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GREEN, COMPETITIVE OR AUTONOMOUS? THE CONTRADICTIONS IN THE EU'S INDUSTRIAL POLICY

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Green, competitive or autonomous? The contradictions in the EU's industrial policy[1]

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Abstract

Since 2019, the European Union's industrial policy has been guided by the European Green Deal, which aims to achieve climate neutrality. However, the green and digital transitions have sharply intensified the EU's dependence on critical raw materials and technologies from third countries, most notably China. The EU is attempting to resolve this tension by enhancing strategic autonomy, encouraging domestic mining, supporting urban mining and the circular economy, and building a European battery manufacturing capacity. This study argues that reconciling environmental sustainability, competitiveness and strategic autonomy represents a theoretical 'wicked problem' (Rittel & Webber, 1973). The paper examines current EU industrial instruments, the intense local and environmental conflicts surrounding European mining projects, the structural limits of recycling, and the struggles of the European battery industry. The paper highlights that an industrial strategy relying purely on technological substitution whilst ignoring absolute demand reduction deepens existing socio-ecological trade-offs, concluding that managing this wicked problem requires flexible, adaptive, and truly collaborative governance frameworks.

JEL: O25, Q34, Q38, Q54, Q58

Keywords: European Union, Industrial policy, Green transition, Critical raw materials, Strategic autonomy, Wicked problems, Battery manufacturing, Local opposition

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1. Introduction

Since 2019, the European Union's industrial policy has been shaped by the green transition (the European Green Deal). This is accompanied by a dependence on imports, partly in terms of fossil fuels (crude oil, natural gas) and partly in terms of mineral raw materials: the self-sufficiency rate has remained below 10 per cent (Eurostat, 2024, European Commission, 2023). The sharply rising demand for rare-earth elements and strategic raw materials, driven by the green transition, further exacerbates this dependence, particularly on China. The challenge lies not only in extraction but also in the lack of processing capacity – in this latter segment, too, China's dominance is virtually unquestionable. Meanwhile, strengthening and developing the EU's competitiveness and industry is on the agenda, which is not yet possible without Chinese components.

This situation therefore creates internal tension within EU policy: a choice must be made between cheap, efficient technologies (which maintain dependence on China) and the reconstruction of supply chains independent of China, albeit at a significantly higher cost. A trilemma has arisen concerning the triad of greening, competitiveness and strategic autonomy. The EU is attempting to reduce its dependence on China in two fundamental ways: by establishing strategic raw materials partnerships (with Chile, Namibia, Kazakhstan, Canada, Argentina, Rwanda, Ukraine, Zambia, Greenland and Norway) and through measures relying on the EU's own resources (Counter Balance, 2026).

So far, these raw materials partnerships have yielded scant results (Barata da Rocha, 2026). Between 2020 and 2024, imports from strategic partner countries actually fell for 13 raw materials, whilst they rose for 13 others and remained static for one (European Court of Auditors, 2026). The EU's appetite for raw materials may follow the pattern of past colonialism: developing countries export only raw or unprocessed materials to Europe, whilst the development of local processing industries and value creation lags behind. The EU must also provide guarantees that the materials used for the green transition are not sourced at the expense of human rights or the environment (ODI, 2026). According to Schulze (2026), the EU's diplomatic presence in Africa has expanded, but due to a limited project portfolio and fragmented infrastructure funding, the EU is unable to keep pace with competing offers from China, the Arab states and the US.

Measures aimed at the EU's own resources may be defensive in nature – such as a ban on the export of valuable waste – or proactive, such as encouraging domestic mining and processing. Focusing on the latter in this paper, I demonstrate that the effectiveness of these measures remains questionable for the time being, and that the extraction of own resources is taking a long time. Reconciling the green transition, competitiveness and strategic autonomy is, in fact, what is known as a 'wicked problem' (Rittel & Webber, 1973). This means that there is no perfect or objective solution; there are only 'better' or 'worse' alternatives. A given decision may benefit one socio-economic group whilst

causing serious harm to another. The costs are felt immediately and at a local level, whilst the benefits of greening are realised in the long term and on a global scale. The question addressed in this paper is whether the EU will succeed in managing this wicked problem whilst causing as little harm as possible.

Strategic autonomy is increasingly coming to the fore in the contexts of defence, digitalisation and artificial intelligence, but a discussion of these topics goes beyond the scope of this paper. Although it relates to the topic, I will not discuss here the political trilemma, which also concerns democracy, according to which governments can achieve at most two of the following three objectives simultaneously: growth, democratic legitimacy and effective climate policy (Regan, et al., 2026). The structural reforms required to tackle the climate crisis create significant tension between voters' expectations and the imperative for economic growth.

In what follows, I will present the EU's industrial policy instruments and the problems associated with mining in its various forms within the theoretical framework of the 'wicked problem'.

2. Theoretical background: wicked problems

Rittel and Webber (1973) introduced the concept of 'wicked problems', contrasting them with the 'tame problems' found in the natural sciences and engineering, which have clear conditions and for which there is an unambiguously correct, testable solution. Most social problems, by contrast, are complex and require value judgements. The authors listed 10 characteristics of wicked problems:

1. They have no final definition; the problem can be described in various ways, leading to differing proposals for how to address it.
2. The search for solutions is not brought to an end by the nature of the task (as there is no clear-cut outcome), but by a lack of funds, time, political will or the exhaustion of decision-makers.
3. There is no right or wrong solution, only better or worse; there is no objective yardstick. The assessment of a solution depends on the perspective of the interest group in question.
4. There is no immediate or definitive test for a solution. Any intervention has unforeseeable and long-term consequences for the social system.
5. Every attempt at a solution is 'one-off and unrepeatable'. There is no scope for risk-free experimentation or for learning from mistakes. Every measure has irreversible consequences that leave their mark.

6. There is no quantifiable, clearly definable set of possible solutions or list from which the best option could be selected.
7. Every such problem is fundamentally unique; even where there are similarities, there is no universally applicable solution due to the local context.
8. Every persistent problem is a symptom of another problem. Problems are intertwined. If we eliminate one symptom, this often brings to light a deeper, separate problem.
9. A problem can be interpreted in various ways; the chosen explanation determines the course of action.
10. The decision-maker has no right to make mistakes. A natural scientist may discard a flawed hypothesis; social decisions, however, affect people's lives, so the decision-maker bears responsibility for the consequences.

Rittel and Webber point out that it is a misconception to believe that expert knowledge and technocratic policy-making can solve everything. Addressing social problems is a political and value-based process in which ongoing negotiation and compromise between conflicting parties must prevail.

Elaborating on this in more detail in the context of public administration, Head and Alford (2015) analyse the struggle with wicked problems. The authors first emphasise that not all problems are equally wicked; there are degrees. Dealing with problems is made more difficult by the fact that, in traditional bureaucracy, strict hierarchies and functional specialisation prevent inter-ministerial thinking. Yet a broader, network-based approach is needed, encouraging cooperation between parties, knowledge-sharing and trust-building. Rather than definitive answers, partial and temporary action plans need to be drawn up.

Perhaps the best example of a 'wicked problem' is tackling climate change, which is complex and has no simple solution, because every attempt at a solution gives rise to further problems, and the interests and priorities of decision-makers clash sharply with one another. Lazarus (2009) defines climate change outright as a 'super-wicked problem' due to four characteristics: 1. time is running out; the longer we delay action, the more difficult and expensive it will be to remedy the problem, 2. the emitters responsible (consumers, companies, governments) are also the very ones who should be implementing the restrictive measures; 3. there is no global organisation with the power to enforce action; 4. the costs must be borne now, whilst the benefits will, for the most part, only materialise decades later. It is not in politicians' interests to make unpopular decisions that entail short-term sacrifices; therefore, according to Lazarus, a legal system must be established that would be extremely difficult and costly for future governments to repeal. Regulation must also be flexible so that it can evolve in line with technological changes.

Freeman (2000) regarded water management – an issue that has come to the fore particularly in recent times – as a classic wicked problem. He demonstrated that divergent, competing interests clash: agricultural, industrial and domestic water demands, hydropower generation, recreation and ecological considerations are in constant conflict with one another. Water abstraction or pollution in a particular section of a river can have a radical impact on the lives of communities further downstream. It is difficult to determine how much water is 'fairly' allocated to each stakeholder. According to Freeman, an approach based solely on technical-engineering or purely economic considerations, as well as top-down state regulation, does not work. The solution lies in local, community-level organisations (e.g. irrigation associations, local water management groups), which share information and negotiate at a higher level. If water-use rules are drawn up jointly, compliance and monitoring become much more effective.

The study by Verweij and colleagues (2006) also focuses on climate change as a persistent problem, recommending 'clumsy solutions'. There are various worldviews within society (individualist, egalitarian, fatalist, hierarchical), and each perceives the same problem differently. These approaches must be combined within an ever-evolving, compromise-based social debate.

The characteristics of wicked problems manifest themselves across a range of sectors. Csutora (2022), in examining the conflicts within the sharing economy, points out that the externalities exerted on local communities and the liveable environment (such as excessive tourism) present an 'extremely wicked' problem that cannot be resolved through mere technological or regulatory refinements of the activity, but can only be mitigated by limiting its scale. This parallel also supports the view that when benefits are dispersed whilst harms are concentrated locally, the wicked nature of the conflict is reproduced.

The concept of the 'wicked problem' has been applied by several authors in recent years specifically to the EU's raw materials policy: Endl (2017) analysed the mineral policies of EU Member States as a 'wicked problem', whilst Vafeas et al. (2024) argue that establishing a genuine circular economy in the EU is a 'wicked problem', as the objectives of the green and digital transitions are not aligned with actual domestic raw material and processing capacities. The green transition (e.g. renewable energy, electric vehicles, smart devices) has caused a sharp increase in demand for critical raw materials such as lithium, cobalt, rare earth elements, copper and platinum group metals. However, EU regulation and practice in this regard are inadequate (see below).

Endl (2017) treats wicked problems as policy challenges and analyses the national mineral strategies of five EU Member States on the basis of the principles of sustainable development. Here, too, there is a need for 'clumsy solutions' and a governance framework that integrates the objectives of the various stakeholders and adapts flexibly. According to the study, Sweden is the most inclusive in its decision-making, whilst Finland

and Portugal have extremely detailed action plans and monitoring systems. Austria and Greece perform less well in terms of long-term action plans and monitoring. In Greece, moreover, public engagement has remained extremely limited. Endl (2017) recommends broad public engagement, as without this, acceptance of the measures cannot be secured. Inter-ministerial cooperation is important; the ministries responsible for the economy, the environment and spatial planning must work together to prevent conflicts. As market and technological conditions change rapidly, policy must be iterative, with regular feedback mechanisms that allow the strategy to be adjusted from time to time.

Allen and Gould (1986) apply the concept of a 'wicked problem' to the field of state forest management and forestry. Forestry has traditionally operated on the principles of calculating maximum sustainable yield, planning timber harvesting and ensuring timber supply. By the second half of the 20th century, society's expectations of forests had changed. Forests are no longer merely a source of timber, but also serve as recreational areas, wildlife habitats, catchment areas, carbon sinks and sources of aesthetic value. There is no clear basis for deciding whether timber harvesting, the designation of tourist trails or nature conservation should take precedence in a given forest area. The priorities of different social groups (environmentalists, loggers, local residents, and day-trippers) vary. Every decision (e.g. declaring a section of forest a protected area or logging it) has long-term, irreversible consequences, the correctness of which cannot be predicted in advance. According to Allen and Gould, it is a mistake to attempt to provide technical answers to questions of values and politics. Instead of rigid, static forest management plans spanning decades, we need systems that are capable of learning quickly and adapting to changing social and ecological conditions. Experts must accept that it is not they who set the objectives, but society. The role of foresters is changing; they must become facilitators of social dialogue.

Kepkay (2002) also analyses a conflict in Canada concerning forest management and nature conservation. In this case, logging companies, local Indigenous communities, environmental NGOs and the government held completely divergent values, and trust between the parties had completely broken down. Bureaucratic state bodies and profit-driven companies operate within rigid legal and economic frameworks that do not allow for experimentation or the admission of mistakes. Kepkay reaches a similar conclusion to that of Allen and Gould, suggesting that indigenous communities and local residents should not merely be consulted, but made equal decision-making partners from the very outset of the process. Political and professional stakeholders must accept that human-societal conflicts cannot be 'resolved' by a definitive plan; continuous negotiation, learning and adaptation are the only viable path.

Salwasser (2004) also calls for a paradigm shift, using the example of the Sierra Nevada National Forests. The persistent problem is similar to those discussed previously: environmentalists, foresters and the local population cannot even agree on what the main issue is (e.g. the lack of trees or the risk of catastrophic forest fires); every decision is the

result of a value judgement, and every attempt at a solution is unique and irreversible. In the forests of the Sierra Nevada, vast quantities of dead wood and dense undergrowth have accumulated, which could lead to huge, devastating fires. Clearing this (through logging or controlled burning), however, disturbs the habitats of endangered species, such as the California spotted owl. Decisions have regularly been challenged in court by dissatisfied interest groups, leading to paralysis. Here too, the emphasis is on accepting uncertainty and on flexibility and cooperation

With the rise in popularity of green energy, wood has come to the fore not only as a raw material for furniture or paper, but also as a source of green energy and biomass. Unfortunately, wood is still regarded as a 'renewable' energy source, however much scientists and members of the public may protest against this.[3] Clark (2010) demonstrates that over-harvested forests lose their renewable character and become a permanently depleted resource. According to Likens and Franklin (2009), once old-growth forests have been felled, it takes centuries for their original ecological functions and carbon stocks to be restored; thus, from an ecological perspective, timber from felled old-growth forests is not a renewable resource.

Burning trees as biomass highlights the contradictions in green regulation. The removal of logging residues and deadwood degrades forest soil and destroys biodiversity. The production of industrial wood pellets is energy-intensive, and their combustion generates particulate matter (PM2.5), nitrogen oxides and, often, CO_2 emissions that are higher than those from fossil fuels. Sterman et al. (2018) model that, in the short and medium term, burning wood emits more CO_2 per unit of energy than coal; therefore, from a climate perspective, it does not function as a renewable energy source.

Due to profit-driven forestry practices, one in five trees felled in Hungary ends up in biomass power stations; moreover, around 60 per cent of the timber used comes from protected forests. The efficiency of these power stations is low (30–40 per cent), and they account for a mere 2.7 per cent of electricity consumption, whilst biomass power stations absorbed 218 billion forints in state subsidies between 2011 and 2021[4] . Under the Orbán government, a significant portion of these subsidies also enriched companies with close ties to the government.

[3] https://www.wwf.eu/?2128466/500-scientists-tell-EU-to-end-tree-burning-for-energy
[4] https://wwf.hu/szemleletvaltast-az-erdokezelesben-ne-egessuk-tovabb-eromuvekben-vedett-erdeinket/

3. EU programmes and instruments

Milestones in the efforts to create a globally competitive, green and digital Europe include the European Green Deal (2019), the 'Fit for 55' package (2022), the Net-Zero Industry Act (2023), which promotes the domestic production of 'clean' technologies, the Critical Raw Materials Act (CRMA, 2023), which identifies 34 types of critical materials, and the Clean Industrial Deal, drawn up in February 2025.

Accelerating decarbonisation and the transition to an electric future is closely intertwined with the need for strategic autonomy. At the same time, the regulatory environment is constantly evolving and becoming more refined, as the impact of the 'second China shock' becomes increasingly apparent (Ban and Scepanovic, 2026). (The first shock, 25 years ago, brought cheap textiles and consumer goods to Western markets. The second shock now concerns the more technologically advanced sectors of electric cars, batteries, solar panels, wind power equipment and industrial robots.)[5] The importance of the automotive industry in Europe is indisputable: it is a major employer, one of the key drivers of research and development, a significant investor and an exporter. In China, however, overproduction and price wars fuelled by state subsidies are forcing Chinese manufacturers to export at low prices. Consequently, the rise of Chinese electric cars poses a serious challenge, for which the EU is seeking solutions. Due to market pressures on European car manufacturers and the slower-than-expected roll-out of Europe's charging infrastructure, the planned 100 per cent ban on petrol engines by 2035 was revised in December 2025 to a 90 per cent reduction target. The regulation thus leaves a 10 per cent margin for emissions, which manufacturers must offset by, amongst other things, using low-carbon 'green steel' or synthetic and biofuels. Whilst manufacturers welcomed the regulation, it has faced criticism from an environmental perspective due to the resulting additional CO_2 emissions. Csutora and Vetőné (2025) empirically confirm this duality by examining the carbon strategies of the three largest German car manufacturers (BMW, Mercedes-Benz, Volkswagen): whilst electrification and the development of more efficient internal combustion engines do indeed reduce emissions, flexibility mechanisms such as pooling emissions for accounting purposes or averaging target values over several years serve as "loopholes" that ensure only apparent compliance with the regulations, without any actual reduction in emissions. According to the authors, the relaxation of regulations has, moreover, failed to protect the competitiveness of the German automotive industry against Chinese manufacturers: its market position within the EU is steadily deteriorating.

In October 2023, the European Commission initiated an ex officio anti-subsidy investigation of Chinese electric vehicles, and in the autumn of 2024, punitive tariffs of varying rates were imposed. This did not yield the desired results, as Chinese cars

[5] There is already talk of a third 'China shock', which is set to take hold in the fields of software services and AI.

retained their price advantage and hybrid models, which were subject to lower duties, were sold even more strongly. German car manufacturers openly opposed the duties, as they have significant production (and export) capacity in China and feared Chinese retaliation. To circumvent the tariffs, Chinese companies began pushing for European production: BYD built a greenfield factory in Szeged (Hungary), whilst Chery established a brownfield investment in Barcelona (Spain) in the form of a joint venture, where production of a hybrid model began in 2024, with production of the electric model set to start in 2026.

In response to the increasingly serious and persistent competitive pressure from China, the Commission has proposed a more protectionist and wide-ranging industrial policy response. The Industrial Accelerator Act (IAA) aims to speed up authorisation processes, strengthen 'Made in EU' local content and encourage joint ventures. The local content requirement would also apply to Chinese components, but as European car manufacturers are increasingly sourcing these from China, many would find it difficult to meet the thresholds. The practical applicability of the requirements also poses a challenge, as it is difficult to prevent private consumers from buying cheap vehicles. The proposal would therefore not exclude Chinese car manufacturers from the European market, but it would exclude them from financial incentives. However, the effectiveness of the IAA is limited by several factors (Williams, 2026). The package would not come into force before 2028, so Chinese exporters will continue to have unrestricted access to the EU market until then. Although linking subsidies for electric vehicles to local content may be effective, only around half of EU Member States provide such subsidies, and these cover only a small proportion of private demand (Whitfield et al., 2026).

Restrictions relating to environmental protection and cyber security may also be applied. Several EU Member States have already restricted Chinese suppliers' access to their 5G telecommunications networks, and controls on vehicles connected to the Chinese network are becoming increasingly stringent. In its proposal to review the Cybersecurity Act (CSA),[6] the Commission is seeking authorisation to require Member States to introduce restrictions on high-risk suppliers, including within the supply chain for internet-connected vehicles. As Chinese law requires companies to share information with the government, Chinese firms are likely to be regarded as less trustworthy under the regulations. China has protested in a statement[7] , but there is also significant resistance to the CSA and the IAA from several EU Member States. Governments fear that the Commission is encroaching on their national security powers, and are concerned about the costs associated with phasing out Chinese suppliers, including the risk of Chinese retaliation. Such retaliation is particularly likely given the EU's dependence on critical raw materials. As for consumers, according to a survey conducted in July 2026 (Project Tempo, 2026), if it costs more, the general public is not particularly supportive

[6] https://digital-strategy.ec.europa.eu/en/library/proposal-regulation-eu-cybersecurity-act
[7] http://en.ccceu.eu/2026-01/22/c_4834.htm

of accelerated decarbonisation. In other words, in line with the characteristics of a 'wicked problem', we are already dealing with the divergent interests of different stakeholder groups.

Alongside restrictions on Chinese imports, efforts to promote European projects have gained momentum. One of the key instruments of EU industrial policy is the system of Projects of Common European Interest (IPCEI), which aims to reduce bureaucracy and secure funding. As a result of the process, which accelerated after 2021, 11 priority projects were launched (in the fields of hydrogen, batteries, microelectronics, cloud technology, healthcare and AI), mobilising a total of approximately 100 billion euros in public and private investment – predominantly dominated by large German, French and Italian companies (Voszka, 2024). As regards state aid, the EU has relaxed or amended the rules on this 11 times since 2020. Some of the subsidised green mega-projects have, however, still encountered financial difficulties (with businesses that previously seemed promising going bankrupt or ceasing operations).

A specific 'IPCEI Critical Raw Materials' initiative is currently being developed, aimed at developing 'sustainable, environmentally friendly and innovative' extraction technologies, to build up raw materials processing capacity in Europe, to develop efficient recycling technologies for extracting secondary raw materials, and to conduct research into materials that can replace rare elements[8] . Artificial intelligence (AI) is also emerging as a key tool in the mining and raw materials value chain. There is discussion of the development of AI-supported geophysical, geochemical and geological modelling tools, low-carbon extraction technologies utilising AI and robotics, and the use of AI-based digital twin models to analyse and control metal purification, enrichment and extraction processes. The contradiction typical of wicked problems pops up here too: artificial intelligence boosts efficiency, but it involves enormous energy and water consumption, noise and heat, and the construction of data centres is already facing significant public opposition.[9]

Green energy sources are supported by hydrogen-related IPCEI projects**;** here, all four major waves have received state aid approval, meaning the projects have entered the physical implementation phase.[10] Electrolyser manufacturing capacities are being developed, and construction work on cross-border hydrogen pipelines and storage facilities has begun. At the same time, the cost of producing green hydrogen remains high, which is slowing down the industrial transition away from fossil-based hydrogen. The end-user market (e.g. the steel and chemical industries) is taking longer to sign long-term purchase agreements due to high prices.[11]

[8] https://www.europeaneconomics.com/en/ipcei/ipcei-critical-raw-materials/
[9] https://futurism.com/future-society/ai-data-center-finances-protests-opposition-social-risk
[10] https://competition-policy.ec.europa.eu/state-aid/ipcei/approved-ipceis/hydrogen-value-chain_en
[11] https://gh2.org/offtake-agreements-and-pricing

In the spring of 2025, the EU drew up the List of Strategic Projects (comprising 47 EU and 13 non-EU investments), granting them the status of being of overriding public interest and limiting the time taken to grant permits for extraction projects to a maximum of 27 months and for processing projects to 15 months. Dohmen & Düngefeld (2026) highlight the inconsistencies and transparency concerns surrounding 'strategic projects.' According to leaked internal Commission documents, the European Commission disregarded the recommendations of independent technical experts when selecting strategic projects. Consequently, 11 projects were included on the final list that had not featured in the preliminary draft (as they had failed to meet the required criteria in the expert assessments) but were nevertheless given the green light following political consultations and lobbying by Member States. Among the projects finally selected are several mining and processing investments that have been fiercely opposed by local communities and environmental organisations for years. In the selection process, environmental, human rights and social considerations took a back seat to geopolitical and economic interests. Citing public security concerns and the need to protect investors, the European Commission has on several occasions rejected requests from civil society organisations for access to assessments and internal review documents (despite references to the Aarhus Convention and EU legislation on access to information). All of this runs counter to the previously mentioned recommendations on how to tackle 'wicked problems': frequent consultations, involvement of local communities, and transparency.

To accelerate the CRMA's objectives, in December 2025 the EU launched the ReSourceEU action plan.[12] ReSourceEU essentially pools several billion euros of EU and national funding (for example, through InvestEU, the Innovation Fund, the Battery Booster and the European Investment Bank's credit facilities) for European and international mining projects in order to mitigate the risks associated with strategic projects (González, 2026). In this way, the EU is becoming not merely a regulator, but also a market player and portfolio manager. This program coordinates strategic mining and processing projects, manages strategic stockpiling by Member States and industry, and organises joint EU raw material procurement. ReSourceEU gives priority to permanent magnets made from rare-earth metals and battery raw materials, as well as to serving the defence sector and AI data centres. ReSourceEU calls for a further acceleration of mining licensing procedures; however, due to 'ecological compensation' loopholes, the push for these projects undermines local communities' right to have a say, as well as environmental and human rights considerations. According to González (2026), ReSourceEU is based on the endless expansion of supply and state support for mining, rather than addressing overconsumption and the absolute reduction of European demand for raw materials.

[12] https://www.iea.org/policies/29510-resourceeu-action-plan

4. European mining conflicts and local resistance

The opening of new European mines and processing plants, pushed through in the name of strategic autonomy, has led to acute local conflicts, which often run counter to the EU's own habitat protection and water management directives. In the following we describe the most important controversial projects (see the summary in Table 1).

In Sweden, Europe's largest reserves of iron ore and rare-earth elements were discovered in 2023 at the Per Geijer (Kiruna) site.[13] The Swedish company LKAB is currently seeking a licence; actual mining is unlikely to begin until the end of the decade at the earliest. The Per Geijer mining area cuts across the reindeer's millennia-old natural migration route between winter and summer pastures and will permanently jeopardise the survival of Sami culture. The Sami communities are challenging the licensing procedures through legal channels and are taking action in international forums. At the same time, the Swedish government has declared the mining of critical mineral resources a national security interest. The nearby Vittangi graphite mine also poses a direct threat to the reindeer herding routes of the indigenous Sami people (Gabay, 2024). The entire town centre of Kiruna (including a 113-year-old church and 6,000 residents) had to be relocated due to ground fissures caused by the mines. Local residents and environmentalists are campaigning to protect the nearby wetland ecosystem, fearing sulphide and heavy metal pollution. In addition to holding protests, they challenged the environmental and mining licences issued through the courts, but the project was given the green light and the legal proceedings concluded in favour of the company Talga. The EU Innovation Fund has provided €70 million in support for the plans, and the European Investment Bank has also secured loan packages to facilitate implementation. The Talga Vittangi project is one of the most advanced European battery raw materials projects in legal terms, where EU and Swedish political will has, for the time being, overcome local resistance.

In Norway, Sami fishermen and Greenpeace are protesting against the Nussir copper mine's marine waste disposal site, fearing for protected salmon and herring habitats. The mine plans to dump more than 30 million tonnes of toxic fine dust and tailings directly onto the seabed of the local fjord. For months, local residents blocked preparatory work by setting up tents, forming human chains and chaining themselves to machinery, which led to mass arrests. In 2021, several major investors and industry players distanced themselves from the project[14] . The Norwegian government and regional development

[13] The size of the discovered mineral reserves is estimated at over 1.2 billion tonnes, of which the quantity of rare-earth metal oxides exceeds 2.2 million tonnes.

[14] Aurubis AG, Europe's largest copper mining and processing company, signed a preliminary agreement with Nussir in 2020 regarding the future purchase of the mined copper. Nussir was set to become the world's first 100 per cent electric, zero-CO_2 copper mine, which fitted perfectly with Aurubis's climate protection goals. In 2021, however, Aurubis concluded that the social and environmental risks of the project outweighed the climate protection benefits (Aurubis, 2021). Following this, European banks and several

authorities support the mine, as they regard copper mining as part of Norway's green industrial strategy (copper is essential for wind turbines, grid development and electric cars). The local council supports the investment because of the expected tax revenue and the creation of hundreds of new jobs. The project is key to securing European copper supply chains independent of China. The company has obtained all the necessary mining, environmental and water use permits from the Norwegian authorities, including the controversial permit for dumping. The Canadian firm Blue Moon Metals has acquired Nussir, securing adequate capital backing for and bringing in US and Canadian companies.[15] The construction of infrastructure and the drilling of underground storage chambers are underway, with full-capacity production expected to commence in the coming years, provided that further acts of civil disobedience do not paralyse the works.

As in the Swedish and Norwegian cases, the Sakatti nickel, cobalt and copper mine in Finland is also situated within a protected Natura 2000 wetland area and Sami territories. Local residents, Sami reindeer herders and Finnish environmental organisations are fighting against the destruction of the fragile Arctic ecosystem and rare peat bogs. This major European strategic project holds vast reserves of copper, nickel and cobalt, which are vital for the green transition. At the behest of the industrial lobby, the European Commission has placed the mine on the list of strategically important projects on the basis of the legal provision of 'overriding public interest', meaning that extraction can go ahead despite its Natura 2000 status (Friends of the Earth Europe, 2023). Lassila (2024) points out that the project's environmental impact assessment is flawed: although it is presented as a model of 'green mining', the project employs biodiversity offsetting – that is, damage caused around the mine is offset by the 'conservation' of another protected area. This framing legitimises environmental damage, as if individual ecosystems (such as the protected local wetland) were interchangeable with other areas. The environmental impact assessment makes no mention of long-term risks such as dust pollution, groundwater contamination or loss of livelihoods.

Portugal's Barroso-Boticasi lithium mine is situated within a FAO World Heritage Site for agriculture. It was included on the EU CRMA strategic project list despite having previously failed to meet the criteria set out in expert assessments. The project was conditionally approved by the Portuguese environmental authority in May 2023, despite opposition from local residents and experts. The planned opencast mines would be very close to residential areas, and mining waste would be stored in an above-ground tailings

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Scandinavian investment funds and asset managers also excluded the mining company, which carries out offshore slurry disposal, from their portfolios, citing the need to protect vulnerable marine ecosystems.

[15] Blue Moon has entered into a long-term strategic agreement with Hartree Partners, a US-based global energy trading and commodities investment giant, which has secured the entire future copper concentrate production from the Nussir mine. The Canadian company Wheaton Precious Metals has acquired a stake in the development as a strategic investor. Norwegian firm Leonhard Nilsen & Sønner has also acquired a significant stake and has undertaken to carry out the underground mining operations. https://www.sec.gov/Archives/edgar/data/1732379/000110465926004291/tm2533647d1_ex99-3.htm

dam, which is risky[16] . In 2023, a UN representative raised the concern that the Barroso project could create a 'sacrifice zone', which is incompatible with the human right to a healthy environment (Human Rights Council 2023). Other concerns raised include water resources, biodiversity, and a lack of transparency and public participation. Local communities and the public prosecutor's office have also waged a legal battle against the mine's environmental permits[17] . In February 2026, legal proceedings were also initiated against the European Commission, whilst the company received a grant of 110 million euros from the Portuguese state[18] . On 9 June 2026, the local court ordered a halt to on-site operations. The Portuguese government reacted immediately, declaring that this violated the national public interest and decarbonisation targets; consequently, the court lifted the suspension and work resumed. At the end of June, the Boticas municipal council adopted a motion of protest demanding the immediate suspension of the project. In August 2026, the mining company signed several land-use and profit-sharing agreements with the bodies managing local community lands. Construction of the actual mine is scheduled to begin in 2027, with production set to start in 2028.

Another neighbouring Portuguese mine, Mina do Romano (Montalegre), borders directly on a national park and a UNESCO-recognised biosphere reserve. Plans for this site include not only open-cast and underground lithium mining, but also a local refinery and processing plant. The project has faced fierce opposition from the outset, with locals fearing that the mine will permanently destroy the water catchment areas and pastures. Portuguese environmental organisations consider it absurd that the Portuguese environmental authority has already granted conditional authorisation for the mining operations, whilst the environmental impact assessment for the chemical processing plant is being carried out in a separate procedure. The project is also overshadowed by the 2023 political corruption investigation in Portugal, which led to the resignation of Prime Minister António Costa. Public consultations with local residents have overwhelmingly yielded negative results, and the local council and civil society groups continue to challenge the licences in court. According to the plans, actual production could begin around 2027, following the completion of construction work.

In Spain (Cáceres), the 'Salvemos la Montaña' civil society movement has taken action against the San José lithium mining project, seeking to protect the mountain's water resources and the nearby UNESCO World Heritage town. They have been campaigning, demonstrating, writing petitions and taking legal action since 2018, and are supported by 134 civil society organisations. The project is currently delayed due to administrative and licensing disputes. At the end of July 2026, the regional government of Extremadura

[1616] Tailings dams: an explainer – London Mining Network. The majority of dams that have collapsed worldwide were of this type, including one in Brazil, which led to this method being banned there.
[17] https://www.reuters.com/markets/commodities/portuguese-prosecutors-seek-annul-environment-permit-savannah-lithium-mine-2024-02-08/
[18] https://www.climatechangenews.com/2026/02/05/green-groups-sue-eu-over-inclusion-of-portuguese-lithium-mine-on-priority-list/

rejected the mining company's concession application.[19] Near Seville, the Cobre Las Cruces polymetallic project involves plans for underground mining and the construction of a new, local refinery, enabling the extraction and processing of four strategic metals – copper, zinc, lead and silver – from a single site.[20] Local residents and civil society organisations fear that groundwater and karst water will be contaminated by toxic heavy metals and acidic mine water. The company has a history of regulatory breaches, so it has lost public trust. In 2019, a massive landslide occurred at the edge of the open-cast mine, reinforcing locals' fears about the geological instability of the area.[21] The project has received the main environmental and mining permits from the Andalusian government, as well as priority funding and an accelerated administrative process due to its strategic importance at European level. Following a change of ownership, the mining company is currently constructing the underground infrastructure and preparing the new refining plant, whilst environmental litigation continues to accompany the process.[22]

In the Czech Republic, Cínovec is the EU's largest lithium deposit, and locals are protesting against the investment launched there due to concerns over water resources, ground subsidence and heavy goods traffic. The environmental impact assessment was published in May 2026, a public hearing was held in June, and the licensing process is due to be completed by the end of 2026.[23] In the Pardubice region, the Chvaletice project plans to process the vast tailings from a former ironworks and mine to extract battery-grade manganese. The Canadian-backed company has completed the integrated environmental impact assessment, which has been approved by the Czech Ministry of the Environment. A pilot plant built on-site has commenced operations, to produce sample material for potential battery manufacturing partners. Residents and local organisations in the surrounding communities continue to express concerns regarding airborne dust, heavy metal pollution, freight traffic associated with transport, and the risks posed by chemical processes. The company is attempting to allay these fears through the use of enclosed systems, wet processing and continuous dust monitoring, and is already in talks with international players in the battery and automotive industries regarding long-term supply contracts.[24]

In Romania, regarding the Rovina copper and gold mine, the Canadian company emphasises that it will use cyanide-free technology, but Romanian environmental NGOs are strongly opposed to the project. The main concerns centre on the destruction of the landscape caused by the huge open-cast mining pits, the risks posed by tailings and waste

[19] https://www.facebook.com/salvemoslamontana/?locale=es_LA
[20] https://www.cobrelascruces.com/index.php/mina/el-futuro-proyecto-pmr/
[21] https://ejatlas.org/conflict/minera-las-cruces-sevilla-spain
[22] https://im-mining.com/2026/06/04/cobre-las-cruces-pmr-project-to-advance-under-new-global-panduro-ownership/
[23] https://kalkine.com.au/news/announcements/european-metals-advances-cinovec-eia-and-flags-potential-us110m-capex-cut-from-tunnel-kiln
[24] https://www.mn25.ca/chvaletice-manganese-project

rock storage facilities, and the loss of mountainous agricultural land. Civil society groups are organising community campaigns and public hearings, providing legal support to local landowners, and pursuing administrative and legal proceedings. The Cluj-Napoca Regional Court has definitively annulled the Rovina project's land-use and environmental permit due to incomplete impact assessments. The company has restarted the environmental permitting process, concluded financial agreements and is continuing with preparations.[25]

In Maramures County, the Verde Magnesium Project (Felsőbánya) intends to reopen an old, disused mine to extract magnesium metal[26] . There is a high level of mistrust amongst the local population due to memories of decades of mining pollution (and the 2000 cyanide spill in Baia Mare). Locals fear that toxic substances will be released into the air and water as a result of the resumption of mining. Residents and local civil society groups are protesting through petitions, speaking out at local public hearings and organising demonstrations. Environmental and human rights organisations are prepared to challenge the first environmental or planning permits in court as soon as the authorities issue them.

The Baia de Fier mine was shut down in the late 1990s and officially declared closed. The Romanian state-owned company SALROM has drawn up an investment programme worth between 190 and 400 million euros, which includes the resumption of mining, the purification of graphite and the recycling of existing tailings dumps[27] . The Romanian government has launched feasibility studies, with commercial production scheduled to begin in 2027–2028. Public reception has been favourable, as unemployment is high in this former coal-mining region. Graphite processing does not require cyanide-based processes; the company has promised to use closed-loop water management and zero-emission technology. The conversion of tailings piles left over from previous mining operations also qualifies as environmental remediation.

In Serbia, despite mass protests by local residents and farmers against Rio Tinto's planned lithium mine in the Jadar Valley, the European Commission included the project among its strategic priorities in June 2025, generating further social tension. The protests are led by local farmers and environmentalists, who fear an ecological disaster. The project is currently on hold under the pretext of 'maintenance'. Dragoljo (2026) demonstrates that the German government and the automotive industry are working closely with the Serbian leadership, whilst the EU is turning a blind eye to the

[25] https://miningwatch.ro/proiectul-minier-rovina-blocat-de-instanta/
[26] https://energyindustryreview.com/metals-mining/verde-magnesium-eus-sole-strategic-project-for-sustainable-magnesium-metal-production/
[27] https://www.salromgrafit.ro/about-us.html

shortcomings in the rule of law in Serbia and the widespread public protests in order to push through the Jadar lithium project.[28]

There are also examples of the government itself halting mining projects. Greenland (Kvanefjeld), which is part of Denmark, is home to one of the world's largest untapped reserves of rare-earth elements and uranium. Mining would result in radioactive by-products in the immediate vicinity of populated areas and agricultural regions. Public opposition was so strong that the issue of opening the mine became the main topic of the 2021 Greenlandic parliamentary elections. The party opposed to mining won, and uranium mining was banned by law, which blocked the entire rare-earth metals project. The Australian mining company initiated legal proceedings and filed a claim for damages against the governments of Greenland and Denmark, but in 2023 the Greenlandic government officially rejected the application for an extraction licence, and in June 2026 it also refused to extend the company's exploration licence.[29]

Table 1: Major European critical raw materials mining projects

LOCATION	RAW MATERIAL	MINING COMPANY	PROTESTERS	MEANS OF RESISTANCE	EU STRATEGIC STATUS	CURRENT OUTCOME
Per Geijer, Kiruna, Sweden	Rare earth oxides, iron ore	LKAB (Swedish)	Sami indigenous community	Cultural and livelihood arguments, international indigenous legal standards	Yes	Mining continues, town relocation is underway
Vittangi Kiruna, Sweden	Graphite, anode material	Talga Group (Australian)	Sami indigenous community, civil society groups, Swedish Society for Nature Conservation	Protests, legal action	Yes	The Swedish Supreme Court and government rejected the appeals; project now in the operational phase
Nussir Kvalsund, Norway	Copper	Blue Moon Metals (Canadian)	Sami fishermen	Protest against an offshore waste disposal site, habitat protection	No	Ongoing, open conflict
Sakatti, Finland	Nickel, cobalt, copper	Sakatti Mining Oy (British parent)	Sami indigenous community, civil society groups,	Protests, demonstrations blocade	Yes	Project of overriding interest, biodiversity offsetting

[28] A German ministry adviser worked for years close to Serbian President Vučić, clearing political and legal obstacles for the project.
[29] https://www.mining.com/web/greenland-rejects-energy-transition-minerals-request-for-licence-renewal/

Table 1 cont.

LOCATION	RAW MATERIAL	MINING COMPANY	PROTESTERS	MEANS OF RESISTANCE	EU STRATEGIC STATUS	CURRENT OUTCOME
Mina do Barroso, Portugal	Lithium	Savannah Resources (UK)	Local communities, public prosecutor's office, NGO ClientEarth	Legal proceedings (national + against the EU), invoking FAO World Heritage status	Yes	Court halted the project, government overruled the decision, work continues
Mina do Romano Montalegre, Portugal	Lithium + refinery	Lusorecursos (Portuguese)	Local council, civil society groups, Portuguese environmental organisations	Public consultations (overwhelmingly negative), legal action against the permits	Yes	Permit applications and legal disputes ongoing; construction and start of production expected around 2027
San José Cáceres, Spain	Lithium	Infinity Lithium (Australian)	Civil society movement (Salvemos la Montaña), 134 organisations	Long-term legal/administrative battles, petitions	Yes	Protracted stalemate, delays
Cobre las Cruces Seville, Spain	Copper, zinc, lead, silver	First Quantum Minerals (Canadian) and subsequently Resource Capital Funds (US investment fund)	Local residents, environmentalists (Ecologistas en Acción)	Protests, legal challenges against the licences, appeal to the Court of Justice of the European Union against the EU's 'strategic project' status	Yes	The High Court of Justice of Andalusia dismissed the appeal
Cínovec, Czech Republic	Lithium	Geomet (Czech, Australian, British)	Local residents	Opposition to the environmental impact assessment, public hearing	Yes	Ongoing (proceedings due in 2026)
Chvaletice, Czech Republic	Manganese	Euro Manganese Inc (Canadian)	Local residents	Public concerns (dust and other pollution, heavy traffic), public hearing	Yes	Environmental impact assessment approved by the Czech Ministry of the Environment; trial operation has commenced

Table 1 cont.

LOCATION	RAW MATERIAL	MINING COMPANY	PROTESTERS	MEANS OF RESISTANCE	EU STRATEGIC STATUS	CURRENT OUTCOME
Rovina, Romania	Copper	Euro Sun Mining Inc. (Canadian)	Local residents, landowners, environmental NGOs	Community campaigns, public hearings, administrative and court proceedings	Yes	The Cluj-Napoca Regional Court has definitively annulled the environmental permit; the company has restarted the licensing process
Verde Magnesium Romania	Magnesium	Verde Magnesium LLC (majority US-owned)	Local residents, environmental and human rights NGOs	Petitions, statements at public hearings, demonstrations; prepared legal action against the permits	Yes	Ongoing, prior to authorisation (environmental/planning permission not yet granted)
Baia de Fier, Romania	Graphite	SALROM (Romanian)	None	None	Yes	Feasibility studies underway, favourable public reception; commercial production planned for 2027–2028
Jadar Valley, Serbia	Lithium	Rio Tinto (Australian)	Farmers, environmental NGOs	Mass protests, road blockades	Yes	'Maintenance suspension' status
Kvanefjeld, Greenland, Denmark	Rare earth elements, including uranium	Energy Transition Minerals (Australian)	Public, government	Election issue, demonstrations	No	Suspension, refusal of a licence

Source: own collection

In the case of mines, therefore, the means of public protest are varied (referendums, court cases, demonstrations). The outcome also depends on the nature of the legal instrument: a referendum is binding, a court case can be challenged, whilst demonstrations alone are not sufficient. The EU's status as a 'strategic project' creates a particular tension, as the EU uses legal instruments to prioritise its own interests over those of its citizens. Mining companies and state actors generally employ conciliatory tactics to break the resistance of the local population. These are tools of social manipulation, such as PR campaigns designed to create a green and sustainable image, or the division of local communities through promises of development programmes. Meanwhile, bureaucratic and institutional means are used to force acceptance of the mining project (Dunlap & Riquito 2023).

Lassila (2024) clearly illustrates how the knowledge, worldviews and values of mining companies and local communities clash under the banner of 'green mining'. The debate also centres on the very essence of nature. Companies treat nature as replaceable. They argue that the inevitable environmental damage can be offset by the protection or restoration of other areas (ecological compensation). For the local people, however, the region in question is not a point on the map that can be bought or relocated, but an inseparable part of their livelihood, culture and identity. During environmental impact assessments, corporate and measurement-based knowledge dominates, seeking to quantify nature, whilst local, experiential knowledge is pushed into the background. The commodification and interchangeability of nature clashes with the irreplaceable networks of relationships experienced by local people. What is more, forests, peatlands and wetlands are critical for carbon storage, their destruction for "green" aims is paradox.

5. Urban mining – recycling

In terms of the circular economy, the EU's average material recycling rate stands at just 12.2 per cent (whilst the global average has fallen to 6.9 per cent).[30] Over the past fifty years, the rate of global material extraction has more than tripled, a trend to which population growth has contributed only partially. Per capita material consumption has soared from 8.4 tonnes in 1970 to 12.2 tonnes by 2020, driven by urbanisation, economic growth and rising prosperity. If this trend continues, material extraction will increase by 60 per cent by 2060 compared with 2020. Material extraction and use are responsible, for example, for around two-thirds of greenhouse gas emissions, as well as for more than 90 per cent of biodiversity loss and water scarcity. The EU and the US account for more than half of global material use, whilst being home to 10 per cent of the world's population. Rising global material extraction, the expansion of accumulated assets and the continuous generation of waste are growing at a faster rate than the development of circular economy initiatives (Sitra, 2025).

There are significant technological and economic barriers to recycling: the separation of chemical elements is a hazardous process, the quality of materials deteriorates over the course of cycles, the process is energy-intensive, and in many cases, it is still cheaper to extract new raw materials than to recycle. Furthermore, the Jevons paradox[31] also applies: increasing efficiency does not necessarily reduce, but may even increase, total resource use due to falling costs. Thus, technological progress alone cannot lead to an improvement in the situation; only a reduction in consumption can do so.

[30] https://ec.europa.eu/eurostat/databrowser/view/env_ac_cur/default/table?lang=en
[31] https://hu.wikipedia.org/wiki/Jevons-paradoxon

In any case, recycling is also one of the cornerstones of the EU's strategic autonomy, as a source of critical raw materials. A central part of the RESourceEU programme is ensuring that strategic secondary raw materials remain within the EU. By the second quarter of 2026, the Commission is expected to propose restrictions on the export of waste permanent magnets and scrap metal (which are important raw materials for European recyclers), and similar, targeted restrictions are also planned for aluminium and copper scrap.

The question is: what are recycling plants like, how much and what kind of energy do they use, and what are their environmental emissions? New technologies involving harmful chemicals are also fuelling fresh public opposition to certain recycling plants. The South Korean battery recycling company SungEel was forced to withdraw from two German towns (Rudolstadt and Gera) due to public opposition, as the documentation provided by the company – which is notorious for its pollution in Hungary – was not convincing. The South Korean company eventually abandoned its plans in Germany[32] and instead obtained a licence from the Orbán government to expand its plant in Bátonyterenye, but this was challenged in court by the local council there.[33]

The Portovesme CRM Hub is a recycling project in Italy that the European Commission has designated as a strategic project. The investment is being planned by the Swiss-British company Glencore on the island of Sardinia, within an existing industrial zone. The hydrometallurgical plant would produce tens of thousands of tonnes of battery-grade lithium, nickel and cobalt annually from black powder derived from electric batteries and manufacturing waste. The soil and drinking water supplies at the Portovesme metallurgical plant are already severely contaminated.[34] Remediation is practically impossible; there is a landfill site for storing red mud (bauxite residue) and other chemical waste, where 30 million cubic metres of highly polluting material is stored across an area of more than 160 hectares, close to the sea. (In Hungary, one million cubic metres of red mud spilled in 2010).[35] The local population and the Sardinian regional authorities fear that the battery recycling plant will bring further toxic chemicals and waste to the island. There is strong local political and civil resistance to Sardinia becoming Europe's battery waste processing hub. The Sardinian regional government has refused to fast-track the project's environmental impact assessment, which has slowed down the construction of the pilot plant.[36]

[32] https://themunicheye.com/cancellation-german-battery-recycling-plant-project-13556
[33] https://atlatszo.hu/orszagszerte/2026/03/17/birosaghoz-fordul-batonyterenye-onkormanyzata-az-akkufeldolgozo-bovitesi-engedelye-miatt/
[34] https://www.ilfattoquotidiano.it/2018/11/11/portovesme-e-i-veleni-della-sua-industria-in-crisi-nellilva-sarda-terre-intossicate-e-piombo-nel-sangue-dei-giovani/4602834/
[35] https://www.lanuovasardegna.it/regione/2023/06/12/news/la-crisi-industriale-e-i-veleni-soffocano-il-futuro-del-sulcis-1.100324128
[36] https://en.ilsole24ore.com/art/portovesme-400-million-plan-to-mine-lithium-AHaA81F

Recycling electronic waste is not straightforward. Vafeas et al. (2024) note that, although collection rates for electronic waste are improving in certain regions, the actual recovery and recycling rates for the critical raw materials they contain are alarmingly low (often less than 1 per cent). In many cases, proper recycling (dismantling, chemical extraction, cleaning) is currently extremely energy- and labour-intensive, and is therefore more expensive than purchasing newly mined metals. If left to market forces, companies will not recycle critical metals because it is not cost-effective. If the state enforces this through legislation, however, it will significantly increase the cost of electronic goods for consumers. Consumers and the market demand lighter, smaller, waterproof and more durable devices (e.g. glued-in batteries, integrated circuits). This design trend, however, makes it impossible for waste management operators to dismantle devices easily and recover components and materials. The shortage of critical raw materials is a global problem, but waste collection and management take place at a local level, and a significant proportion of e-waste flows illegally into developing countries. In light of this, the circularity of critical raw materials is not merely a technological issue. Any progress would require simultaneous action on international trade, product design standards, waste management subsidies and consumer habits – whilst changing any one of these elements would provoke opposition from some stakeholders. This is precisely what makes recycling such a wicked problem.

It will not be easy for companies to meet the recycling targets set out in the EU Battery Regulation either.[37] Products currently coming onto the market will only become waste in 10–15 years' time. For this reason, there simply won't be enough genuinely end-of-life batteries by the 2031 deadline. In the short term, the targets will likely be technically achievable thanks to manufacturing scrap and secondary materials from other sources; the real bottleneck will arise with the higher targets set for 2036. However, if manufacturers become more efficient and reduce production waste, there will be less material available for recycling, making it harder to meet the targets. Furthermore, meeting these targets may encourage the premature recycling of used batteries, which could hinder efforts to extend their lifespan or facilitate their secondary use (Zhou et al., 2024). In other words, as is characteristic of a 'wicked problem', there is no good solution, and when we tackle one problem, another arises.

Activities that support linear patterns of production and consumption – which lead to the unsustainable management of natural resources – are deeply embedded in our current system. To successfully transition to a circular economy, we would need to change the system of behaviour, norms and legislation that currently allows for the unrestricted extraction of resources, the emission of pollutants and the generation of waste. Governments have the opportunity to reshape economic incentives, capital flows and

[37] The threshold values for EV batteries set out in Article 8 of EU Regulation 2023/1542 on batteries: 16 per cent cobalt, 85 per cent lead, 6 per cent lithium and 6 per cent nickel from 18 August 2031, then 26 per cent, 85 per cent, 12 per cent and 15 per cent from 2036.

pricing mechanisms in line with the principles of the circular economy. They can also further strengthen extended producer responsibility and eco-design regulations, ensuring that products are designed from the outset to be durable, repairable and recyclable (Sitra, 2025).

The EU's 2020 Circular Economy Action Plan[38] set out the objectives of extending the lifespan of products, eco-design requirements and reparability. It set out targeted measures in specific sectors: for example, the introduction of standardised chargers, regulations on the recycled content of batteries, the reduction of excessive packaging, and the management of textile waste. Several regulations and directives were subsequently adopted under the action plan. The Regulation on the eco-design of sustainable products was adopted, introducing the digital product passport and prohibiting the destruction of unsold clothing. The mandatory use of the USB-C standard has come into force for the majority of electronic devices, and the 'right to repair' directive has been adopted. Hungary is also transposing this legislation, meaning that from 31 July 2026, manufacturers may be subject to repair and reuse obligations even after the warranty period has expired. New battery regulations have come into force, mandating the use of recycled materials, carbon footprint measurement and easier replaceability. A new regulation on packaging and packaging waste has been adopted, setting out restrictions and recycling targets. The rules on verifying 'environmentally friendly' and 'green' corporate claims have been tightened. The rules on waste exports from the EU have been reformed, restricting the shipment of hazardous waste to developing countries.

According to critics,[39] although the measures are useful, the Action Plan is unable to prevent the unchecked overconsumption of resources. The package of measures originally included a target to reduce the EU's 'material footprint', but the final version is weaker: there are no specific targets set for reducing resource consumption; the measures merely serve to monitor our consumption. The Commission is expected to present the EU Circular Economy Act in autumn 2026, with adoption anticipated in 2027 following the negotiation phase. The aim of the Act is to eliminate regulatory discrepancies between Member States (regarding the classification of materials as waste or secondary raw materials) and to create a single internal market for secondary raw materials, so that the EU can double its rate of circular material use by 2030.

A major transition to a circular economy causes a range of conflicts of interest and exhibits the characteristics of a wicked problem. In the short term, the burden on households and businesses may increase, whilst the benefits will only materialise over a period of decades. Taxing resource use or phasing out cheap, disposable products leads to price increases, which may give rise to consumer dissatisfaction. As long as it is cheaper

[38] https://eur-lex.europa.eu/TodayOJ/index.html?uri=cellar:9903b325-6388-11ea-b735-01aa75ed71a1.0003.02/DOC_1&format=PDF
[39] https://friendsoftheearth.eu/press-release/circular-economy-plan-eu-commission-burying-its-head-in-the-sand/

to throw away a product and manufacture a new one than to repair it, the rational choice for companies remains the linear model. Changing this would entail decades of political battles. However, due to four-year electoral cycles, it is in the interests of policymakers to achieve quick, visible results. Repairing goods, buying less and extending their lifespan reduces the volume of goods traded and consumption tax revenues. Monitoring repairability or recycled content across global supply chains places an enormous administrative burden on the authorities. If the EU introduces stricter eco-design rules, companies may relocate to countries with less stringent regulations. The large corporate sector generally exerts significant influence on law-making anyway, and often waters down regulations.

The wicked nature of the problem is also highlighted by the fact that the 'circular economy' is itself a concept with a disputed meaning, with different interest groups interpreting it differently (material flow efficiency or genuine reduction in consumption). Every regulatory intervention has its losers, so there is no objectively optimal solution. Once introduced, regulation immediately alters the behaviour of economic actors; therefore, it is not possible to 'experiment' and then reverse the measures without consequences. At a systemic level, it is intertwined with other issues, such as climate change, global inequality and trade policy. The value systems of the various actors differ fundamentally on the question of whether growth and circularity are compatible. Consumer culture (convenience, the desire for novelty, brand and fashion) and corporate performance measurement (the pressure for quarterly growth, share prices) encourage continuous, ever-increasing consumption. Society is currently coming up against the limits of growth, as it defines growth solely in terms of economic activity and material goods (European Environment Agency 2021). Changing this would also be a cultural challenge.

According to Ban (2026), the European Union's regulatory model is outdated and, unless it changes, its vulnerability in the area of critical minerals will persist. Although the EU is endeavouring to develop an interventionist state industrial policy in the field of critical raw materials, the process is slowed down and constrained by the fact that it has no common budget for this purpose. Member States are also competing with one another through their own state aid schemes, which distorts the internal market. Under the CRMA, the EU has set specific percentage targets but has not allocated sufficient public funding to meet them. Furthermore, mining and refining projects are progressing extremely slowly due to strict environmental regulations and protests by local communities.

6. Challenges facing the European battery industry

Battery manufacturing is a 'green' industry, still relatively new in Europe, linked to mining and recycling. Electric vehicles account for the vast majority (around 77 per cent) of demand for batteries, whilst stationary energy storage systems make up around 15 per cent of the market. The latter are crucial for the grid integration of renewable energy sources and even for powering AI data centres (Bielewski et al., 2026). The leading battery manufacturers are based in Asia; the Chinese firm CATL holds a 40 per cent share of the global market, and there are also significant South Korean players (LG, Samsung SDI, SK)[40] . European-owned battery cell factories are currently struggling to establish and scale up battery production; their production efficiency and quality indicators lag behind those of their Asian rivals, and their capacity utilisation hovers at around just 20 per cent of their nominal capacity. The European factories operate at high costs, rely on imported materials, narrow chemistries and are forced to involve a Chinese partner (Whitfield et al., 2026). Furthermore, the technological trend has shifted towards cheaper LFP (lithium iron phosphate) batteries, a sector in which Chinese manufacturers clearly dominate (nearly 90 per cent of cathode production is based in China).[41] Although pilot production of solid-state batteries and cobalt-free LFP cathode active materials has begun in Europe, the EU is at a disadvantage compared to Asian players due to high energy and investment costs, as well as a shortage of skilled labour. More recently, Chinese factories have also begun mass production of sodium-ion batteries.[42]

Whitfield et al., (2026) provide a detailed view on European battery production. A number of attempts at cell manufacturing have spectacularly failed. The best-known case is that of the Swedish company Northvolt, but Britishvolt, Freyr and Morrow have also failed to succeed. The common reasons behind this are that Asian players have a decades-long experience in cell manufacturing chemistry and the precision of mass production, and have flooded the market with cheap batteries, whilst demand for electric cars in Europe has fallen short of earlier expectations.

Britishvolt was set to be the cornerstone of the British car industry's green transition in the North of England. The start-up undertook a massive investment without having any tried-and-tested technology of its own, guaranteed customers or a stable financial backing. The company ran out of funding even before the factory was built. As the UK government refused to make early payments of the promised state grants due to a failure to meet performance requirements, the company went into liquidation in early 2023.[43]

[40] https://cnevpost.com/2026/05/06/global-ev-battery-market-share-jan-mar-2026/
[41] https://source.benchmarkminerals.com/article/infographic-regional-trends-in-cathode-production-capacity
[42] https://sodiumbatteryhub.com/2026/07/31/china-mass-producing-evs-with-sodium-ion-batteries/
[43] https://www.theguardian.com/business/2023/jan/17/britishvolt-expected-enter-administration-tuesday

Serious production issues, high scrap rates and quality assurance failures have arisen at Northvolt's gigafactory in Skellefteå. The ramp-up to mass production was not completed on time. BMW cancelled a significant order due to the delays. The company eventually filed for bankruptcy protection, halted its expansion plans and carried out significant redundancies (Tagliapietra and Trasi, 2024).

Freyr Battery was a Norwegian battery manufacturing start-up founded in 2020, which aimed to produce battery cells using dry-electrode manufacturing technology and green energy. In 2023, the company suspended development of its planned gigafactory, as the European Union was unable to provide state support comparable to the US subsidy scheme. It relocated its headquarters to the United States, but due to the price advantage of cheap Chinese batteries and a slowdown in battery demand, Freyr sold the factory site in early 2025, withdrew completely from the battery cell manufacturing business and is now focusing on solar panels.[44]

Morrow Batteries, a Norwegian company founded in 2020, would have based its operations in Arendal on the cheaper and greener LFP and LNMO (lithium-nickel-manganese oxide) technologies. The company had established a reliable shareholder base and had also secured significant state funding, totalling over 5.1 billion Norwegian kroner. The Arendal plant initially started with a capacity of 1 GWh, which was to be increased to 42 GWh by 2028. Commercial-scale series production began in January 2026, with the first shipments going to Finland (Renpenning, 2026). However, due to a slowdown in European demand for electric cars, extremely high energy and operating costs, and an aggressive price war waged by Chinese manufacturers, Morrow was unable to raise sufficient capital in time and filed for bankruptcy. Both Northvolt and Morrow are being acquired by the US company Lyten.[45]

The European battery IPCEI project focuses primarily on the premium EV segment and grid-scale energy storage systems. Europe remains heavily dependent on imports for the processing of battery raw materials (lithium, graphite, nickel). China also leads globally in terms of patent and scientific publication activity (Bielewski et al, 2026). Among the EU member states, France and Spain are attempting to establish significant domestic cell manufacturing capacity.

In northern France, around Dunkirk, the government has established an industrial hub comprising several factories (the French firms ACC and Verkor, and the Asian-backed companies AESC Envision and ProLogium). French firms are struggling with proper production.[46] Local residents and environmentalists are also voicing opposition here. Their main concerns are the potential release of large quantities of volatile organic

[44] https://www.manufacturingdive.com/news/freyr-battery-cancels-georgia-battery-plant-pivot-solar-module-cell/740250/
[45] https://dealroom.co/news/146812-lyten-to-buy-norways-bankrupt-morrow-batteries-in-european-push/
[46] ACC stopped its planned factories in Italy and Germany.

compounds (VOCs), NMP solvents and heavy metal dusts into the environment, as well as the depletion of local groundwater. As battery factories are classified as high-risk due to the chemicals they use, residents living in the immediate vicinity of the factories fear chemical leaks, potential battery fires and the release of toxic gases. The environmental authority has officially required Verkor to better assess and mitigate its environmental impacts, emphasising a more thorough analysis of technological risks, air pollutant emissions, and emissions arising from routine operations and in the event of a fire (including PFAS).[47] The ACC battery plant in Douvrin will consume nearly 1 million cubic metres of water per year above a vulnerable water catchment area, and the project could exacerbate the already problematic groundwater contamination.[48] The region's fifth battery factory is planned for the site of Maubeuge Airport, though the investor has not yet been named. The project promises 2,000–3,000 jobs, but is facing fierce opposition from associations using the airport and local farmers. In Dunkirk and Douvrin, industrial regions in crisis, job creation was a key argument; in Maubeuge, however, a functioning airport that serves the local community and agricultural land would be sacrificed, and the water supply would also be put at risk.[49]

Near Zaragoza in Spain, Stellantis is building a major LFP battery cell factory with a capacity of 50 GWh in partnership with CATL. Although the Spanish and regional governments regard this as a priority strategic project, the investment has come in for sharp criticism. Local trade unions and business organisations have protested vehemently against the plan to bring in large numbers of Chinese engineers and skilled workers to build the factory and implement the technology.[50] The Zaragoza region has a semi-arid climate, so local farmers and environmentalists have expressed concerns about the cooling water and electricity requirements of battery production, which could jeopardise the area's water supply. The factory will use around 1 million litres of water a year from the River Ebro and other canals; this will require the construction of a new water pipeline and the expansion of the capacity of the existing water treatment plant . According to the authorities, there will be no supply issues.[51] Civil society organisations also criticise the fact that the project is receiving huge amounts of public funding, whilst a significant part of the decision-making process and the environmental impact assessments lacked transparency for the public. In total, the Stellantis Group has secured

[47] https://www.deltafm.fr/bourbourg-et-craywick-verkor-va-devoir-mieux-evaluer-et-compenser-ses-impacts-environnementaux
[48] https://reporterre.net/Batteries-electriques-dans-le-Nord-la-resistance-aux-gigafactories
[49] In À la Salmagne, near Maubeuge, the arrival of a Gigafactory is causing a divide – LATITUDES 2025
[50] China's CATL breaks ground on a huge Spanish battery plant – bringing its own workers | MarketScreener
[51] Water consumption at the Stellantis gigafactory: one billion litres of water each year from the Imperial Canal and the Ebro

nearly 300 million euros through the so-called PERTE VEC tenders[52] , and the Aragonese government has authorised the investment under a fast-track procedure.[53]

In Central and Eastern Europe, there are places where there is virtually no battery production capacity, whilst in others, a significant amount is being developed. In Dolní Lutyně, the Czech Republic, 88 per cent of locals voted against the planned Asian battery factory in a referendum, meaning the project has been scrapped by 2026. In Nagysurány, Slovakia, Gotion-InoBat's investment in a 40 GWh battery factory, backed by €194 million in state aid, raised environmental concerns. Despite this, trial operations began in 2026. In Poland, the South Korean company LG Energy Solution's cell factory has been operating near Wrocław since 2016, making it Europe's largest factory to date. Numerous other players in the supply chain are also present, and significant energy storage facilities are being built. Conflicts have also arisen in Poland, primarily in relation to the supporting industries. In relation to the planned electrolyte production plant by the Chinese company Guotai-Huarong, the local authority's appeal court overturned the local council's approval, citing the investment's environmental impact; the entire licensing process must now be restarted from scratch. The government office did not grant approval for Chinese firm Capchem's planned electrolyte production at the former BASF site after local residents, fearing pollution, began to protest and it emerged that the investor had not carried out an adequate environmental risk assessment.[54] Instead of the town of Złotoryja, the South Korean battery recycling company SungEel has relocated its operations elsewhere due to local opposition.

Hungary has become a key player in European battery manufacturing, working with Asian-owned companies and suppliers in the sector. In terms of the capacity being developed (targeted at 252 GWh by 2030) and the number of jobs per capita in the battery industry, Hungary is the clear leader in Europe. In addition to direct subsidies, the state has spent billions more on indirect infrastructure developments (power lines, warehouses, motorways, public utilities, energy storage facilities), meaning that total state expenditure exceeds 2 per cent of annual GDP. The legal and environmental irregularities characteristic of the autocratic over-development of the Hungarian battery industry under the Orbán government are detailed by Éltető (2024a), whilst the industrial security issues are outlined in detail by Éltető (2024b). The push for investment in the Asian battery industry essentially served power-political and geopolitical manoeuvring objectives rather than a well-thought-out, sustainable industrial development strategy. There was a lack of public consultation and legally binding strategic environmental assessments, whilst South Korean factories factored in the possibility of low fines for any irregularities. