energy consumer.[13] Primary sources of emissions are direct energy use for heat and power, feedstock use for products, and electricity use. Chemicals manufacturing is, at present, reliant on fossil fuels for heat and power source, feedstock, and electricity.

The January 2023 EU Transition Pathway was published **without any sector-specific decarbonisation targets for EU chemicals.**[14] However, the French Agency for Ecological Transition (ADEME) published a Sector Decarbonisation Roadmap for chemicals in March 2021 with an emissions reduction target of 26% by 2030 and 81% by 2050 (compared to 2015) and transition plans for ethylene, chlorine, and ammonia production.[15] At a more granular level, however, the EU Taxonomy does provide carbon intensity thresholds that define low-carbon chemicals, which are intended to decrease over time in line with decarbonisation pathways.[16] To achieve this, a range of decarbonisation levers are required including energy efficiency, resource efficiency, electrification, use of alternative feedstocks and increased use of carbon capture, usage and storage (CCUS).

Summary table: Technical levers for the transition of the chemicals sector

Energy Efficiency

Resource efficiency

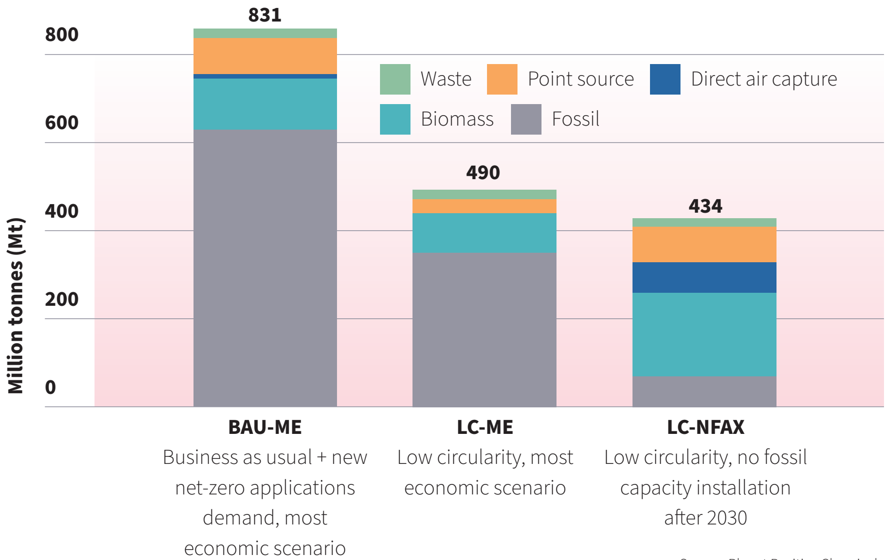
Alternative feedstocks: Use of biomass as feedstock for organic chemicals production and low-carbon hydrogen as feedstock

Circularity

Electrification: Low-carbon electricity from renewable origin to phase out fossil fuel use as energy carrier.

CCUS: Carbon capture and usage (CCU) as substitute for virgin carbon feedstock of fossil origin

Figure 1. Scenarios for diversification of carbon feedstock sources by 2050[26]



Source: Planet Positive Chemicals

Energy efficiency and resource efficiency

Maximising energy efficiency in chemicals manufacturing can achieve emissions reductions quickly. Given the recent rise in energy prices, most energy efficiency measures have already been exploited with further gains likely to be limited in comparison to other levers available.

Resource efficiency, however, is a decarbonsation lever that requires investment. In February 2022, Systemiq and the University of Tokyo unveiled seven alternative pathways for the four main chemical groups. These pathways rely on implementing resource efficiency and circularity to reduce global chemicals demand by 23-33% as compared to a business-as-usual scenario of 1692 Mt (excluding methanol demand for methanol-to-olefins/propylene/aromatics) from 693 Mt in 2020.[17]

Alternative feedstocks and circularity

Scope 3 emissions for the chemicals sector amount to approximately 64% of total emissions with some estimates even higher.[18] The Science-Based Targets initiative (SBTi) requires the inclusion of science-based targets for scope 3 emissions if these are greater than 40% of total emissions. Hence, any transition pathway or decarbonisation objective for the chemicals sector or a chemical company must include scope 3 emissions. The majority of scope 3 emissions come from the release of GHGs stored within the chemical product until disposal, either through incineration or landfill, at which point GHG and other emissions are released into the atmosphere. For some products, this may occur soon after production (e.g., single use plastics that are incinerated) while for other more durable products, the GHGs may be emitted years later.

Addressing scope 3 emissions requires a shift from virgin fossil feedstock to alternative carbon sources and the use of captured CO_2 as a feedstock involving point source capture (PSC) of CO_2 that would otherwise have been released into the atmosphere. Biomass grown for the purpose of chemicals manufacture also avoids the extraction of fossil carbon from the ground. Figure 1 demonstrates the importance of point-source and biomass by 2050 as a substitute for virgin fossil feedstock in chemicals manufacture under business-as-usual (continued reliance on fossil fuels), and two alternative scenarios taking different assumptions on circularity and demand reduction.

Production of ammonia, which is the main component of fertilizers, can substitute green hydrogen for fossil feedstock without need of a carbon component. Moreover, circularity reduces the amount of virgin feedstock required and can be achieved through chemical recycling processes such as pyrolysis, gasification or incineration combined with carbon capture and usage (CCU) of emissions.

