Policy Paper

THE WAY FORWARD FOR A LOW-CARBON INDUSTRY IN ROMANIA

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The way forward for a low-carbon industry in Romania

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About EPG:

The Energy Policy Group (EPG) is a Bucharest-based non-profit, independent think-tank specialising in energy and climate policy, market analytics and decarbonisation strategy, grounded in 2014. EPG is committed to promoting long-term decarbonisation policies and actions across all economic sectors. Through publications and public events, EPG disseminates knowledge about the green transition and provides well-documented input to stakeholders and decision-makers. Its publications are freely available as research reports, opinion papers, and policy briefs. EPG's conferences, roundtables and workshops provide a platform for informed discussion and expert analysis. EPG's funding comes mainly from research grants, but also from sponsorships and membership fees.

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Executive Summary

Romania's industry will need to transform fundamentally to align with climate commitments and remain competitive in a low-carbon world. With increasing pressure from EU policy and a race to decarbonise industrial production in EU Member States, there are progressively fewer windows of opportunity for implementing the new processes and technologies required for greening heavy industry. A fragmented national policy framework and a narrow fiscal space mean that Romania will face significant difficulties in keeping its industry competitive. However, it also has key advantages it can capitalise on to become a low-carbon industry leader.

To achieve economy-wide net zero emissions by 2050, the main pathways for industrial decarbonisation are electrification, continuous improvements in energy and resource efficiency, the uptake of renewable hydrogen and other low-carbon fuels, and carbon capture, utilisation, and storage. Romania's primary steel, cement, and chemicals production (particularly fertilisers) require the deepest transformation to enable industrial emissions reductions. The technologies needed to achieve these changes are costly, have long lead times, and in some cases imply new materials and supply chains. Furthermore, industrial transformation is not just technological – concerted action will be needed to safeguard the rights of workers in industrialised regions and prepare them for meaningful employment in Romania's decarbonised industries and in those new industries which may emerge.

To decarbonise Romania's industry sustainably and justly, three main areas of action must be addressed: industrial policy, funding and market creation, and infrastructure development. Firstly, Romania needs a cornerstone industrial strategy anchored in long-term climate commitments and driven by selective support rather than across-the-board crisis management. This industrial strategy must clearly assign responsibilities to competent authorities, commit to funding and financing instruments, and address socio-economic impact, supply chain management, and research, development, and innovation. Romania's wider domestic policy framework, as well as its positioning in EU negotiations, must also be consistent with the commitments and goals of its industrial policy.

Secondly, industrial transformation in Romania will require a massive mobilisation of funding and the stimulation of new markets for green industrial products. As a country with a comparatively low fiscal space, Romania cannot rely excessively on state aid granted to industrial producers, as done in countries such as Germany and France. Instead, eventual state aid schemes targeted at competitive industries should be complemented by the use of EU funding opportunities, including the Modernisation Fund and the Innovation Fund, the unlocking private financing, and the implementation of green public procurement to stimulate a reliable lead market for products such as low-carbon steel and concrete. There are significant opportunities in this space, given Romania's massive planned spending on large-scale infrastructure projects.

Finally, decarbonising Romania's industry will require huge infrastructure for enabling renewable electricity, hydrogen transport, and carbon dioxide (CO_2) transport and storage. The scale of the challenge is significant: electricity consumption will increase and its geographical distribution will change, straining an unprepared transmission grid; new pipelines will be needed for hydrogen and CO_2 transport; and CO_2 storage capacities must be developed very rapidly. Romania must thus invest significantly in the expansion and strengthening of the electricity transmission grid, and in essence start from scratch in developing a network of hydrogen and CO_2 pipelines, as well as CO_2 storage.

These key actions for decarbonising Romania's industry will not be easy. They will require massive investment, coordination within the state apparatus and with industry, and significantly more political engagement on the subject. However, the benefits are undeniable: increased industrial competitiveness, a well-prepared workforce, reliable infrastructure, and a significant contribution to Romania's climate ambitions. Reaping these benefits will depend first and foremost on understanding the magnitude of the challenge, and subsequently on internalizing it in concrete policy, funding, and infrastructure measures to enable decarbonisation at the required scale and pace.

Sumar Executiv

Industria României va trebui să se transforme fundamental pentru a se alinia cu angajamentele climatice naționale, și pentru a își păstra competitivitatea într-o lume cu emisii reduse de carbon. Sub presiunea crescândă a politicilor europene și în mijlocul întrecerii între statele membre UE pentru a își decarboniza producția industrială, există din ce în ce mai puține ferestre de oportunitate pentru a implementa noile procese și tehnologii necesare decarbonizării industriei grele. În România, cadrul politic fragmentat și spațiul fiscal redus vor impune dificultăți semnificative în menținerea competitivității industriale. Cu toate acestea, România dispune de avantaje semnificative pentru a deveni un lider în decarbonizarea industrială.

Pentru a ajunge la net zero emisii la nivel de economie până în 2050, principalele rute pentru decarbonizarea industrială sunt electrificarea masivă a industriei, îmbunătățirea continuă a eficienței de consum a energiei și resurselor, folosirea hidrogenului regenerabil și alți combustibili alternativi și captarea și utilizarea sau stocarea emisiilor de dioxid de carbon (CO_2). Din sectoarele industriale românești, producția de oțel primar, de ciment, și de chimicale (mai ales îngrășăminte) vor trebui să se transforme cel mai profund pentru a-și reduce emisiile. Tehnologiile necesare pentru această transformare prezintă costuri mari și termeni de execuție lungi, iar în unele cazuri implică un necesar de materiale și lanțuri de aprovizionare noi. Mai mult, transformarea industrială nu este doar una tehnologică - vor fi necesare intervenții pentru protecția angajaților din regiunile industrializate și pregătirea lor pentru noile locuri de muncă asociate transformării industriale, în noi sectoare industriale.

Pentru a decarboniza industria României într-un mod sustenabil și just, sunt necesare acțiuni-cheie în trei arii majore. În primul rând, România are nevoie de o politică industrială fundamentată de angajamentele climatice pe termen lung și de o abordare de susținere selectivă a industriilor competitive, în locul simplelor măsuri de criză. Această politică industrială trebuie să desemneze clar responsabilitățile autorităților competente, să se angajeze la lansarea unor programe de finanțare și să adreseze aspectele de impact socio-economic, management al lanțurilor de aprovizionare și cercetare, dezvoltare și inovare. Cadrul mai larg de politici domestice al României, precum și poziționarea sa în negocierile UE, trebuie să fie aliniate cu angajamentele și țintele politicii industriale.

În al doilea rând, transformarea industriei românești va necesita o mobilizare masivă de fonduri și stimularea de noi piețe pentru produse industriale verzi. Dat fiind deficitul fiscal, România nu poate să se bazeze excesiv pe instrumente de ajutor de stat pentru producătorii industriali, precum se întâmplă în Germania și Franța. Complementar cu eventualele scheme de ajutor de stat bine-orientate către industriile competitive, statul român ar trebui să folosească

oportunitățile de finanțare UE, precum Fondul de Modernizare și Fondul de Inovare, să deblocheze finanțări private, și să implementeze un sistem de achiziții publice verzi pentru a stimula o piață pilot pentru produse precum oțelul verde. România dispune de oportunități importante în aria achizițiilor publice verzi, dat fiind cheltuielile semnificative pe proiectele mari de infrastructură.
În al treilea rând, decarbonizarea industrială în România necesită infrastructură pentru asigurarea energiei regenerabile, hidrogenului și captării și stocării de dioxid de carbon (CO_2). Aceasta este o provocare semnificativă: consumul de energie electrică va crește și își va schimba distribuția geografică, punând la încercare o rețea de transport nepregătită, vor fi necesare noi conducte pentru transportul hidrogenului și al dioxidului de carbon, iar capacitățile de stocare a dioxidului de carbon trebuie dezvoltate într-un ritm foarte rapid. Statul român trebuie să investească semnificativ în extinderea și consolidarea rețelei de transport a energiei electrice și, în esență, să înceapă de la zero dezvoltarea rețelelor de conducte de hidrogen și CO_2 și a capacităților de stocare de CO_2.

Aceste acțiuni-cheie pentru decarbonizarea industriei românești nu sunt simplu de implementat. Ele vor necesita investiții masive, coordonare între autorități și agenții economici, precum și un angajament politic semnificativ mai mare pe această temă. Cu toate acestea, beneficiile sunt evidente: o competitivitate industrială sporită, o forță de muncă bine pregătită, o infrastructură fiabilă și o contribuție semnificativă la ambițiile climatice ale României. Realizarea acestor beneficii implică în primul rând înțelegerea magnitudinii provocării și implementarea de măsuri concrete pentru a permite decarbonizarea industrială la scara și în ritmul necesar.

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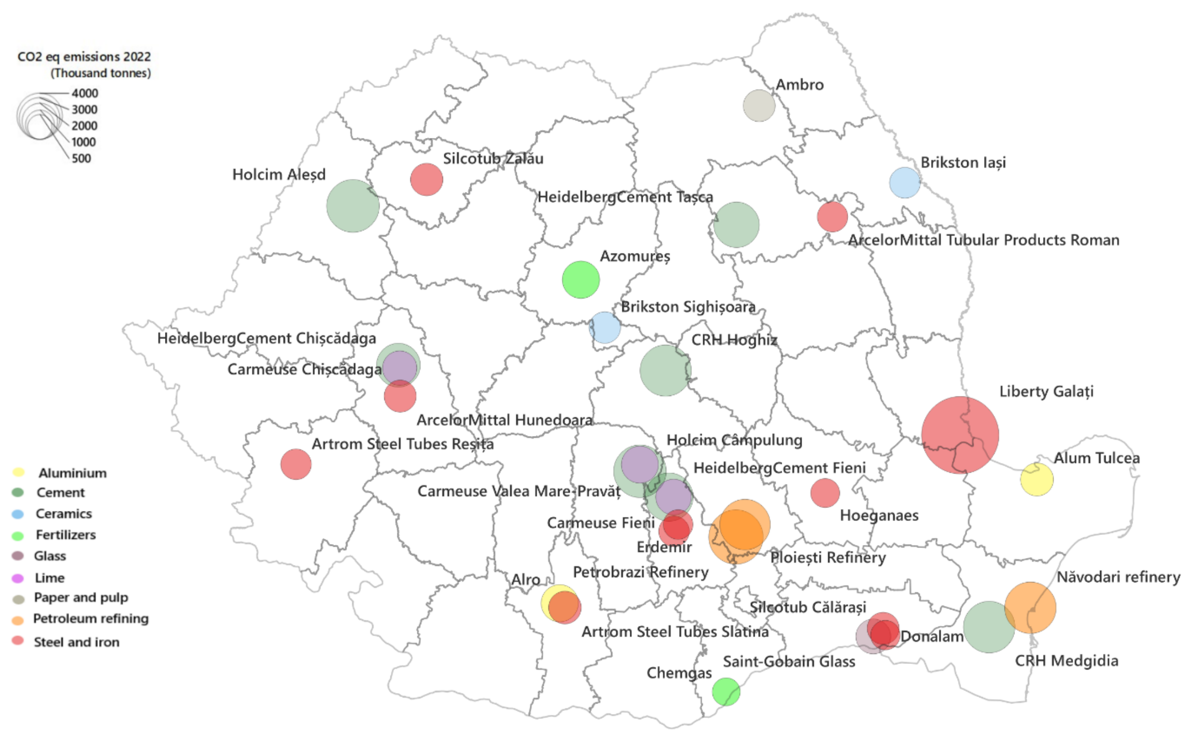
CCfD	carbon contracts for difference
CO_2	carbon dioxide
CCU	carbon capture and utilisation
CCUS	carbon capture, utilisation, and storage
CCS	carbon capture and storage
EU	European Union
EU ETS	EU Emissions Trading System
GDIP	Green Deal Industrial Plan
GHG	greenhouse gas
GPP	green public procurement
GVA	gross value added
GW	gigawatts
GWh	gigawatt-hours
Kt	kilo-tonne
MS	Member State
Mt	mega-tonne
MW	megawatt
MWh	megawatt-hours
NZIA	Net Zero Industry Act
PPA	Power Purchase Agreement
RFNBO	renewable fuel of non-biological origin
TWh	terawatt-hours

Introduction

Despite undergoing deindustrialisation since 1990, Romania's economy is still heavily dependent on industrial production. Overall, manufacturing contributed 16.5% to national Gross Value Added (GVA) in 2021, 11% more than the EU average, and employs around a fifth of the total active workforce.[1] Romania's industry is also emissions-intensive: in 2021, emissions from industry amounted to 25.1 $MtCO_2$ (of which 10.7 Mt were process emissions), mainly from the production of cement, iron and steel, and chemicals. These emissions are a result of the significant amounts of fossil fuels consumed both as a source of energy and as a feedstock in conventional industrial processes, with inherent process emissions (Figure 1).

Figure 1. Industrial facilities in Romania with emissions over 100,000 tonnes CO_2-eq in 2022 under the EU ETS. Azomureș, Romania's largest fertilizer plant, emitted 1.6-2 Mt CO_2-eq under the EU ETS in the last decade, but has partially suspended production since 2021. Source: EPG own work, based on data from the European Commission.[2]



Considering the emissions and economic contribution of Romania's industry, the successful decarbonisation of the national industrial base is of strategic importance. Ensuring the

[1] Energy Policy Group, 2023. Decarbonising Romania's Industry.
[2] European Commission, 2023. Climate Action – Union Registry.

conditions for industrial transformation is paramount not only for maintaining economic competitiveness in the long run, but also for delivering fair and equitable outcomes for workers in industrialised regions. As shown in the next chapter, this is a highly complex challenge involving a substantial transformation of current industrial processes and the simultaneous development of necessary infrastructure. This will require coordination and large capital investments by both industry and the state, as well as rigorous strategic planning to manage the significantly different patterns of energy and resource consumption which will emerge from industrial transformation.

Romania currently lacks a robust national policy framework for industrial decarbonisation, as planning and funding remain fragmented and institutional responsibilities are scattered. Despite some recent positive developments, progress is slow and industrial transformation remains challenging. This comes in a time of mounting pressure in the EU policy landscape. The revision of the EU Emissions Trading System (EU ETS), including the phase-out of free allowances until 2034 and no new allowances being released on primary markets from 2039, means that deep decarbonisation is vital for industrial producers shielded so far by the issuance of free allowances. Competition within the EU is also increasing for bringing to market low-carbon industrial products, nudged by EU policies such as the Ecodesign for Sustainable Products Regulation and the Carbon Border Adjustment Mechanism.

In the wake of the EU's Green Deal Industrial Plan (GDIP), Romania may face additional challenges in financing industrial decarbonisation. While a welcome rethinking of industrial policy, the GDIP risks creating an imbalance between Member States (MSs): without significant dedicated national funding streams, most financial support for industry will be granted through state aid, particularly given the flexibility offered by the Temporary Crisis and Transition Framework and the General Block Exemption Rules until 2026. With no dedicated funding streams and a range of producers to support, more fiscally restrained countries like Romania risk being outspent by the generous industry support schemes implemented in countries such as Germany and France, and thus lagging in terms of the pace and scale of industrial decarbonisation.

Despite these significant challenges, Romania is well-positioned to drive ambitious action for industrial decarbonisation. Its geographical characteristics endow it with significant potential for renewable energy, green hydrogen, and onshore CO_2 storage. As a lower-income EU MS, Romania also benefits from access to funding such as the Modernisation Fund and Cohesion Fund, which can finance industrial decarbonisation and help create new markets for green industrial products. Romania can also benefit from a wealth of international experience with infrastructure business models, financing instruments, and market creation mechanisms for decarbonising industry, which are being tested and implemented throughout Europe and around the world.

This paper outlines the main pathways for decarbonising Romania's industry and provides recommendations for enabling them. It has been prepared with input from a stakeholder platform on industrial decarbonisation in Romania, coordinated by EPG.

Pathways to net zero for Romania's industry

Similar to other EU countries, the main pathways for decarbonising Romania's industry are: i) electrification and renewable electricity; ii) improvements in resource use (resource efficiency and material substitution); iii) alternative industrial fuels (renewable hydrogen, sustainable biomass and biofuels, and other fuels); and iv) carbon capture, utilisation, and/or storage (CCUS). These measures could collectively slash industrial emissions and help achieve an economy-wide target of net zero greenhouse gas (GHG) emissions by 2050. Their implementation would radically change the consumption landscape for Romania's industry, including an exponential growth in renewable hydrogen consumption and carbon dioxide (CO_2) capture (Table 1) and a significantly higher share of electricity in the industrial energy mix (Figure 2).

Many of these technologies and processes are capital-intensive, have long lead times and are best implemented at the start of new investment cycles, of which only one remains before 2050 for the steel, cement, and chemicals industries.[3] They also require the development of significant infrastructure to enable real emissions reductions and benefits to Romania's industrial operators. The following sections detail the technological pathways for industrial decarbonisation and their outlook in Romania, including barriers to their deployment. More detail on these technological pathways and ongoing projects or plans in Romania can be found in the Annexes of this study.

Table 1. Projected changes in industrial greenhouse gas (GHG) emissions, energy consumption, CO_2 capture, and renewable hydrogen consumption, in a balanced scenario of reaching net zero emissions by 2050. Most of these results are based on modelling done by EPG in partnership with Climact.[4] The consumption of hydrogen by refineries is not included in this table, as it is categorised under the transport sector by the relevant EU legislation.

Measures	2021	2050
Industrial greenhouse gas emissions	25.34 Mt CO_2-eq/year	2.67 Mt CO_2-eq/year
Total industrial energy consumption	92.63 TWh/year	61.51 TWh/year
Captured industrial CO_2	0 Mt/year	3.98 Mt/year
Renewable hydrogen consumption by industry	2,938 t/year[5]	~187,800 t/year

[3] International Energy Agency, 2020. Aligning investment and innovation in heavy industries to accelerate the transition to net-zero emissions.
[4] Energy Policy Group, 2022. Recommendations for Romania's Long-Term Strategy: Pathways to climate neutrality.
[5] Ministry of Energy, 2023. National Hydrogen Strategy and Implementation Plan (draft).

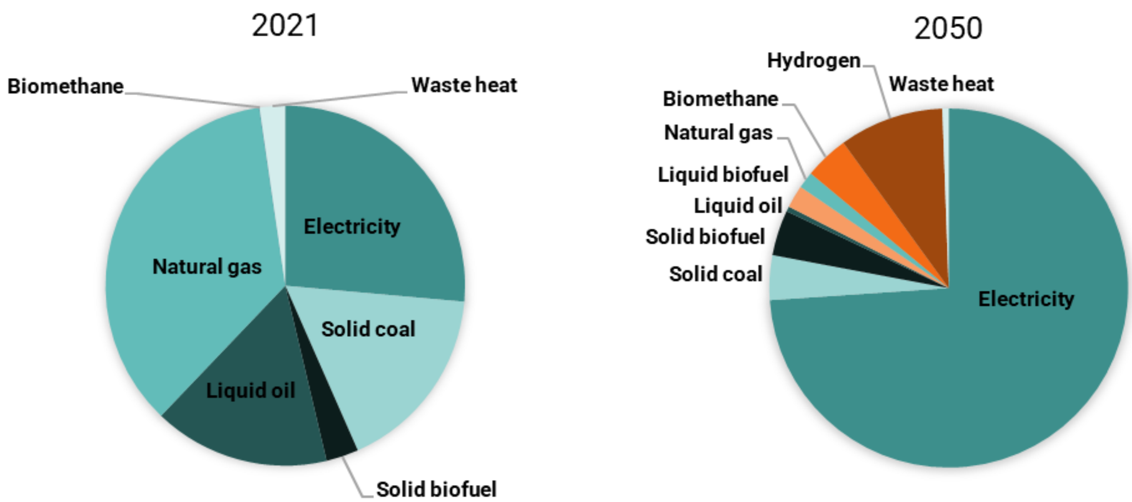


Figure 2. Projected changes in the industrial energy consumption mix between 2021 (left) and 2050 (right). These results are based on a modelling exercise done by EPG in partnership with Climact (see footnote 4).

Direct electrification and renewable electricity

The direct electrification[6] of industrial processes could replace up to half of global industrial fuel consumption.[7] Electric alternatives are commercially available for some industries which require low- or medium-temperature heat, such as paper and pulp, but the electrification of high-temperature heat (for example, in steelmaking) is more challenging and costly (Box 1). The electrification of industrial processes also has significant implications for the national energy system, given the implicit additional electrical loads which will require constant flows of renewable electricity at affordable prices to enable real emissions reductions. This in turn requires the development of large-scale renewable energy capacities, which has been slow in Romania despite significant policy strides such as enabling direct Power Purchase Agreements (PPAs) and developing a Contracts for Difference scheme for 5 GW of renewable energy.[8] Other significant barriers are the need for expanding Romania's electrical grid capacity, permitting issues, an incoherent governance framework and a high share of inefficient state-owned energy companies.[9]

[6] Direct electrification refers to the replacement of technologies or processes which use fossil fuels with electrically-powered equivalents.
[7] McKinsey, 2020. How electrification can help industrial companies cut costs.
[8] Ministry of Energy, 2023. Romanian Renewable Energy Tender – Information note to bidders.
[9] Energy Policy Group, 2022. What's holding back large-scale renewable deployment in Romania?

Box 1. The electrification of steel production

The electrification of steelmaking implies replacing primary steelmaking using the conventional blast furnace-basic oxygen furnace (BF-BOF) route, with secondary steelmaking using electric arc furnaces (EAFS) to melt scrap steel, or with primary steelmaking using the direct reduction of iron (DRI) to produce sponge or hot briquetted iron which is then melted in EAFs (DRI-EAF route). Both pathways have significantly lower CO_2 emissions than the conventional route, particularly if renewable electricity is used to power the EAFs, and if renewable hydrogen is used as a reducing agent in the DRI process.

Currently, Romania has 4 secondary steelmakers using EAFs, and Liberty Galați, Romania's only primary steel producer, is planning to convert from BF-BOF production to a DRI-EAF route, including using scrap steel, while doubling its production to 4.1 million tonnes (Mt) liquid steel/year by 2030. This shift is projected to increase the demand for scrap steel of Liberty Galați from 345,000 tonnes to 1.45 Mt per year by 2030, equivalent to nearly 80% of Romania's current steel scrap exports.

Resource efficiency and material substitution

Resource efficiency improvements generally occur through equipment modernisation and process control optimisation, which can lead to an overall reduction in the consumption of energy, water, and raw materials. While industrial resource efficiency has significantly improved since 1990, incremental improvements are still ongoing. In the context of the current energy price crisis, improvements in energy efficiency are the most visible measures taken by industry (including the reuse of waste energy), but material efficiency improvements are also important: EPG's modelling with Climact shows that the cement sector could achieve up to 50% emissions reductions through increases in material efficiency.[10]

Material substitution can be applied upstream (replacing industrial feedstocks with lower-carbon alternatives) as well as downstream (substituting industrial products for lower-carbon alternatives). Upstream material substitution occurs in secondary steel production, which uses scrap steel as its primary input, in the cement industry, where clinker is substituted for industrial waste products, and in the chemicals industry, where the recycling of intermediate chemical products or waste streams is common, including using captured CO_2 in the production process.[11] Downstream, material substitution can take place in construction (e.g., replacing steel or concrete with wood construction products), and can be part of a broader circular economy approach to increase the useful lifetime of industrial products.

The deployment of these measures is hampered by several barriers, including limited capital for investment.[12] Financial support for industrial energy efficiency projects is available, but the Ministry of Energy has been slow in disbursing key sources of funding, such as the Modernisation

[10] Energy Policy Group, 2022. Recommendations for Romania's Long-Term Strategy: Pathways to climate neutrality
[11] Systemiq, 2022. Planet Positive Chemicals.
[12] US Department of Energy, 2015. Barriers to industrial energy efficiency.

Fund.[13] In turn, the cost and availability of material substitutes may be a constraint, and alternatives may need to be investigated. For example, Romania could potentially face a shortfall of steel scrap,[14] or of blast furnace slag and fly ash (both material substitutes in cement production) as blast furnaces and coal-fired power plants shut down.[15] Furthermore, resource efficiency improvements have a technical limit for driving emissions reductions and will not achieve deep decarbonisation on their own. Downstream material substitution also lacks the right incentive structure, partly given the lack of accounting for embedded CO_2 emissions in materials. Adopting a whole-lifecycle approach for assessing sustainability, for example for building materials, can help move markets towards substituting for materials with a lower carbon content.

Low-carbon industrial fuels and feedstocks

The most important low-carbon fuels and feedstocks for industry are renewable hydrogen (produced by electrolysis using renewable electricity),[16] sustainable biomass and biofuels, and other fuels such as ammonia, methanol, and e-fuels.

Renewable hydrogen

Romania is bound by the EU's targets for using renewable fuels of non-biological origin (RFNBOs, which include renewable (green) hydrogen and e-fuels) in industrial production. By 2030, 42% of industrial hydrogen consumption must be met by RFNBOs, rising to 65% by 2035.[17] The most promising industrial uses for hydrogen are as a feedstock in chemicals and ammonia production,[18] as a reducing agent in DRI-based steelmaking, and, to a lesser extent, as a fuel to produce high-temperature industrial heat.[19] By 2050, the demand for hydrogen in these use cases could range between 187,000 and 393,000 tonnes per year, according to two different models.[20]

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[13] In the most recent revision of the EU ETS Directive and the Modernisation Fund, industry is specified as a recipient of priority investments for improving energy efficiency. Source: General Secretariat of the Council of the EU, 2023.

[14] In 2021, Romania exported 42% of the 3.23 Mt of scrap steel it generated. Under the assumption that Liberty Galați installs two EAFs as planned, and both the COS Târgoviște and Artrom Steel Tubes Reșița EAFs reach their full production capacity, Romania's steel sector would require all current scrap exports, plus 300,000 tonnes.

[15] Liberty Galați produces approx. 500,000 tonnes of slag per year, of which 50,000 tonnes was exported to a cement plant in France. Source: Liberty Steel Group, 2021.

[16] In this report, we refer exclusively to the use of renewable (green) hydrogen, as the most cost-competitive type of low-carbon hydrogen for reaching net zero emissions by 2050. Source: Energy Policy Group, 2021.

[17] Legislative Portal, 2023. Lege nr. 237 din 19 iulie 2023 privind integrarea hidrogenului din surse regenerabile și cu emisii reduse de carbon în sectoarele industriei și transporturilor.

[18] Renewable hydrogen will also play a significant role as a feedstock for fuel production in refineries. However, under the definitions associated with RFNBOs, hydrogen use in petroleum refining is classified under the transport sector, rather than the industry sector.

[19] Energy Policy Group, 2021. Clean Hydrogen in Romania – Elements of a strategy.

[20] In EPG's modeling studyl with Climact, the demand for hydrogen is projected to reach 187,870 t/year by 2050, while in Agora Energiewende's GEXIT model, the demand is projected to reach 393,939 t/year. Both figures exclude the use

The use of hydrogen in steelmaking can enable the largest emissions reductions per tonne,[21] and Liberty Galați is already planning to use renewable hydrogen in its future steelmaking process (Box 1). Renewable hydrogen could also generate new business opportunities for Romania's chemicals sector, as a future hydrogen supplier to industry and other sectors, such as transport.

Switching to hydrogen as an industrial fuel faces several challenges in Romania. Firstly, the required growth in renewable hydrogen production is huge: in its draft Hydrogen Strategy, the Romanian government estimates that the industrial consumption of renewable hydrogen will reach 80,000 tonnes by 2030; in 2021 Romania's production of hydrogen through electrolysis amounted to only 2,938 tonnes.[22] These projections are also likely to be significant underestimations: of these 80,000 tonnes, 23,700 are estimated to be used in DRI-based steelmaking at Liberty Galați, barely enough for the annual production of 0.5 Mt of steel, compared to Liberty's ambition to produce 4.1 Mt yearly by 2030. Such shortcomings need to be urgently addressed in the revision of the Hydrogen Strategy.[23]

Secondly, significant investments in renewable electricity for hydrogen production will be needed, and face the same challenges as outlined in

Direct electrification and renewable electricity. If Romania's existing industry is to meet 42% of its hydrogen demand from RFNBOs by 2030, this could require as much as 1.6 GW of additional renewable energy[24] (by comparison, at the end of 2022 Romania had 4.4 GW of total renewable energy capacity installed). Thirdly, the costs of an industrial hydrogen supply chain are significant. Industrial operators must bear the costs of expensive large equipment (such as electrolysers and DRI plants) with strained supply chains and long lead times, and potentially high transport costs for isolated hydrogen users.[25] For the Romanian state, the development of hydrogen transport infrastructure will likely be a costly and lengthy process[26] (see Infrastructure development to enable industrial transformation).

Biomass and bioenergy

Biomass and bioenergy will likely play a key role in industrial decarbonisation, provided that the biomass is carbon neutral and produced sustainably. Given the limited availability of sustainable

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of hydrogen as a refinery feedstock, which falls under the RFNBO transport category, rather than the industry one, and is outside of the scope of this report.

[21] Ministry of Energy, 2023. National Hydrogen Strategy and Implementation Plan (draft).

[22] Ministry of Energy, 2023. National Hydrogen Strategy and Implementation Plan (draft).

[23] Legislative Portal, 2023. Lege nr. 237 din 19 iulie 2023 privind integrarea hidrogenului din surse regenerabile și cu emisii reduse de carbon în sectoarele industriei și transporturilor.

[24] This figure does not include hydrogen consumption by refineries (included in the transport sector under the revised Renewable Energy Directive) or future industrial demand, such as from Liberty Galați after switching to DRI.

[25] European Alternative Fuels Observatory, 2023. Alternative fuels.

[26] Ministry of Energy of Romania, 2023. Draft National Hydrogen Strategy and Action Plan 2023-2030.

biomass, its utilisation should be prioritized for industrial processes with few alternatives for decarbonisation. Importantly, if biomass is utilised conjunction with carbon capture and storage (CCS), net-negative emissions could be achieved, to compensate emissions that cannot be completely abated.[27]

Biomass can supply industrial process heat by direct combustion or by conversion to biomass-based fuels. For the former, the use of industrial biomass residues is comparatively advantageous for industries with on-site biomass availability.[28] For the latter, the required conversion technologies, such as torrefaction, liquefaction, or gasification (e.g., to produce hydrogen and biomethane) are currently not commercially mature. Depending on the required temperature, different forms of biomass or its derivatives can be used to substitute fossil fuels in industry, for example in the non-metallic minerals sector (cement, lime, and glass production).

High investment costs and the availability of sustainable biomass are significant barriers to the use of biomass and bioenergy in industry. To contribute to emissions reductions and avoid disruption to existing ecosystems, the use of biomass and its derivatives must meet strict sustainability standards, and second-generation biomass must be prioritised to avoid exacerbating deforestation issues in Romania.

Green ammonia, methanol, and e-fuels

Other low-carbon fuels which can contribute to industrial decarbonisation are green ammonia (i.e., ammonia produced using renewable hydrogen), methanol, and synthetic fuels (e-fuels). Green ammonia is an important measure for decarbonising the production of nitrogen-based fertilisers (such as at Azomureș, Romania's largest fertilizer producer), but also as a key low-carbon fuel for shipping. Its development is primarily constrained by the availability of renewable hydrogen. Methanol is a key building block of a variety of chemical products and can replace naphtha as a lower-carbon feedstock to produce other downstream chemicals.[29] The emissions reduction benefits of methanol can be even higher if it is produced using biomass or waste as a feedstock, or by synthesis from renewable hydrogen and recycled CO_2 ("e-methanol"),[30] rather than from natural gas as a feedstock. Romania's only dedicated methanol producer, Viromet Victoria, bankrupted in 2020, and any effort to revive its production should plan for producing methanol from biomass or waste, or e-methanol.

[27] The climate neutrality scenario in Romania's draft Long-Term Strategy foresees 9.1 Mt CO_2 of industrial emissions remaining in 2050, which would need to be compensated through sources of negative emissions, such as BECCS. Source: Ministry of Environment, 2023.
[28] IEA Bioenergy, 2021. Decarbonizing industrial process heat: the role of biomass.
[29] Systemiq, 2022. Planet Positive Chemicals.
[30] Chimcomplex, 2021. Non-financial report 2021.

As with e-methanol, other useful hydrocarbons can be synthesised from renewable hydrogen and captured CO_2. Collectively termed „synthetic fuels" or „e-fuels", they are receiving increasing attention in the EU, and have contributed to the diversification of chemicals production portfolios. No chemicals company in Romania has made a clear commitment to advancing e-fuels production, and their use is currently not mentioned in key climate strategies. The development of these fuels in Romania may be constrained by their economics, particularly considering conversion losses, but could be investigated as a decarbonisation measure for aviation and shipping, and as a new value chain for chemicals producers.

Carbon capture, utilisation, and storage

Carbon capture, utilisation, and/or storage (CCUS) may be the only solution for avoiding inherent process emissions in sectors such as cement and chemicals. To meet its potential obligations under the proposed Net Zero Industry Act (NZIA; see Box 2), Romania may need to store as much as 10 Mt of CO_2 annually by 2050; for comparison, the national draft Long-Term Strategy commits to only 2.6 Mt annually. Romania does have good potential for geological CO_2 storage (see Box 2), but currently has no large-scale CCUS projects in operation, and few publicly stated plans by industry (see Box 2). The deployment of large-scale CCUS has been hampered by a general lack of engagement from national authorities, resulting in an incomplete regulatory framework, including the absence of procedures for CO_2 transport, and low institutional capacity. Recent developments, such as the establishment of a working group on CCUS within the Government's Interministerial Committee on Climate Change, may indicate fresh political interest in the subject. However, at the moment these institutional barriers are still present, and state support for financing the high capital and operating costs of carbon capture units and for building out transport infrastructure is lacking. Public awareness and acceptance of CCUS, particularly of onshore CO_2 storage, may delay or even derail carbon capture and storage (CCS) projects: although reception was generally positive to Romania's Getica project, a planned CCS demonstrator which never materialised, more recent experiences have shown concentrated local opposition from communities local to CO_2 storage sites. [31] This suggests that more may be required of project developers and state partners to meaningfully engage the public with CCUS.

[31] Jurnalul de Argeș, 2023. Video. Răscoală la Boţeşti împotriva OMV Petrom!

Box 2. Carbon capture and storage opportunities in Romania
CCUS comprises the capture of CO_2 from flue gases and its subsequent utilisation (CCU, whose climate impact depends on the utilisation pathway) or storage in geological formations (CCS, the most certain pathway for permanent sequestration of CO_2 away from the atmosphere). A significant barrier to the deployment of CCS has been the lack of injection-ready storage capacity, exacerbated by the lack of a specific target or mandate for making storage available. The EU's recently proposed Net Zero Industry Act (NZIA) aims to break this deadlock by mandating oil and gas operators to develop CO_2 storage capacity. In Romania, viable storage capacity could be as high as 514 Mt in onshore depleted hydrocarbon reservoirs alone, equivalent to storing the CO_2 emitted over 55 years by Romania's cement and chemicals industries at current levels of production. Storage potential in onshore saline aquifers may be much higher, but is less well-researched, as is offshore storage potential in the Black Sea, which may increase from the late 2030s after deepwater gas capacities are exploited. This potentially significant national storage capacity, coupled with Romania's significant history of subsurface exploitation for oil and gas extraction, could even position Romania as a regional CO_2 storage hub.

A roadmap for industrial decarbonisation in Romania

There are numerous pathways for decarbonising Romania's heavy industry, involving technologies at different levels of maturity, cost, and applicability to different sectors. While their purposeful deployment will provide critical support to reaching economy-wide net zero emissions, they are costly, require significant infrastructure and supply chain investments, and may be vulnerable to a host of new trade and import dependencies. To overcome these challenges, urgent action is needed in the areas of **industrial policy**; **funding, financing, and market creation**; and **infrastructure development**. These three broad enablers will help unlock industrial decarbonisation projects, as well as capitalise on some of Romania's key advantages to increase competitiveness and open new business opportunities. The below table shows the necessary steps in these three areas, based on EPG's research and input from industrial stakeholders. It is designed to be read in conjunction with the remainder of this paper, which provides additional detail on the three areas of intervention.

Priority actions for decarbonising Romania's heavy industry

Industrial Policy

TIMELINE	KEY ACTION	APPROACH	RESPONSIBLE
by 2025	**Develop a national industrial strategy**	Develop a comprehensive national industrial strategy, underpinned by a climate neutrality commitment (e.g. in a national framework climate law or a cross-party agreement), grounded in a continuous dialogue with industry, a good level of coordination between authorities, proactive positioning in EU negotiations, and an honest appraisal of institutional gaps and bottlenecks. The strategy should: • Explain the fundamental transformation of the industrial landscape • Identify and selectively support the industries with high potential competitiveness • Contain clear emissions reduction targets, a clear sectoral decarbonisation plan, a clear funding and financing plan, green public procurement plans and infrastructure development, and an evaluation of costs, socio-economic impact, supply chains and R&D • Be based on an extensive stakeholder consultation process with economic operators and civil society.	Chancellery of Prime-Minister (strategic oversight) Ministry of Economy (implementation)
2025-2026	**Assign institutional responsibilities and build capacity**	Elaborate a clear governance framework (Fig. 4), assigning clear responsibilities for implementing the strategy, managing the various relevant funds, and offering assistance. Commit to increasing institutional knowledge and capacity in industrial decarbonisation (e.g., new staff positions, knowledge exchange).	Ministry of Economy (governance framework) All involved institutions (building capacity)
2025-2026	**Ensure internal consistency of policies**	Align industrial strategy with strategies for attracting foreign direct investment (FDI), economic development, competition, infrastructure development, and educational policies. Promote increased participation in international R&D projects and establish centres of excellence for a low-carbon industry. Ensure equitable distribution of the positive effects of industrial transformation, particularly in Just Transition regions, especially through dedicated training and reskilling.	Ministries of Economy, Trade, Investment and European Projects, Energy, Transport and Infrastructure, Education, Research, Innovation and Digitalisation, Development
2023-2027	**Proactively engage in EU negotiations**	Assume a strategic position as an EU Member State to ensure that appropriate incentives for industrial decarbonisation are being distributed equitably: • Support the adoption of the Net Zero Industry Act • Engage with the revision of the Multi-annual Financial Framework and the redesign of EU Cohesion Policy to support new industrial value chains • Support the introduction of green public procurement criteria for disbursing Structural and Cohesion funding • Support the earmarking of funds for low-income Member States in the Innovation Fund.	Ministries representing Romania in relevant EU Council configurations Permanent Representation of the European Commission to Romania Romanian Members of the European Parliament

Funding, Financing and Market Creation

TIMELINE	KEY ACTION	APPROACH	RESPONSIBLE
by 2025	**Increase the absorption rate of EU funds and the efficiency of disbursement of national and EU funding**	Open the call for projects on industrial energy efficiency and CCS under the Modernisation Fund. Encourage and support applications to the Innovation Fund. Clarify the disbursement of the Just Transition Fund to Romania's industrial Just Transition regions. Participate in Projects of Common Interest or Important Projects of Common European Interest to unlock EU funds under the Cohesion Policy. Ensure that state aid for industrial producers is granted to selected operators with the highest competitiveness, as identified in the industrial strategy.	Ministry of Energy (Modernisation Fund, state aid) Ministry of Investment and European Projects (Innovation Fund, Just Transition Fund)
by 2025	**Create a market for green intermediate industrial products**	Adopt a GPP framework for intermediate industrial products, including steel, concrete, and other building materials, based on standards formulated by Romania or adopted from existing international standards.	Environmental Fund Agency Ministries of Energy and Environment
2023-2025	**Increase public spending on industrial decarbonisation**	Fund R&D for innovation in industrial decarbonisation. Fund priority infrastructure for electricity, hydrogen and CO2 transport. If deemed necessary, implement carefully targeted state aid schemes to support energy costs, conditioned by operators' transition plans. The National Bank of Romania adopts a green mandate.	Ministry of Research, Innovation and Digitalisation (R&D) Ministry of Transport and Infrastructure, Ministry of Energy, National Regulatory Authority for Energy, National Agency for Mineral Resources (infrastructure) Ministries of Finance and Energy (state aid schemes) National Bank of Romania
2025-2026	**Unlock private financing**	Mobilise private finance through blended finance and other instruments, e.g. carbon contracts for difference (CCfDs). De-risk private financing of industrial decarbonisation, including through public-private partnerships, blended finance, state-backed guarantees, and issuing green bonds or time-limited subsidies to cover operational costs. Support industrial operators in preparing their business plans by encouraging the procurement of low-carbon industrial products, increasing confidence in associated revenue streams. Attract development financing from international development banks, such as the European Bank for Reconstruction and Development. Implement a one-stop service for companies, including technical assistance and facilitating commercial agreements with buyers.	Ministry of Finance (financial instruments, green public procurement, development financing) Industrial operators (preparing and advancing business plans for commercial financing) Ministries of Development, Economy, Energy and Environment (development financing) Ministry of Economy (one-stop shop)
2025- 2030	**Assign institutional responsibilities and build capacity**	Use EU ETS revenues to support industrial decarbonisation, e.g., by designing a support scheme for industrial companies to apply for EU funding.	Ministry of Finance and Ministry of Environment

Enabling Infrastructure

TIMELINE	KEY ACTION	APPROACH	RESPONSIBLE
by 2025	**Prepare Romania's national electricity grid for industrial decarbonisation**	Expand and modernize the electrical transmission grid. Update TSO 10-year development plans to reflect the need for grid expansion and modernisation, the increased renewables targets under the Fit for 55 and RePowerEU packages, as well as the geographical changes in electricity demand of an electrifying Romanian industry. Review and commit to needs for energy storage to facilitate uptake of renewable energy by an electrifying industry.	Ministry of Energy Transelectrica (TSO)
by 2025	**Establish Romania's national CO2 transport system and encourage CO2 storage**	Clearly assess and highlight the role of CCU and CCS in industrial decarbonisation. Conduct an evaluation of Romania's CO2 storage potential. Amend or develop relevant legislation for CO2 transport, including ratifying the London Protocol. Assign transport development and operation obligations to a specific operator. Improve institutional capacity and knowledge to accelerate permitting procedures. Consider public-private partnerships for the operation of storage sites. Support the adoption of the Net Zero Industry Act.	Ministries of Economy, Energy, and Environment National Regulatory Authority for Energy, National Agency for Mineral Resources (secondary legislation, permitting)
by 2027	**Establish Romania's national hydrogen transport system**	Elaborate a clear plan for the repurposing of natural gas pipelines and building of new hydrogen pipelines, including investigating potential "hydrogen valleys". Establish a framework for regulating hydrogen pipeline transport, including ensuring third-party access. Roll out support schemes for funding hydrogen pipelines, making best use of state aid and other financial instruments. Consider joining the European Clean Hydrogen Alliance or other similar platforms to enable the development of large-scale, cross-border infrastructure.	Transgaz (elaboration of pipeline plan) Ministry of Energy (regulatory framework, support schemes, Clean Hydrogen Alliance) National Regulatory Authority for Energy (secondary legislation)

A Romanian industrial policy fit for a low-carbon future

Central to Romania's industrial decarbonisation is **the development of a national industrial policy** which tackles emissions and competitiveness together. The current ruling coalition has committed to revising Romania's industrial competitiveness strategy (2021-2027),[32] an excellent opportunity to comprehensively address the needs of the transition to a low-carbon industry. Romanian industrial policy is currently fragmented and lacking ownership, leading to investment

[32] Romanian Government, 2023. Programul de guvernare iunie 2023-decembrie 2024.

bottlenecks, an unclear regulatory and permitting landscape, and low public awareness of the scale of the transformation challenge.[33]

To be successful, Romanian industrial policy must be resilient, clear, and well-reflected in other national policies. To promote **long-term resilience over political cycles**, the strategy (in whatever form it is adopted) should be anchored in longer-term climate policy and in continuous dialogue with industry to secure long-term buy-in. Some first engagement in this sense is already underway between government and industry, on climate partnerships and on CCUS. An industrial strategy can be made resilient by also being forward-looking and frank in its assessment of how Romania's industrial landscape will need to transform. Rather than seeking a bailout of the industrial status quo, Romania's industrial policy should identify and selectively support the industries with high potential competitiveness in a low-carbon world, based on a *Smart Specialisation*[34] approach.

Romania's future industrial policy must also provide **clarity, including on institutional responsibilities.** An industrial strategy should contain clear CO_2 emissions reduction targets for 2030, 2040, and 2050 (industry-wide and sectoral), and clear sectoral decarbonisation plans,[35] outlining the role of different technological pathways. It should clearly outline how much the transition is estimated to cost, how different funding, financing, and market creation measures will contribute, and how the required infrastructure will be developed. The strategy must also evaluate the impact of decarbonisation beyond industrial sites, including a commitment to alleviate the socio-economic impact of industrial decarbonisation through training and reskilling, an evaluation of the expected changes in supply chains (considering the need for new or alternative materials), and a plan to enable R&D and innovation.

Romania's industrial strategy must also assign institutional responsibilities for implementing, monitoring, evaluating, and revising national industrial policy, for example as shown in Figure 3. Within such a framework, institutions must be well-coordinated and must commit to increasing their knowledge and administrative capabilities for industrial decarbonisation, by staffing dedicated positions, engaging in knowledge exchange, and implementing educational efforts.

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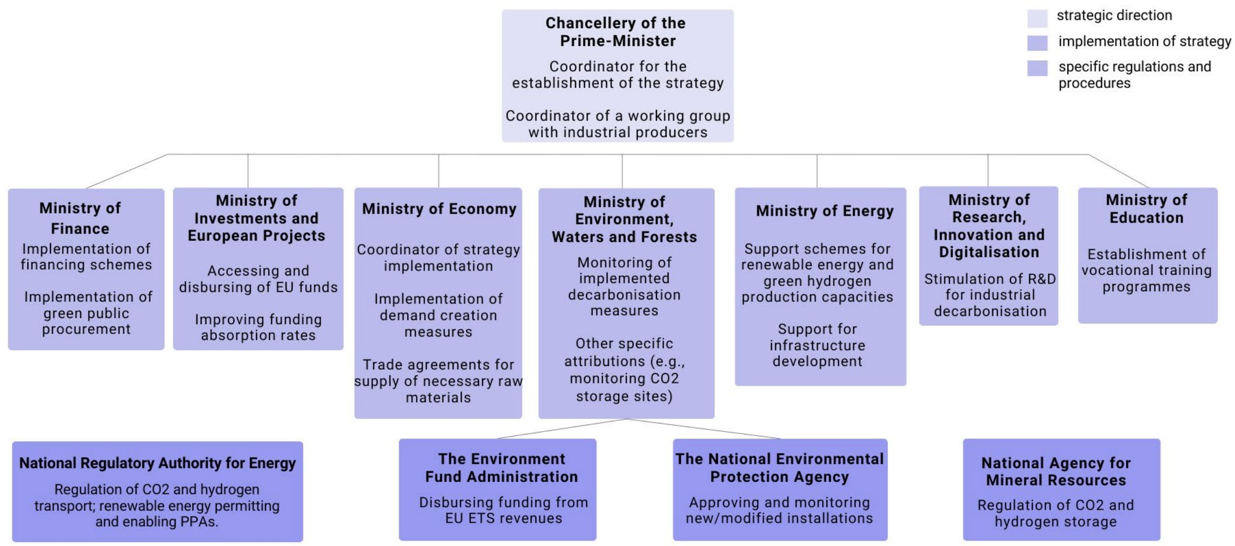
[33] Vienna Institute for International Economic Studies, 2023. Industrial Policy for a New Growth Model.
[34] Smart Specialisation refers to an approach characterised by the identification of strategic areas for intervention, guided by an analysis of strengths and economic potential. It is already used at EU and national levels, including in Romania (for research and innovation, and for regional development).
[35] These sectoral plans can be anchored in existing analyses, such as the European Commission's roadmap for decarbonizing the chemicals sector.

Figure 3. Example organizational diagram for the formulation and implementation of an industrial policy focusing on the needs of the transition to a low-carbon industry. The Presidential Administration could also provide strategic input into the formulation of the strategy.



Finally, Romania's industrial strategy must be **consistent and reflected in other key policy areas**, both in terms of positioning on the EU arena and of the domestic policy landscape. Externally, Romania can accelerate its industrial decarbonisation by proactively and strategically engaging in EU negotiations and promoting instruments for industrial decarbonisation which do not require excessive reliance on state aid, a major divider between Western and Eastern European MSs.[36] Internally, the Romanian government should pay particular attention to the alignment of its industrial strategy with other domestic policy areas, targeting efforts to attract foreign investment at competitive industries, ensuring the equitable distribution of investment returns and positive effects, keeping economic development and competition healthy, and aligning with spending on infrastructure, technical education and skills, and R&D.

Funding, financing, and market creation instruments

The high capital and operating costs of many industrial decarbonisation measures make funding and financing one of the priorities for reducing industrial emissions. Importantly, the ongoing international revival of national industrial policy implies a new focus on supporting industry through state aid, which in the EU has been given significant additional scope until 2026, through

[36] One example could be the economic convergence instruments anchored in the EU's Cohesion Policy, which could benefit Romania by supporting new industrial value chains through economic convergence instruments.

the Temporary Crisis and Transition Framework and the General Block Exemption Rules. State aid measures to support industrial decarbonisation are already being negotiated in Member States such as Germany, which seeks to introduce a de facto cap on electricity prices for companies providing industrial transformation plans. Romania is considering launching similar state aid schemes, but as a country with a narrower fiscal space and generally lower capacity to mobilise national funds, it will need to **carefully prioritize its state aid**, conditioning support on operators' transition plans, and design its schemes in complementarity with allocating available EU funding and leveraging private financing. Indeed, EU funding and the mobilisation of private financing must be prioritised as the primary instruments for supporting industrial decarbonisation and aligned with sustainability criteria including the EU Taxonomy.

Certain EU funds are good instruments for enabling industrial decarbonisation, and Romania must **improve its absorption rate and efficiency of disbursement** for these funds. The most impactful actions will likely be around better use of the Modernisation Fund for industrial decarbonisation (however, these funds need to be spent by 2030), increasing participation in the Innovation Fund, and unlocking EU funds under the Cohesion Policy by participating in cross-border projects. The disbursement of these funds must consider the fact that some industrial operators have higher capital than others, and some require solutions which are not yet technologically mature. A small pot of funding could also be made available from Romania's **revenues from auctioning EU ETS allowances**. Although Romania has chosen to transfer most of this revenue to its share of the Modernisation Fund, €5.4 billion in ETS revenues are estimated to still be available between 2021 and 2030,[37,38] which must be spent entirely on climate-related activities. A small amount of these revenues could be made available through the Environmental Fund Agency to help industrial companies apply for EU funding or financing (such as the Innovation Fund, the European Investment Bank, or the European Bank for Reconstruction and Development).

In addition to directly supporting industrial decarbonisation through targeted state aid, funding for R&D and infrastructure, Romania should **leverage its public funds to unlock private financing**. In general, Romanian debt financers, such as commercial banks, have restricted their lending to energy efficiency projects. De-risking private financing for deep decarbonisation measures can be enabled through a variety of instruments, such as public-private partnerships (including with local authorities), blended finance, state-backed guarantees, and green bonds or time-limited subsidies to cover the operational costs of industrial decarbonisation. If the state helps create new markets for green industrial products (see next paragraph) and provides assurance that the necessary infrastructure will be built, industrial operators can gain more revenue certainty and further attract private finance. Development banks, such as the European Bank for Reconstruction and Development, can also signal the mobilisation of private financing by increasing their loan

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[37] Assuming a carbon price of €90/tonne CO_2. Source: E3G, 2023. Industrial transformation for all Europeans.

[38] E3G, 2023. Industrial transformation for all Europeans.

base for industrial decarbonisation in Romania, which also requires more involvement from the state to attract development financing.

Alongside funding and financing, the success of industrial decarbonisation is also dependent on a reliable lead market for green industrial products. While European buyers of intermediate industrial products have already initiated partnerships for purchasing low-carbon industrial products (such as automakers Porsche,[39] Volvo, and others[40]), such commercial agreements are less common in Romania. To this end, a key instrument for market creation could be **green public procurement (GPP)**, whereby state authorities commit to purchasing intermediate industrial products (such as steel and cement) which meet green criteria. With large-scale infrastructure spending projected to be significant (Romania has committed to dedicating 2% of GDP over the next decade to transport infrastructure alone[41]), these purchases could become an important market pull instrument.

Efforts to promote GPP in Romania have mostly been restricted to consumables and finished products such as motor vehicles.[42] A law to this effect was passed in 2016, but Romania failed to adopt the subsequent action plan, and to this day most public authorities have not respected GPP criteria when purchasing consumables.[43] This means that expanding this GPP framework to include industrial products such as steel and cement requires new regulation as well as a shift in mentality and a build-up of capacity on GPP by public entities.

Infrastructure development to enable industrial transformation

The pathways for industrial decarbonisation come with a significant need for infrastructure: a decarbonised electrical grid capable of sustaining increasing loads, and networks of pipelines for the transport of i) renewable hydrogen and ii) captured CO_2. Although outside of the main scope of this report, the Romanian government must also consider the need for road, rail, maritime and riverine transport corridors to better connect industrial producers to buyers of green industrial products and to enable them to access new markets. All this infrastructure will be costly, requires significant state regulatory and financial support, and may also be more challenging than elsewhere in Europe, as industrial emitters tend to be more dispersed and thus require longer distances for connection to electricity, hydrogen and CO_2 infrastructure.

[39] H2 Green Steel, 2023. Porsche plans to use CO_2-reduced steel from H2 Green Steel in sports cars from 2026.
[40] Green Steel World, 2022. Green steel partnerships: a lynchpin for auto industry's real transformation.
[41] Economedia, 2021. România ar trebui să aloce, în 10 ani, circa 2% din PIB pentru cofinanțarea proiectelor de dezvoltare a infrastructurii.
[42] Legislative Portal, 2016. Lege nr. 69 din 25 aprilie 2016 privind achiziţiile publice verzi.
[43] Romanian Association for Local Sustainable Development, 2021. Primul studiu național privind utilizarea achizițiilor publice verzi în România.

To prepare Romania's national electricity grid for industrial decarbonisation, **the electrical transmission grid must be expanded and strengthened, quickly and significantly**. The implications for added load are not trivial; the electrification of primary steel production could create additional loads as high as 8.4 TWh/year if the associated renewable hydrogen is produced in Romania (Box 3). Other additional increases could follow a growth in production (e.g., from secondary steelmakers[44]), or from the electrification of lower-temperature heat in other industrial sectors. The geographical distribution of industrial electricity consumption may also change if new consumers come online for facilities at locations where electricity demand is currently relatively low. Of course, for electrification to enable true emissions reductions, all these new electrical loads from industry must be supplied by renewable electricity.

Box 3. Increased electrical loads from the transformation of Liberty Galați
Liberty Galați's planned shift to a DRI-EAF steel production route implies additional electricity consumption for i) producing the renewable hydrogen to be used in the DRI plant, and ii) powering the EAFs to melt sponge iron and scrap steel into liquid steel. The majority (around two-thirds) of this electricity consumption will be from the electrolysers used to produce renewable hydrogen. If produced in Romania, this will add a significant load to the national grid, which must be met by renewable electricity. In total, Liberty's planned transformation (including an increase in production and the use of scrap as well as sponge iron), would add an electrical load of approx. 8.4 TWh per year to Romania's grid by 2030, if the hydrogen is domestically produced. This is equivalent to almost one-fifth of Romania's total electricity consumption in 2022.

To facilitate industrial hydrogen use, Romania will need to **develop a network of hydrogen transport and storage capacities**. Although Romania's draft Hydrogen Strategy assumes that industrial hydrogen will be produced on-site until 2030, in some cases it is unclear how such significant electrolyser capacities would be implemented on-site (for example, at Liberty Galați). A hydrogen pipeline network, complete with local storage, will therefore be needed. It is possible to modify existing gas transport corridors for hydrogen transport, but this may require major retrofit (Box 4) and would be unlikely to perfectly match the future sources of demand for industrial renewable hydrogen, thus potentially requiring new pipelines to be built. As such, a clear plan is needed both for retrofitting and building new hydrogen pipelines, aptly locating new large-scale hydrogen production capacities (such as in "hydrogen valleys") and providing appropriate regulation and financial support for hydrogen transport.

[44] For example, if ArcelorMittal Hunedoara and COS Târgoviște returned to their full production capacities, this could add an estimated 0.63 TWh of electricity consumption to the grid.

Box 4. A new life for Romania's gas pipelines: hydrogen transport

The retrofitting of natural gas pipelines for enabling hydrogen transport implies an improvement in corrosion resistance and impermeability, both to allow the injection of hydrogen into the grid for blending, and to repurpose gas pipelines for hydrogen transport. Romania's gas TSO Transgaz has identified eleven potentially eligible corridors, some of which may benefit large industrial consumers looking to switch to hydrogen as part of their decarbonisation efforts. For example, Liberty Galați is well-positioned in proximity to eligible transport corridors which would require little investment for transporting hydrogen. These include the three parallel pipelines linking Isaccea to Negru Vodă which traverse the south-eastern region of Dobrogea, a potential clean hydrogen valley, as well as connecting to the grids of Ukraine and the Republic of Moldova. However, gas corridors in the vicinity of other major industrial operators, such as Azomureș and OMV Petrom's Petrobrazi refinery, may require major retrofit before they are suitable for hydrogen transport.

Finally, to enable CCUS as a decarbonisation pathway for specific industries, Romania must **develop** CO_2 **transport and storage infrastructure** (currently non-existent within its territory). Unlike hydrogen, repurposing gas pipelines for CO_2 transport is more challenging (although sometimes suitable over short distances),[45] and the buildout of new infrastructure is reliant on several key components: a detailed understanding of Romania's actual CO_2 storage potential, appropriate regulatory procedures for CO_2 transport, an increase in CCS knowledge of local authorities to enable a coordinated approach to pipeline construction, and completion of cadastral surveys to help identify landowners and obtain construction approvals.[46] Mandating a specific CO_2 transport operator (such as Transgaz) could accelerate infrastructure buildout, which should be based on a CO_2 network development plan which would allow remote emitters to pursue optimal strategies for sending their CO_2 to storage or utilisation sites. To make storage capacity available, Romania should support the storage obligations outlined in the proposed NZIA, which could provide a major stimulus for converting depleted hydrocarbon reservoirs to CO_2 storage sites, which represent a regional asset.

[45] Berstad et al, 2021. Current state of CCS technologies and the EU policy framework.
[46] Miu et al, 2021. Assessment of current state, past experiences and potential for CCS deployment in the CEE region: Romania.

Annexes

Annex 1. Steel

Overview of Romania’s steel industry

Steel is an essential material in many industries, including in infrastructure development and in construction. It is manufactured through primary production (using iron ore and most commonly the blast furnace-basic oxygen furnace (BF-BOF) route) or secondary production (using scrap steel and most commonly the electric arc furnace (EAF) route). The EAF route is much less carbon-intensive (0.07 t CO_2 per tonne of crude steel, compared to 1.8 t CO_2 for the BF-BOF route), but there are limitations to the final steel products which can be manufactured through this route.

The Romanian steel sector is an important contributor to the national economy. In 2019, the steel-related sectors accounted for 2.9% of total industrial production value, 1.4% of total value added, and 1.6% of the workforce. The sector is export-oriented, primarily towards EU countries, and in 2022 exports of semi-finished and finished steel products accounted for around 7% of total exports, and ten steel products ranked among country’s top-100 most competitive exports. Romanian steel production is also highly energy intensive, accounting for 22-24% percent of total industrial energy consumption over the period 2015-2012. The greenhouse gas (GHG) intensity of Romania’s basic metals sector stagnated between 2008 and 2020 and is currently more than double the EU average of 0.49 kg CO_2-equivalent per Euro of output.

Liberty Galați is Romania’s only primary steel producer, using the BF-BOF steelmaking process, with only one blast furnace still operational. In 2021 it produced 2.35 Mt of liquid steel and 3.51 Mt of finished products. It is a major employer, accounting for more than of 17% of employees in the basic metals sector in 2021. Its production and emissions have decreased dramatically since 1990, but in 2022 it remained Romania’s largest point-source industrial emitter, with 3.2 Mt of CO_2-eq verified under the EU ETS.

Romania’s remaining steel producers are all secondary steel producers using the EAF route: Tenaris Silcotub Călărași (formerly Donasid), ArcelorMittal Hunedoara (formerly Siderurgia Hunedoara), Artrom Steel Tubes Reșița (formerly TMK Reșița) and COS Târgoviște, now owned by Donalam (Beltrame Group). They each produced between 45 and 600 thousand tonnes of liquid steel in 2021 and generated relatively small amounts of emissions. However, they are important electricity consumers who would benefit from securing contracts with renewable electricity providers, and important consumers of steel scrap who may be strained under a scenario of increased demand and low scrap availability (Romania currently exports approx. 40% of its scrap steel).

Net zero for the steel industry: technologies and pathways

In Europe, the most viable measure for decarbonisation of the steel industry is to substitute the BF-BOF steelmaking process for a lower-carbon process.[47] The most advanced substitute process is direct reduction of iron (DRI) using hydrogen and EAF melting. In this process, iron ore pellets are used as a raw material to produce sponge iron, which is then melted into crude steel in an EAF. For the direct reduction of iron, the lowest specific emissions are enabled if renewable hydrogen is used as a reducing agent. The DRI-EAF route using hydrogen is mature, and commercial announcements have been made for plants in Sweden and Germany. In Romania, Liberty Galați has stated that it plans to use the DRI-EAF route to substitute its current production route and reach net zero CO_2 emissions by 2030.[48]

Switching to DRI-EAF encompasses two key decarbonisation measures, which must be deployed together: electrification and use of low-carbon fuels.

Electrification

By replacing the basic oxygen furnace with EAFs, the energy mix requirement of a steel producer will change from being primarily a natural gas consumer (for the production of high-temperature heat) to being primarily an electricity consumer (to power the EAFs). In Romania, the electrification of steel production began a few decades ago, with Artrom Steel Tubes Reșița and ArcelorMittal Hunedoara changing from blast furnaces to scrap-based EAF production in 1993. Both these steel plants significantly reduced their production volumes after electrification; however, Liberty Galați plans a doubling of its liquid steel production capacity (see below).

Low-carbon fuels: hydrogen

Using hydrogen as a reducing agent can reduce the specific emissions of the steel production process to virtually zero, if the hydrogen is renewable (produced through electrolysis using exclusively renewable energy). Some Romanian steel producers and processors already use hydrogen (Liberty Galați and Oțelinox, a steel processor, and Erdemir, a producer of iron powders), but none of it is known to be renewable. The transformation of Liberty Galați will lead to a much more profound shift in renewable hydrogen consumption. It is not clear how this consumption will be supplied, particularly given that natural gas will be used as a reducing agent in a transitional period before switching to renewable hydrogen (see below).

Alongside process switching to DRI-EAF, incremental improvements in energy and material efficiency are also still achievable in Romanian steel production, particularly given the age of some assets. Their contribution to decarbonisation is minor compared to that of electrification and that of fuel switching with renewable hydrogen, but there is still potential for improvement.

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[47] E3G, 2021. 1.5°C Steel - Decarbonizing the steel sector in Paris-compatible pathways.
[48] Liberty Galați, 2022. Our journey to GREENSTEEL and CN30.

Investments and plans by Romania's steel producers

The electrification of steel production will depend on the deployment of large renewable electricity capacities at affordable prices, to meet increased electricity demand. Liberty Galați has requested funding under the national Recovery and Resilience Plan (RRP) for mostly small renewable capacities destined for supplying non-industrial operations (50 MW of photovoltaic energy, which can produce up to 90 GWh per year; the plant's electricity consumption even before electrification was nearly 820 GWh). In 2020, the company announced a joint venture with gas producer Romgaz to invest in greenfield developments for wind and solar energy. Since 2021, Liberty Galați has also introduced a series of incremental investments in energy efficiency, totalling €18 million.

The most important decarbonisation plan put forward by any Romanian steel producer is the aforementioned plan to switch to DRI-EAF at Liberty Galați. The company has released a public decarbonisation plan in which it outlines its transition from BF-BOF to DRI-EAF using renewable hydrogen by 2030, in parallel with a doubling in liquid steel production capacity to 4.1 Mt liquid steel/year, by increasing capacity of its mills and the installation of a compact mini-mill rebar and wire rod plant. This phased approach is stated to reduce specific emissions from 1.8 to 0.75 tCO_2/tonne of liquid steel (natural gas DRI), and further to 0.3 t CO_2/tonne liquid steel (renewable hydrogen DRI). While the transition to hydrogen-based DRI will eliminate the use of coking coal and associated import dependence, the transitional use of natural gas will increase the plant's natural gas consumption fourfold compared to 2021 levels. According to the company, in late 2021 it had started its R&D project for hydrogen usage.[49] Two EAFs are planned to be installed, already purchased from the Dongbu steel plant in South Korea, reducing dependence on imported iron ore (including from Ukraine) and on coking coal, but increasing the demand for natural gas fourfold during the transition period, and the demand for steel scrap from 345,000 tonnes to 1.45 Mt per year, equivalent to nearly 80% of current Romanian scrap exports. [50]

Annex 2. Cement

Overview of Romania's cement industry

Cement is the main ingredient of concrete and mortar and one of the most widely used building materials in the world. Its production involves a significant proportion of hard-to-abate emissions (nearly two-thirds) from the chemical processes involved in production, most notably the production of clinker (the precursor to cement). Clinker production involves the calcination of limestone, more precisely the heating of limestone to produce calcium oxide (or lime), the main ingredient of clinker.

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[49] Liberty Galați, 2022. Our journey to GREENSTEEL and CN30.
[50] Liberty Galați, 2022. Our journey to GREENSTEEL and CN30.

Like with all heavy industry sectors in Romania, cement production declined after 1990, halving in the decade to 2000 alone. Romania's seven operational clinker production plants are owned by multinational companies (HeidelbergMaterials, Holcim, and CRH, with the latter operating under the subsidiary Romcim in Romania). Their total cement production capacity stands at 16 Mt, with around 8 Mt of cement production in 2016 and plants relatively scattered around the country, generally co-located with lime producers and isolated from large industrial clusters. Cement, lime, and glass production employed 48,237 people and contributed 0.74% to national gross value added (GVA) in 2021. The export competitiveness of these sectors declined between 1990 and 2010, rising slightly after 2015.

Emissions from fuel combustion and process emissions from the cement sector are a major driver of Romania's industrial emissions. Overall, emissions from the cement industry have remained relatively stable over the 2007-2021 period, except for an increase at Holcim's Câmpulung plant due to the opening of a new clinker production line, with further increases in production planned. In 2021, emissions from fuel combustion in the cement, lime, and glass manufacturing sectors stood at just under 4 Mt CO_2/year, nearly 5% of total national emissions, while process emissions from the cement industry alone (approx. 4 Mt CO_2/year) made up a higher-than-average share of total national emissions in Romania than the EU average (5% of national CO_2 emissions, compared to the EU average of 2.4%).

Net zero for the cement industry: technologies and pathways

Improvements in resource efficiency, material substitution, and carbon capture and storage (CCS) are the main pathways for decarbonising the cement industry. While the first two pathways are generally incremental improvements whose technical potential is limited, the implementation of carbon capture is possibly the only way to reduce hard-to-abate process emissions from the cement production process itself.

Resource efficiency and material substitution

Globally, the cement industry has implemented a suite of measures to improve energy and resource efficiency: a switch from wet to dry kilns, the industry's modern standard for producing clinker, and the installation of pre-calcination units, have driven improvements in the efficiency of energy and resource consumption. Digitalization, including the use of AI and robotics, can also offer operational efficiency gains in the 10-20% range.[51] Further efficiency improvements can be gained from the reuse of waste heat, as there are significant heat losses from the manufacturing process which could be recovered and converted to electricity.

Material substitution is also an important driver for decarbonising cement production. This can occur upstream, as part of the cement production process: in blended cement production, it is now relatively common to substitute clinker for other cementitious binding agents, reducing the

[51] Fennell, P.S., Davis, S.J., Mohammed, A., 2021. Decarbonizing cement production.

"clinker content" of the final cement product. The most common substitutes are blast furnace slag (a waste product from steel production using the BF-BOF route) and fly ash (a waste product from coal-fired power plants). As coal-fired power production is phased out, and steel producers look to move away from the BF-BOF production route, the availability of these substitute materials could decline. Some pilot and demonstration projects are underway for various alternative binding agents, including ones that can act as CO_2 sinks, as they enable concrete hardening to take place in a CO_2-rich environment, where this CO_2 can be absorbed by the concrete as it hardens (*concrete curing*).[52]

Most cement producers also partially substitute the fossil fuels used for producing high-temperature heat (e.g., coal and petcoke) with biomass and various types of waste (including biogenic waste, municipal waste and tires). These materials are co-incinerated with fossil fuels but could theoretically replace fossil fuels completely to generate the required heat. However, the emissions reduction benefits delivered by this substitution depends on a careful analysis to trace the origin and life-cycle emissions of these substitutes. The use of biomass and waste substitutes is the most promising for reducing fossil fuel use – the use of hydrogen or electricity requires new kilns which are complex and costly to design and deploy.

Carbon capture, utilisation, and storage

Carbon capture, utilisation, and/or storage (CCUS) is one of the most potentially impactful measures for decarbonising cement production. It involves the separation of CO_2 from the plant's waste gases, preparation of the CO_2 (including purification and temporary storage) before transport to a location for further use (CCU) or permanent storage (CCS). There are several different technologies available for capturing CO_2, and for transporting it through pipelines or by road, rail, ship, or barge.

The capturing of CO_2 is a complex technology with a growing number of options available, including ones deployed in conjunction with the electrification of high-temperature process heat. For cement plants, the typical concentration of CO_2 in the flue gas stream is approx. 14-33%, making it easier to capture this CO_2 than from other emitters where concentrations are lower (such as coal-fired or natural gas power plants, where concentrations are around 15% and 3%, respectively).[53] Nevertheless, the capture process itself introduces an "energy penalty", i.e., the process of separating and capturing CO_2 requires energy, and the added consumption of required heat (or electricity, in some cases) can be significant for a cement plant. This can theoretically be addressed with further changes to the cement production process, for example by using the oxyfuel process in which the limestone is heated in oxygen, rather than air, enabling easier CO_2 capture from the resulting flue gas stream. This process can provide capture rates of up to 100%

[52] Agora Energiewende, 2020. Breakthrough Strategies for Climate-Neutral Industry in Europe.
[53] Fennell, P.S., Davis, S.J., Mohammed, A., 2021. Decarbonizing cement production

and is technologically mature,[54] but is more difficult to retrofit to a cement plant than other capture technologies.[55]

As mentioned in this report, the decarbonisation benefits of carbon capture depend on the captured CO_2 being securely stored away from the atmosphere for long periods of time (of the order of centuries). This is primarily achievable through storage in appropriate geological structures, such as depleted hydrocarbon reservoirs or saline aquifers, or in longer-lived products such as concrete. The challenges for implementing carbon capture in cement plants is the access to suitable storage and utilisation sites, particularly given that cement producers are relatively isolated in Romania. A final note is that if CCS is implemented in conjunction with combusting significant fraction of biomass or biogenic waste for producing process heat (bioenergy with CCS, or BECCS), the entire cement production process could potentially result in "negative emissions" – although this depends significantly on the life cycle of said biogenic material.

It is also worth mentioning that the above decarbonisation measures should be deployed in combination, and with consideration for the wider picture of decarbonisation. For example, a cement plant using BECCS will generate higher negative emissions per tonne of cement if it is inefficient, i.e., if it burns more biomass and uses more clinker than is optimal. However, as a constrained resource with difficult-to-trace life-cycle emissions, biomass should be used efficiently in a cement plant, to enable the largest economy-wide emissions reductions.[56]

Investments and plans by Romania's cement producers

Improvements in resource efficiency have been ongoing in Romania's cement plants. The switch from wet to dry kilns and installation of pre-calcination units have largely been taken up by Romanian cement producers following the privatisation and acquisition of cement plants. Other improvements are ongoing: in 2020, HeidelbergMaterials reduced its energy intensity by 1.3% year on year in Romanian facilities; and Holcim Câmpulung reduced its specific coal consumption from 0.08 to 0.05 tonne/tonne, and its specific limestone consumption from 1.7 tonne/tonne to 1.12 tonne/tonne, between 2008 and 2020. Some plants also reuse waste heat: for example, Holcim's facilities regularly capture and reuse waste heat for drying raw materials or additives, as well as electricity production at the company's Aleșd plant.[57]

All Romanian cement producers substitute cementitious materials for clinker to some extent, the highest being at the CRH plant in Medgidia (3% of final cement volumes) (Table A.1). Material substitution driven by the modernisation of Holcim's two production plants in 2002 reduced the

[54] Berstad et al, 2021. Current state of CCS technologies and the EU policy framework.
[55] Fennell, P.S., Davis, S.J., Mohammed, A., 2021. Decarbonizing cement production
[56] Fennell, P.S., Davis, S.J., Mohammed, A., 2021. Decarbonizing cement production
[57] Holcim Romania. Eficiență energetică și energie regenerabilă.

"clinker factor" (the clinker-to-cement ratio) to 0.7,[58] slightly better than the industry goal.[59] The use of biogenic waste for co-incineration is frequent, alongside non-organic wastes such as used tires and industrial wastes. In Romania, Holcim has set a target for replacing at least 60% of its fossil fuel use for energy with waste co-incineration by 2030; in 2022, its Aleșd plant supplied 43.7% of energy required for clinker production from waste.[60]

Table A.1. Cement production and substitute consumption in Romania's cement plants. No public data was not available for HeidelbergCement Fieni and Tașca.

Installation	Yearly cement production (tonnes)	Yearly limestone, clay, and marls consumption (tonnes)	Yearly slag consumption (tonnes)	Yearly ash consumption (tonnes)
HeidelbergCement, Chișcădaga (2019)	1,096,000	1,346,989	92,915	16,145
Holcim, Aleșd (Astileu) (2021)	1,822,628	2,395,893	Unknown	Unknown
Holcim, Câmpulung (Valea Mare-Pravăț) (2020)	1,803,254	2,395,030	145,442	Unknown
CRH Ciment, Medgidia (2019)	1,320,488	1,808,076	78,298	99,173
CRH Ciment, Hoghiz (2017)	Unknown	1,461,969	9,472	81,190

Several of Romania's cement producers have submitted applications to the Recovery and Resilience Fund, under Romania's National Recovery and Resilience Plan, for funding to install renewable electricity capacities. Romcim (CRH) requested funding for the installation of 72 MW of wind energy, which could cover a substantial portion of its electricity consumption (155,504 MWh in 2021). Holcim also requested funding for installing renewable energy capacities at its Valea Mare Pravăț facility, but no details are available. Holcim has also recently announced the construction of a 990-kW photovoltaic plant at its Aleșd cement plant.[61]

No plans for CCUS have been publicly stated by Romanian cement producers, but there is a significant interest in deployment, particularly expressed by Romania's business association for cement and lime producers. Furthermore, multinationals HeidelbergMaterials and Holcim are already engaged with carbon capture projects at other European facilities, including in Croatia, and could provide valuable knowledge and experience to kick-start CCS projects in Romania's cement industry.

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[58] Holcim, 2022. Project for reduction of CO_2 emissions at Aleşd Cement Plant and Campulung Cement Plant.
[59] Galvez-Martos, J-L., Schoenberger, H., 2014. An analysis of the use of life cycle assessment for waste co-incineration in cement kilns.
[60] Agenda Construcțiilor, 2023. HOLCIM lanseaza ECOPlanet PLUS, ciment cu 30% mai putine emisii de CO_2
[61] Produs în Ardeal, 2022. Holcim instalează o centrală fotovoltaică cu o putere de 0.999 MW la fabrica din Aleşd, judeţul Bihor.

Annex 3. Basic chemicals

Overview of Romania's basic chemicals industry

The production of basic chemicals comprises a wide range of processes and products, some of which are further used downstream to produce plastics, rubber, and specialty chemicals such as pharmaceutical products. Chemicals manufacturing is an energy- and resource-intensive process; the main sources of CO_2 emissions in the chemical industry are industrial power plants, steam crackers (in petrochemicals production), and hydrogen production units, where hydrogen is traditionally produced through steam reforming of natural gas, an emissions-intensive process. The chemicals industry also has significant potential both for decarbonisation and for supporting a shift towards a low-carbon economy, for example by expanding into renewable hydrogen production or e-fuels manufacturing.

In general, the most important branches of basic chemicals production (not including the petrochemicals industry, which is outside the scope of this report) are the manufacturing of ammonia (the precursor to nitrogen-based fertilisers) and of chlorine (the precursor to various inorganic chemicals as well as a reactant in the petrochemicals industry). In Romania, only one nitrogen-based fertilizer plant is still in operation: Azomureș, a large plant based in the Just Transition county of Mureș, with a production capacity of around 2 million tonnes of finished products. The company has been on partial suspension of operations since late 2021, due to the extremely high prices of natural gas, the main feedstock for fertilizer production, and has only recently resumed production. Virtually all the remainder of Romania's chemicals production is owned by Chimcomplex, which operates two platforms for the production of bulk chemicals at Râmnicu-Vâlcea and Onești, using brine electrolysis to produce chlorine and subsequently a range of products, including chlorinated products and biocides.

The limited presence of chemicals producers in Romania comes at the end of a long period of shrinking since the end of the communist regime and a recent wave of shut-downs of plants owned by the Interagro group, an entity embroiled in financial and legal issues, as well as issues of serious environmental pollution. This includes Romania's only methanol producer, Viromet Victoria, which went bankrupt in 2020. By 2021, Romania's chemicals industry was contributing 0.5% to national gross value added and employed just under 24,500 people. Export competitiveness is relatively low for basic chemicals and plastics, but high for rubber and rubber products, whose export competitiveness has risen significantly since 2000.[62] However, the currently defunct or suspended plants of the Interagro group could potentially reopen, if investments are forthcoming into their modernisation.

[62] Industrial Analytics Platform. Competitive Industries.

Net zero for the chemicals industry: technologies and pathways

The decarbonisation of chemicals production depends on the process in question. The main decarbonisation pathways for Romania's chemicals sector (not including the petrochemicals sector) are the replacement of fossil fuels for industrial heat generation, the substitution of conventional hydrogen production for renewable hydrogen production, particularly in ammonia manufacturing.

Decarbonisation of industrial heat production

In most cases, the necessary electricity, steam and heat for manufacturing basic chemicals is provided by natural gas combined heat and power (CHP) plants or heat-only plants. To decarbonise this energy supply, chemicals producers can increase the efficiency of their heat plants, install power-to-heat plants supplied by renewable electricity, or implement CO_2 capture in existing CHP plants.[63]

Renewable hydrogen

The synthesis of ammonia requires large amounts of hydrogen, which are produced mostly through conventional processes (steam methane reforming, using natural gas as a raw material) which result in process emissions of approx. 0.5 tonnes of CO_2 per tonne of ammonia. When including energy-related emissions across the ammonia production chain, the total CO_2 emissions amount to 1.8 tonnes of CO_2 per tonne of ammonia.[64]

Using renewable hydrogen rather than hydrogen produced from unabated steam reforming of natural gas (grey hydrogen) can avoid the CO_2 emissions associated with conventional hydrogen production. As shown in Annex 1, renewable hydrogen is also an important component of decarbonisation in the steel sector, and beyond industry also as a fuel for heavy transport. This means that a switch to renewable hydrogen by chemicals producers could also bring new revenue streams and support economy-wide decarbonisation. Blue hydrogen (produced by steam methane reforming with carbon capture) and turquoise hydrogen (produced by methane pyrolysis) are also options for replacing grey hydrogen, but their ultimate impact on emissions reductions is still being debated, and both rely on the availability of natural gas.[65]

Renewable hydrogen can also be used as a precursor for the synthesis of low-carbon "e-methanol", i.e., methanol manufactured from renewable hydrogen and recycled CO_2, as opposed to natural gas. Methanol is an important building block for many chemical products, and increasing interest is shifting towards using it as a fuel for industry and heavy transport, such as shipping.

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[63] Agora Energiewende, 2020. Breakthrough Strategies for Climate-Neutral Industry in Europe.
[64] Agora Energiewende, 2020. Breakthrough Strategies for Climate-Neutral Industry in Europe.
[65] Howarth, R.W., 2021. How green is blue hydrogen?

As with other sectors, other decarbonisation measures for the chemicals industry include improvements in energy and resource use efficiency. These can deliver incremental improvements in environmental impact and energy-related emissions.

Investments and plans by Romania's chemicals producers

Azomureș is planning two energy efficiency projects on its ammonia production plants, reducing emissions by 171,000 tonnes CO_2/year (13.1% of its 2021 emissions). Chimcomplex is also improving the efficiency of its industrial heat provision by building a gas-powered high-efficiency cogeneration plant to supply its operations at Râmnicu-Vâlcea, funded under the Recovery and Resilience Facility.[66] It is has also applied for funding install photovoltaic plants at both its industrial platforms, including 48 MW at the Onești platform, which could cover a significant portion of its electricity consumption (102 GWh in 2021). The company also engages in the reuse of its waste products, recycling hydrochloric acid and brine solutions into its processes.

The most significant decarbonisation plan in Romania's chemicals industry is that of Azomureș, which is planning to shift from natural gas to renewable hydrogen as a feedstock for ammonia production, and is a recipient of Just Transition funding for the installation of a 20 MWh electrolyser[67] from 2029 onwards at a cost of €35 million just for the construction of the electrolyser. Reducing dependence on natural gas, used by both as a feedstock and for energy production, is opportune for Azomureș, whose production has been suspended due to high natural gas prices.

Besides delivering emissions reductions through renewable hydrogen use, Romania's chemicals industry could benefit from developing hydrogen production to supply a progressively hydrogen-based economy. Romania's draft Hydrogen Strategy foresees the annual consumption of 72,400 tonnes of renewable hydrogen in transport (including refineries) and 23,700 tonnes for steelmaking, by 2030.[68] This could potentially be supplemented by new industrial demand from non-steel sectors, such as the glass industry, and by other areas of demand such as long-term energy storage. Romanian chemicals producer Chimcomplex has put forward renewable hydrogen production as a core business opportunity[69] and a plan to invest up to €1 billion, based on its experience in collecting and using hydrogen as a by-product of chlor-alkali electrolysis. [70] It has also signalled interest in e-methanol production.[71] Oil and gas producer OMV Petrom has also stated ambitions to invest in hydrogen.

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[66] Impact Real, 2023. Chimcomplex va avea cea mai mare centrală de cogenerare de înaltă eficiență construită în România.
[67] Ministry of Investments and European Projects. Perioada 2021-2027.
[68] Ministry of Energy, 2023. National Hydrogen Strategy and Implementation Plan (draft).
[69] Bursa.ro, 2022. ŞTEFAN VUZA, CEO CHIMCOMPLEX: "Investiţiile de peste 245 milioane euro derulate de Chimcomplex în ultimii ani au creat premisele unei dezvoltări eficiente şi sustenabile".
[70] Chimcomplex, 2021. Energia și chimia hidrogenului – integrare present cu viitor.
[71] Chimcomplex, 2021. Non-financial report 2021

Romania's chemical industry has some experience with CCU. In 2021, Chimcomplex's Râmnicu Vâlcea platform used approx. 22,000 tonnes of CO_2 in its operations, mostly captured from the platform's lime calcination unit, and in 2019, Azomureș captured and used 320,000 tonnes of CO_2 to produce NPK fertilizers and urea. Compared to the emissions of these operators, the captured quantities are small, and there is little option for selling captured CO_2 on Romania's small and uncoordinated market. Azomureș has stated that a lack of buyers for CO_2 forces them to vent two-thirds of the CO_2 which they capture.[72]

Tentative inroads into CCUS deployment have been made by both of Romania's large chemicals producers. Azomureș aims to implement a pilot CCS project by 2035 under the Just Transition Fund, leading to the avoidance of 140,000 tonnes of CO_2/year.[73] Finally, Chimcomplex plans to invest in CO_2 capture as part of a €125 million portfolio of projects.[74]

[72] Bursa.ro, 2021. VIDEOCONFERINŢA ENERGIA ÎN PRIZĂ / HARRI KIISKI, DIRECTORUL GENERAL AL AZOMUREŞ: "Tranziţia energetică va costa trilioane, dar este moştenirea pe care o lăsăm copiilor şi nepoţilor noştri şi este calea pe care trebuie să păşim".

[73] Ministry of Investments and European Projects. Territorial Just Transition Plan of Mureș county. Available at Perioada 2021-2027 (gov.ro)

[74] Chimcomplex, 2021. Non-financial report 2021

The Energy Policy Group (EPG) is a Bucharest-based non-profit, independent think-tank specialising in energy and climate policy, market analytics and decarbonisation strategy, grounded in 2014. EPG is committed to promoting long-term decarbonisation policies and actions across all economic sectors. Through publications and public events, EPG disseminates knowledge about the green transition and provides well-documented input to stakeholders and decision-makers. Its publications are freely available as research reports, opinion papers, and policy briefs. EPG's conferences, roundtables and workshops provide a platform for informed discussion and expert analysis. EPG's funding comes mainly from research grants, but also from sponsorships and membership fees.

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