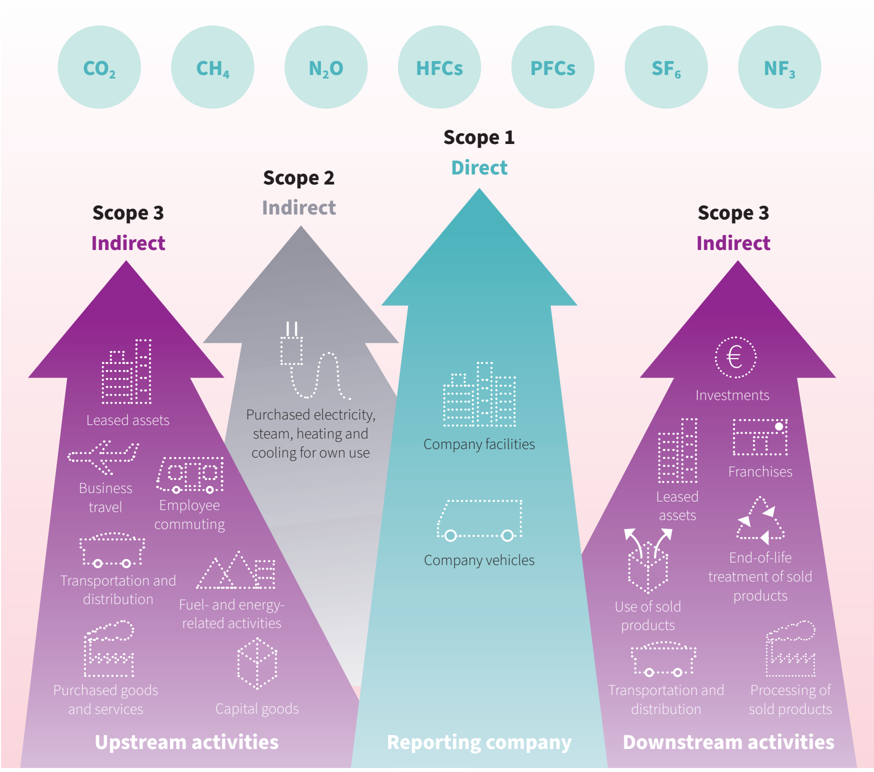
End-of-life solutions also have a significant impact on reducing scope 3 emissions, especially for certain chemical products such as olefins and aromatics production (used to manufacture plastics) which generate 35% of total scope 3 emissions for the chemicals sector. Currently, end-of-life of treatment methods rely on landfill disposal and unabated incineration.

Yet the chemicals industry has done very little, so far, to address scope 3 emissions, partly due to limited availability of upstream and downstream emissions data. SBTi reports that only 25% of chemical companies have information on their product end-of-life emissions and advises companies to make the best of imperfect data by using assumptions to calculate scope 3 emissions. For example, a split of 80% to 20% in end-of-life treatment through landfill disposal and incineration respectively.[19] While companies in other economic sectors are making progress, chemical companies lag in the inclusion of scope 3 targets when issuing sustainability-linked bonds (SLBs) and their sustainable finance frameworks.

Electrification

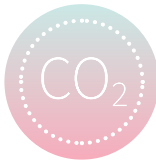
Chemical manufacturing processes are predominantly powered by fossil energy. While electrification remains challenging for high-heat processes across industry sectors, there are a range of low-heat requirements in the chemicals sector which could be electrified using technology currently available.[20] The One Earth Climate Model concluded that globally the chemicals sector can achieve a 1.5°C-aligned pathway by rapidly transitioning to renewable energy. A 2022 review of their model included sector transition pathways for 12 major industries, including chemicals, to provide the granularity required by the financial sector to guide on net-zero investments.[21]

Figure 2. Scope 1, 2 and 3 emissions across the chemicals value chain[27]



Source: Greenhouse Gas Protocol

Carbon capture usage and storage



The UN Intergovernmental Panel on Climate Change (IPCC) identified carbon capture usage and storage (CCUS) as essential to keeping global warming under 1.5°C and vital for hard-to-abate industrial emissions, such as those from the chemicals sector.[22] Carbon capture usage (CCU) may be either point-source (PS) or direct air capture (DAC) and is instrumental to phasing out fossil carbon use as feedstock. An important application is the reduction of process emissions of CO_2 from the manufacture of ammonia for fertilizers, released when fossil fuel is used to produce hydrogen. However, plants also provide the means to capture CO_2 from the atmosphere, through bioenergy with carbon capture and storage (BECCS), which together with CCU provide the main alternative to carbon feedstock sources.

Even so, BECCS and CCUS present a new set of challenges which impact their impact on emissions reduction. Carbon capture (PS or DAC) is extremely energy intensive and requires transportation and additional infrastructure, depending on the source and process for capturing the CO_2.[23] It is estimated that around half the CO_2 captured by 2030 will be from technologies and applications still under development.[24] Moreover, as industrial processes are decarbonised, PS CO_2 will be less abundant as a feedstock. The use of biomass competes with land use for food production and bioenergy production (most importantly biofuels for transport), which presents biodiversity and deforestation considerations.[25]

3. Policy levers for the transition of the EU chemicals sector

To decarbonise the chemicals sector, a strong policy framework is required to facilitate and sustain the private sector investments that are needed for the sector to transition.

Standards, taxonomies, and sector criteria

Standards and taxonomies are important practical tools for sectoral and company level transition to net zero, which determine the metrics, thresholds and other criteria that define what a low-carbon chemical is. Once in place, they can then be used to regulate or guide corporate disclosures, policy making, setting of incentives and establish trade windows with low tariffs for low-carbon trade.[28]

The EU Taxonomy aims to guide the growing sustainable finance flows to achieve the EU's climate objectives by regulating disclosures for large corporates and financial institutions, and requiring member states to utilise the Taxonomy in setting policy.

While the EU Taxonomy puts forward thresholds to define what sustainable production of chemicals looks like, it does not sufficiently encourage the use of low-carbon basic chemicals. As the EU Taxonomy's scope broadens to include new economic activities, such as the manufacture of intermediate and advanced chemicals, this may become integrated into the value chain given that decarbonising intermediate chemicals requires the decarbonisation of basic chemicals.[29]

Due to the large variety of chemical products, a one-size-fits-all approach to setting standards is not feasible. This makes it necessary to categorise chemical products and processes according to alternative approaches such as energy intensity, carbon emissions, or using a value chain perspective. The latter can identify the very few molecules that form the basis of all chemicals production and allows the use of low-carbon basic chemicals in intermediate and specialty chemicals production, which can ultimately decarbonise the entire chemicals value chain.

Standards often utilise emission intensity thresholds to identify chemical products with a lower carbon intensity when compared to those manufactured with the carbon intensive processes heavily dependent on fossil fuels. At EU level, the EU Taxonomy defines a list of environmentally sustainable or green economic activities by establishing thresholds or technical screening criteria for each of its six objectives, most importantly in terms of emission intensity (i.e., the mitigation objective). While this is useful, there are issues relating to the usability of the EU Taxonomy which need to be resolved for future iterations. For example, at present less than 3% of the installed capacity for chlorine production in Europe meets the EU Taxonomy criteria, which restricts the application of the EU Taxonomy in this specific case. Furthermore, the EU Taxonomy does not sufficiently encourage the use of low-carbon basic chemicals, for example, olefins in plastics manufacture, which is one of the sustainable economic activities already included in the EU Taxonomy.

Carbon pricing to improve the business case for decarbonisation

Carbon pricing mechanisms such as carbon taxes and the EU emissions trading system (ETS) can promote the transition of the chemicals industry.[30,31] These mechanisms favour the use of low-emission technologies, which are often more expensive than fossil-based production and require significant upfront capital expenditure. Carbon pricing generates revenue that can be used to subsidise capex to adopt energy-efficient technologies.

Such mechanisms are also effective because their costs can be passed to end consumers. Recent research on the impact of a 100% increase in basic chemicals carbon prices on final consumer prices found the impact is quite low (e.g., 0.7 to 3.2% for soft drinks), even factoring in additional indirect price increases from other sectors.[32] The Global Centre for Commons and Systemiq argue that chemical companies should not wait for public policy action but take advantage as first movers to establish premium markets for their low-carbon production.[33]

In 2021, the OECD estimated that a price of EUR120 per tCO_2 would be required by 2030 for the chemical sector to reach carbon neutrality by 2050. However, currently only 3% of industry in 44 OECD and G20 countries pays this price as measured by the Carbon Pricing Score (CPS), which is the percentage of carbon emissions priced at a given level.[34] The OECD suggests that changes in public policy could increase CPS and improve the efficiency of carbon pricing mechanisms.

To date, carbon pricing has not been implemented effectively in the EU. Many sectors have been exempted from the EU ETS due to the risk of losing competitiveness against trade partners not subject to carbon pricing. The chemicals sector was included under the EU ETS but received free allocations for most of its emissions as seen in Figure 3.

Yet this did not prevent a reduction of 60% in the EU's share of global chemical investment between 2000 and 2020.[35] The rapid development of non-European chemical producers has increased competition and driven down the profits of European chemical companies with China currently the world's largest chemicals producer, pushing Europe into second place.[36]

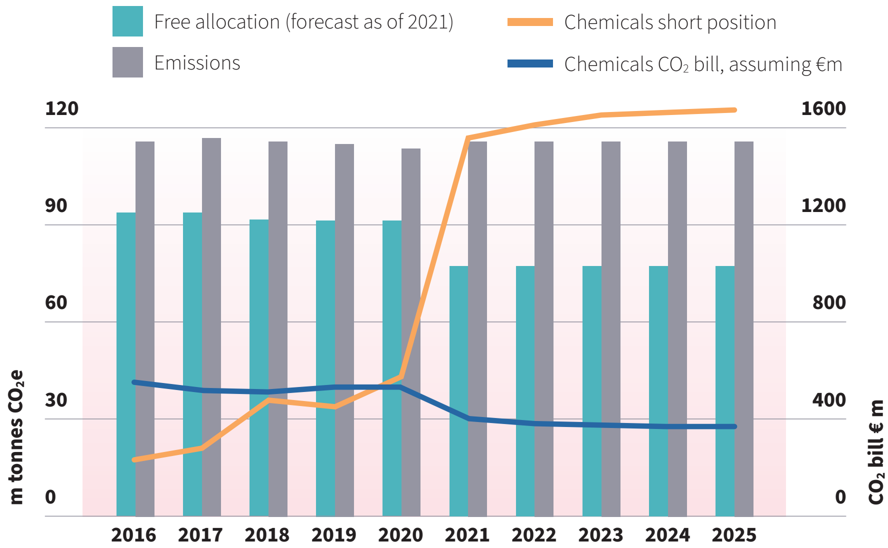
REACH and its impact on the transition of the EU chemicals sector

The EU Directive for Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) dates from 18 December 2006 and is a mandatory standard the EU chemicals industry needs to comply with to address human health and environmental protection (as opposed to the voluntary nature of the EU Taxonomy). In early 2022, the European Commission consulted stakeholders on a review of REACH, after the October 2020 Chemicals Strategy for Sustainability had defined the path to counter emerging risks for chemicals production.[41] In April 2022, the European Commission presented its Restrictions Roadmap under the Chemicals Strategy for Sustainability to prohibit thousands of the most problematic chemicals as part of the zero-pollution commitment from the EU Green Deal.[42]

The European chemical trade body, Cefic, deemed compliance with the EU Chemicals Strategy for Sustainability an added challenge to the requirement to fulfil transition to net-zero emissions, given the economic effect of REACH on the sector and its wider impact on other industries with value chains dependent on chemicals.[43] Nevertheless, higher European standards on hazardous substances can also bring benefits to the chemicals industry. In December 2021, a group of 23 investors managing USD4.1tn in assets urged chemical companies to phase out production of products damaging the environment and human health. These investors stressed that sustainable management of chemicals is key to financial outperformance and referred to litigation cases linked to hazardous substances, which in some cases led to fines and payouts.[44]

By 2030, China is forecast to account for more than half of global chemical production, with the EU and United States accounting for only one quarter.[37] Over time, the European chemicals industry is expected to shift its focus to specialty chemicals and formulated materials, while economies like China will focus on high-volume basic chemicals. The Middle East and United States have a competitive advantage over other economies due to the availability of fossil fuels at lower cost and, in the case of United States, due to recent investments in ethanol steam cracking of shale gas.[38] By way of example, production of naphtha-based olefins in Europe is 2.5 times more expensive than from ethanol in the USA.[39] This could incentivise European ethylene producers towards a fast transition to non-fossil-based ethylene production. Hence, the implementation of the new CBAM and the reviewed EU ETS is critical to ensuring that increased investment in decarbonisation does not lead to reduced competitiveness and offshoring.

Figure 3. EU chemical sector emissions and EU ETS credit allocation, 2016–2025[45]



Source: ICIS Analytics

The EU chemicals sector accounts for 8% of the emissions covered in the EU ETS with discussions to extend CBAM scope further by 2030 to include other chemical products such as polymers.[40] In 2022, European institutions agreed on the reform of the EU ETS, and the new CBAM to tax non-EU imports of selected products based on their carbon intensity. The EU chemicals industry had long demanded safeguards, due to higher costs derived from compliance with European rules, which should also support their decarbonisation efforts. Without such measures the risk of carbon leakage (i.e., chemical production moving out of Europe to avoid the costs of carbon schemes) would remain very high.

Following the previous EU ETS reform in 2018, carbon prices increased so that by 2020, the chemicals industry was facing a EUR600m carbon bill. In the fourth trading period of the EU ETS beginning in 2021, free allocations for the chemicals industry decreased by 24% for the 2021–2025 period and the sector faced an expected short position of 35 million tonnes CO_2e. In addition to the cut in allocations, prices rose to a high of EUR45/tCO_2e, resulting in an annual carbon bill of EUR1.5bn for the chemicals industry. Figure 3 underscores the need for the EU chemicals industry to accelerate its transition to become climate neutral well before 2050.

CBAM entered into force under a transitional phase as of 1 October 2023. It will initially apply to imports of cement, iron and steel, aluminium, fertilisers, electricity production, and hydrogen, covering 50% of emissions of the sectors under the EU ETS.[46] During the transitional phase to December 2025, before CBAM is fully operational, the European Commission will have to assess its potential expansion to cover polymers and organic chemicals with the objective to fully include EU ETS-covered sectors under CBAM by 2030.

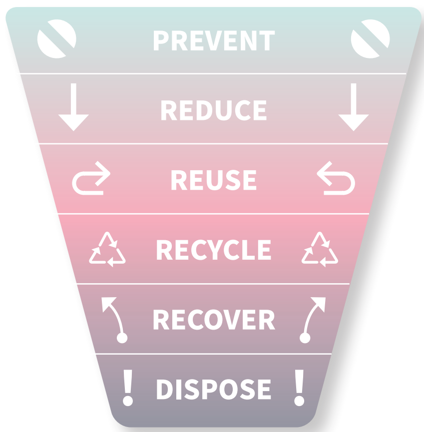
The inclusion of polymers within the scope of CBAM would create an important spill over effect in the global chemicals sector. To date, the chemical industry does not pay a carbon tax for using fossil fuels as feedstock anywhere in the world.[47] The full inclusion of indirect emissions from electricity in CBAM, however, should incentivise non-EU chemical companies to increase the use of renewable energy. Chemical imports from countries with very high carbon intensity of electricity, such as China which is the largest chemical producer globally, would be penalised. This would have a significant impact on China's trade with the EU since organic chemicals account for up to 3% of Chinese exports to the EU, with plastics 2.9%.[48]

Fertilizer production (and ammonia which constitutes 97% of nitrogen fertilizers) are also directly impacted by CBAM, given that the EU is largely reliant on Russia for imports, as well as Egypt and Turkey.[49,50] Sanctions and record-high gas prices resulting from the Russian invasion of Ukraine temporarily halted ammonia and fertilizer production in the EU, which was also largely dependent on Russian fossil gas imports.[51] This prompted calls from within the EU for the transition to low-carbon ammonia-based fertilizers and a demand from the EU chemical industry body (Cefic) for strong tax incentives, following the United States Inflation Reduction Act (IRA) stimulus. However, as taxation is not harmonised at EU level but determined at national level, the European Commission took aim at greening the production of fertilisers by encouraging EU countries to support investments in clean hydrogen and biomethane for ammonia production.[52]

Demand reduction and circularity policies

The production of basic chemicals represents 72% of all chemical emissions, of which scope 3 represents 64%. This is driven by high upstream scope 3 emissions from oil and gas extraction (0.5 Gt CO_2eq), as well as carbon-dense products such as plastics and urea resulting in high associated downstream scope 3 emissions (1.0 Gt CO_2eq).[53] This is why the implementation of waste hierarchy principles is critical (Figure 4).

Figure 4. The waste management hierarchy presents a systematic order for waste management[81]



Source: Axil

Demand reduction policies can decisively tackle excessive production and use of the two main chemical end products: fertilizers, commonly based on ammonia which is the main inorganic chemical product; and plastics, which are carbon-based organic compounds. These two, fertilizers and plastics, represent up to 74% of chemicals production globally.[54]

Fertilizer production and use can be reduced significantly without generating any impact given that up to 50% used on crops does not generate additional agricultural output.[55] In May 2019, as part of the Green Deal, the EU released its Action Plan: Towards a Zero Pollution for Air, Water and Soil, which targeted a 50% reduction in nutrient losses by 2030 with no deterioration in soil fertility and a 20% reduction in fertiliser use.

Circular economy measures aimed at recovering carbon from end products can provide an increasing proportion of feedstock inputs for the basic chemicals industry while significantly reducing carbon end-of-life emissions. Currently, chemicals manufacturing is predominantly linear and its carbon feedstock originates almost entirely from virgin fossil sources, which is set to be replaced by feedstock from biological sources. Recirculated carbon represents only a minor share of the feedstock used by the chemicals industry but this needs to be increased due to the limited availability of feedstock from biological sources.

The EU has focused on plastics recycling, particularly packaging, to promote chemicals circularity. Packaging is responsible for 40% of plastic use in the EU, over 60% of plastic waste generated in the EU, and 36% of solid municipal waste, with its use increasing at a faster rate than GDP. The EU 2018 Circular Economy Package contains four legislative proposals on waste and revised the existing Waste Framework Directive (WFD), the Landfill Directive, and Packaging and Packaging Waste Directive (PPWD), among others.[56] The PPWD contains recycling targets for plastic contained in packaging waste of 50% by 2025 and 55% by 2030, which are the same targets established by the previous Directive from 1994. Plastic packaging recycling rates vary enormously across EU member states, ranging from under 30% in France to over 70% in Lithuania and Slovenia.[57] This demonstrates the significant potential to improve recycling efforts within the EU by applying known solutions already put into practice in other member states.

Despite these measures, global plastics production is soaring. Future forecasts vary greatly, depending on assumptions on the success of demand reduction and circularity policies, with some estimates at four times current production levels (e.g., 1,230 Mt by 2060 under BAU according to OECD).[58] However, circularity policies could drastically reduce this with estimates ranging from 589 Mt by 2050 according to the IEA, to the low plastics consumption scenario of 400 Mt by 2050 from the Overseas Development Institute.[59] Given that plastic waste in the EU could reach 45 million tonnes, the EU 2018 Strategy on Plastics sets a 100% recyclability objective for the EU packaging market with a 60% target for plastic recycling by 2030.[60] The updated Ecodesign for Sustainable Products Regulation (ESPR) from March 2022 establishes requirements that permit greater circularity, including limits to substances inhibiting circularity, and mandatory minimum recycled content in products. The ESPR will also contribute to curbing demand by promoting the reuse, repair, and durability of products.

EU member states are free to set more ambitious objectives for plastics circularity. For example, Denmark established an Action Plan for Circular Economy with objectives that include the removal of 80% of plastic waste from incineration plants by 2030.[61] Currently, Denmark generates the greatest waste per capita in the EU, up to 800kg a year, and imports plastic waste from abroad for its incineration plants to generate electricity. As Denmark has an overcapacity of 700,000 tonnes compared to its domestically generated waste, seven incinerators will be closed to match waste volumes, and municipalities will be obliged to treat all recyclable waste.[62,63]

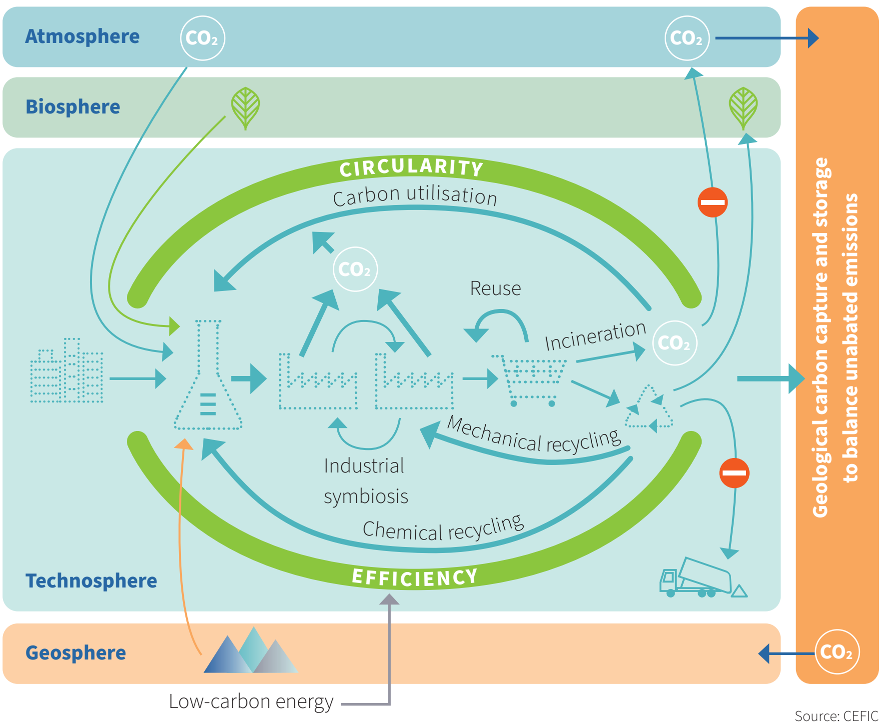
In October 2020, the European Court of Auditors (ECA) warned that the EU risks missing its plastic recycling targets for 2025 and 2030.[64] The ECA stressed the need for more accurate recycling reporting and a tightening of plastic waste export rules. In November 2021, the Commission presented its proposal for the revision of the EU Waste Shipment Regulation to ban intra-EU shipments of waste for disposal, while facilitating waste shipments for reuse and recycling within the EU to promote economies of scale. This regulation follows the Basel Convention Plastic Waste Amendments that required changes to EU law to ban most plastic waste shipments to non-OECD countries from 2021 onwards. The new EU Waste Shipment Regulation also aims to ensure that waste shipped outside the EU is managed in an environmentally sound manner, as nearly a third of the EU's plastic packaging recycling target is achieved through shipments to non-EU countries.

EU plastic waste exports accounts for up to 28.7% of total plastic waste exports in OECD countries and 70.3% in non-OECD countries, which makes the EU one of the main contributors to the trade in global plastic waste. Plastics comprise most of the waste exported outside the EU, together with metals, paper, textiles, and glass. As the EU lacks recycling capacity, it has so far mostly relied on exporting to non-EU countries to reach its recycling targets. However, this trend is changing with more plastic waste being recycled domestically, and less exported by OECD countries to non-OECD countries.[65]

In November 2022, the European Commission released its second Circular Economy Package, which included a communication on bio-based, biodegradable, and compostable plastic, and a proposal for review of the regulation on packaging and packaging waste.[66] The aim was to promote a better functioning of the EU internal market for packaging. It establishes high thresholds for what constitutes recyclable packaging, with requirements such as design for recycling at scale and easy sorting. Crucially, it includes a demand reduction policy by targeting practices such as excessive empty space in packaging, single-use packaged items, and superfluous packaging.[67] However, what is lacking is an update of recycling calculation methodologies, which overestimate real recycling rates that could fall from 42% to 30%.

In addition to this, a key priority for EU policy should be harmonising and reinforcing the existing Extended Producer Responsibility (EPR) schemes across EU member states, which

Figure 4. Sustainable carbon life cycle



Source: CEFIC

promote recyclability through fee modulation (i.e., fees based on the percentage of recycled content in packaging), promoting deposit-return schemes, and other similar practices.

Non-recyclable waste, which is mainly collected by municipalities and contains a large amount of plastic, can be used in waste-to-fuels and waste-to-chemicals initiatives. The EU's Innovation Fund, which aims to scale-up new circular economy technologies, awarded EUR106m to Enerkem and Suez to convert municipal waste into green methanol. This will increase recycling rates to up to 70%, and possibly to 100% in the future, from current levels of 10%.[68]

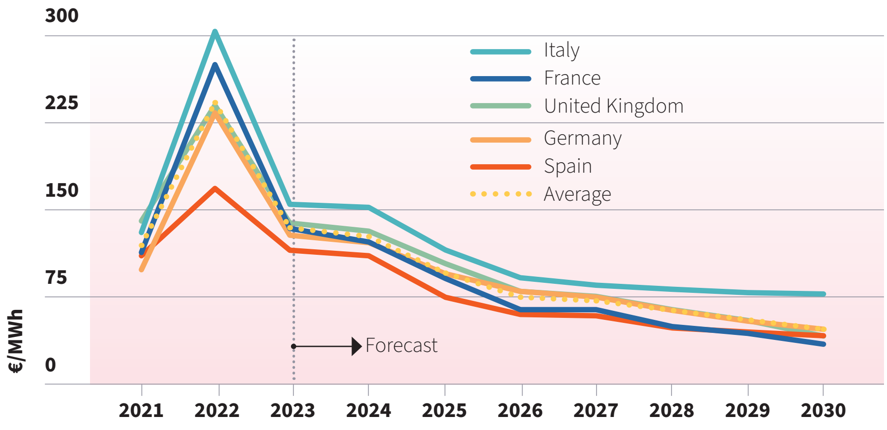
While chemical recycling drastically increases plastic recycling rates, it requires vast amounts of electricity and is a highly toxic and potentially polluting activity. Currently, around 24 million tonnes of EU plastic waste is burnt to generate energy for hard-to-abate sectors, mainly cement, and to generate electricity. Although burning plastics replaces fossil fuels, as power and heat systems shift to clean energy sources, burning plastic for energy increasingly displaces clean energy sources instead of fossil fuels.[69]

Therefore, the reform of the EU ETS at the of end 2022 has the potential to bring the incineration of municipal waste under its scope. The European Commission has until 31 July 2026 to decide whether to include the municipal waste incineration sector in the ETS from 2028 onwards, and establish an opt-out until 31 December 2030.[70] Given the labour-intensive nature of incineration, subjecting it to carbon pricing should further incentivise recycling by making it comparatively cheaper, which would reduce emissions and has the potential to create jobs.[71]

Landfill for plastic waste, which is not recycled or incinerated, is the least preferred method of disposal. Therefore, the EU aims to limit this practice as much as possible using the EU Landfill Directive. When exposed to solar radiation, plastic emits methane as it decomposes. This gas, which also originates from agriculture and fossil fuel extraction, is responsible for about 30% of global warming. As recycling capacity is expanded in the EU, landfill and incineration will likely be further restricted while stepping up efforts to reduce the amount of plastic waste overall.

Finally, The European Commission Communication on Sustainable Carbon Cycles projects that industrial carbon capture of between 300mt and 500mt of carbon from power generation, industrial processes or directly from the air will be required to meet the EU's climate neutrality objective. By 2050, the energy transition will be at a very advanced stage leaving few industrial process emissions remaining. Therefore, the EU will need to source most of its carbon feedstock industrial needs (especially, for chemicals manufacture) directly from the air and from biogenic sources, considering environmental limitations, by 2050.

Figure 5. Baseload power prices should fall across Europe's five largest power markets



Source: Standard & Poor's Financial Services LLC

The European Commission Communication on Sustainable Carbon Cycles has set the aspirational objective that at least 20% of the carbon used in the chemical and plastic products is from sustainable non-fossil sources by 2030. This aspiration is also conditional on the EU's biodiversity goals, hence carbon from biomass needs to be responsibly sourced and its availability is limited. The result is that carbon directly obtained from waste and biomass will be more expensive and less available than captured carbon dioxide. The criteria under the Climate Bonds Standard also has limitations on the use of biomass.

Examples of EU support for technological development in this area include the funding received by Recycling International (CRI) to scale up CO_2-based methanol after their first Icelandic demonstration plant in 2012.[72] The EUR2m Horizon funding will also allow CRI to expand its Finnfjord plant in Norway to reach a yearly production capacity of 100,000 tons of methanol using a yearly 146,000 tons of carbon dioxide and clean energy.

Electrification: policies to enhance interconnection and RE capacity

Due to high dependence on fossil fuels, chemical sites are often located close to refineries. To ensure the supply of clean energy from where it is produced, electrical grid infrastructure will need to be strengthened and connectivity between EU electricity markets improved.

European institutions will need to raise electrification-related ambitions, including renewable energy generation and electricity interconnection targets, especially for countries like Portugal and Spain with poorly linked networks.[73] Reform of the EU electricity market is already proceeding as announced in the European Commission's 2023 work programme.[74] This should be carefully designed to improve the access to clean and affordable electricity by transitioning industries.

The European Commission also aims to promote renewable purchase power agreements (such as, for example, Solar PPAs or SPPAs) given that take-up in recent years has been slow. It has urged EU member States to remove barriers for renewable purchase power agreements as part of their national energy and climate plans since, to date, only eight EU Member States have done so.[75] Nonetheless, future electricity prices in the EU are expected to decrease significantly from 2026 onwards, in line with double-digit growth rates in wind and solar capacity.[76] This should facilitate the ramping up of industrial processes electrification.

The 2023 revision of the Renewable Energy Directive (RED III) increases targets for renewable energy use to 42.5% and sets an indicative target of 1.6% for annual increases in renewable energy use by the industry. RED III originally envisaged a renewable energy share increase to 40% by 2030, but this was revised upwards as a result of the war in Ukraine. Unless the EU can significantly increase its production of renewable energy, or import clean electricity from outside the EU, existing electrification targets will not be feasible.

Any support for the chemicals industry from EU institutions or national governments should be on condition that companies adopt credible transition plans. Fossil fuel substitution by electrification is relatively straightforward for activities requiring low- to medium-grade heat. Therefore, electrifying chemical processes up to 500 degrees Celsius by 2035 through the deployment of electric boilers and heat pumps should be a priority.[77] Electrification of manufacturing processes requiring high grade heat is also possible, such as steam cracking which is the highest energy-consuming process in the chemicals industry. Although the substitution of fossil fuels with low-carbon hydrogen firing is possible, it would be a suboptimal solution, as direct electrification is more efficient.

Developing low-carbon hydrogen production and use at scale

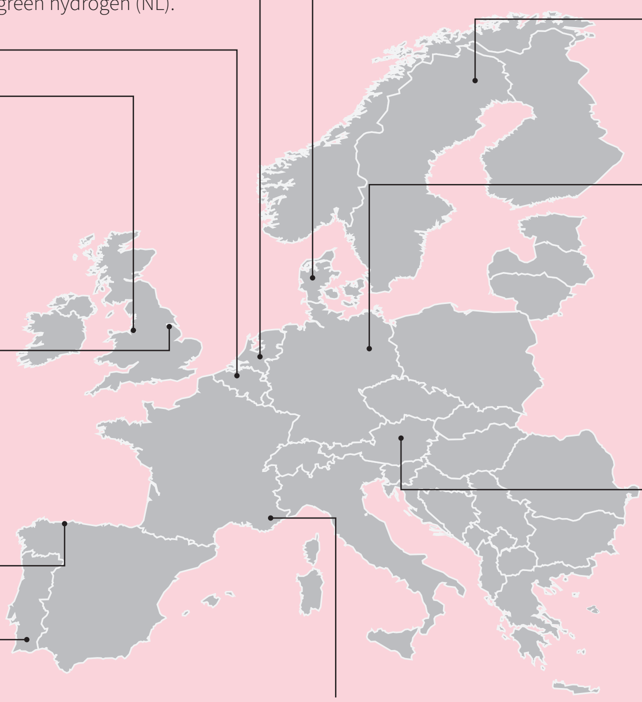
Low-carbon hydrogen production and use must be rapidly scaled up since its use as feedstock by the EU chemical industry is a required transition element, particularly in the production of low-carbon ammonia, but also other basic chemicals such as methanol. RED III establishes a binding target for industry to reach 42% of renewable hydrogen in total hydrogen consumption by 2030. The EU Hydrogen Strategy targets a 40GW electrolyser capacity and 10 million tons of green hydrogen production yearly by 2030. Hydrogen strategies at national level and the diverse public financing instruments (most significantly, through the EU Green Deal) have been put forward by public institutions. President von der Leyen has unveiled plans to create a EUR3bn hydrogen bank following the May 2022 REPowerEU plan to end energy dependence from Russia.

The EU chemicals industry currently consumes 10 million tons of hydrogen per year.[78] About half is used to produce ammonia and methanol, and the other half to refine oil, with almost all of it being grey hydrogen derived from fossil fuels. EU annual demand for hydrogen is expected to exceed 100m tons by 2050 and be driven mainly by demand from the transport and industry sectors. Hydrogen demand in the EU will grow to 35mt by 2030, 86mt by 2040, and to 113mt by 2050 from which 51% of demand (58mt) will come from sustainable fuels for transport, 40% (45mt) from industry (including 6mt specifically for chemicals),and 9% (10mt) as feedstock for chemicals. Figure 6 below provides an overview of the main green hydrogen initiatives developed by the EU chemical industry in the EU.

Carbon contracts for difference (CCfDs) present an important means by which to scale up the hydrogen economy. To ensure access to hydrogen for its energy-intensive industries, including chemicals production, Germany has introduced a subsidy scheme establishing price guarantees for technologies related to transition.

However, support via CCfDs for the production of steel, ammonia and cement which amount to between EUR10bn and EUR43bn would be significantly reduced by adopting German and EU climate policy and limit the need for public financing of this scheme to EUR10bn.[79,80] On 30 August 2023, the European Commission released the terms and conditions for its planned hydrogen bank pilot auction following the inclusion of an EU-wide CCfD scheme in its 2023 work plan. European institutions will need to pursue an ambitious, EU-wide CCfD scheme following success of the UK scheme, which has proved its effectiveness in developing the UK offshore wind sector. EU resources will have to be frontloaded to speed up investments in renewables-based, low-carbon hydrogen production and minimise the role of fossil-based grey and blue (with carbon capture) hydrogen, avoiding any public funding of these.

Figure 6: Main ongoing hydrogen projects related to the chemical industry in the EU[82]



Source: Sources: Deloitte Analysis

4. Conclusion

Green and transition finance can enable the EU chemicals industry transition towards carbon neutrality, provided an appropriate policy framework is in place to establish the right incentives for issuers and investors.

Achieving net-zero emissions by 2050 will require varying levels of effort in terms of required investments and technological development across hard-to-abate sectors. The transition of the EU chemicals sector to net-zero by 2050 is achievable, but requires significant action by policymakers, companies, and investors.

The lack of transition pathways for chemicals, until very recently, partly explains the limited progress achieved by chemical companies. Transition debt instruments issued by chemical companies (mainly, Sustainability Linked Bonds) have only included scope 3 emissions targets to a very limited extent, which undermines the credibility of the sector's transition and deters commitment from investors to finance the industry's efforts. The new Basic Chemicals criteria contained in the Climate Bonds Standard should decisively help investors and issuers address this and boost issuance in the sector to fund the key investments needed in the short and medium term, following the example of early movers in the chemicals sector.

The completion of the Fit-for-55 package will provide a strong framework for decarbonising chemicals production, even if ambition must be raised in the particular case of the CBAM to include a large part of production (i.e., organic chemicals and polymers) currently out of scope. Chemicals transition must accelerate, given the expected increase in costs derived from the new EU ETS and the energy crisis linked to the war in Ukraine, which limits the availability of fossil gas (currently the main input to the chemicals industry) and hinders the industry's electrification efforts. Additionally, strong provisions around transition plans as currently negotiated under the Corporate Sustainability Due Diligence Directive (CSDDD) will enable chemical companies to ensure credibility on their commitments to access much-needed green and transition finance flows.

Policymakers, companies, and investors in the chemicals sector must consider that scope 3 emissions reduction has the greatest abatement potential and will be primarily based on circularity and demand reduction policies. The substitution of virgin carbons of fossil origin as feedstock with renewable carbon sources and low-carbon hydrogen is particularly urgent but requires scaling up existing and new technologies, and most importantly carbon capture. Targets for recirculated carbon use in the chemicals industry would make the case for investment in these areas by the chemicals sector. Currently available circularity measures can deliver much needed results in the short and medium term until other measures are mature enough for its mass implementation. Other circularity innovations such as chemical recycling are not yet available at mass scale but can further increase circularity once the easier to implement solutions are exploited.

Summary Policy Recommendations

1. Incentivise low-carbon basic chemicals production and demand, most importantly in the manufacture of plastics and fertilizers, through official standards such as the EU taxonomy.

2. Prioritise demand reduction policies tackling overproduction and overuse of plastics and fertilizers to curb feedstock demand. Alternative carbon feedstock must be scaled up to achieve a phase-out of fossil fuels use for chemicals production in the longer term.

2.1 Optimise fertilizer production and use through joint action from fertilizer companies and the agricultural sector and scale up ammonia-based low-carbon fertilizers production to substitute fossil-based ammonia fertilizers.

2.2 Adopt plastics demand-reduction policies (especially of single use plastics and packaging) and boost chemical circularity by achieving increased plastics recycling rates, greater recyclability and strengthened minimum recycled content requirements.

3. Ensure the supply of renewable energy at stable and affordable cost and the required investments in electrical grids to guarantee an increased use of electricity in the EU industry. Strengthen efforts for the electrification of manufacturing processes requiring low to medium heat in the short term, while also supporting electrification of processes requiring high-grade heat where barriers for electrification are higher and technology is being developed.

4. Support the production of low-carbon hydrogen by bridging the cost gap between renewable and fossil hydrogen through Carbon Contracts for Differences (CCfDs), prioritising its use as feedstock by the chemicals industry, and especially for basic chemicals manufacture. Specific chemical sectoral targets for hydrogen use must be implemented.

5. Promote recycling of plastics at end-of-life. Incineration should not become the go-to option for municipal waste, even if in future carbon capture for incineration is expected to generalise.

6. Facilitate the use of captured carbon from hard-to-abate sectors by the chemicals industry through dedicated public investment and appropriate regulatory frameworks such as standard-setting for the use of captured carbon and CO_2 infrastructure.

7. Public policy and finance should give preference to electrification rather than to a continued use of fossil fuels, even with carbon capture, to power industrial processes.

8. Promote scope 3 emissions disclosure and target setting by chemical companies following voluntary sectoral standards from organisations such as SBTi, which should be reinforced across the supply chain though partnerships with clients and suppliers.

9. Strengthen carbon pricing by broadening the scope of CBAM to include polymers and organic chemicals.

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Acknowledgements: Sean Kidney, Rachel Hemingway, Bridget Boulle, Marian Rodriguez, Climate Bonds Initiative

Paul Münnich, Agora Energiewende

Gbemi Oluleye, Imperial College London

Dimitrios Koufos, Sam Maauyf, European Bank for Reconstruction and Development - EBRD

Editorial support: Stephanie Edghill, Caroline Harrison

Design: Godfrey Design, Joel Milsted

Climate Bonds INITIATIVE

Prepared by the Climate Bonds Initiative

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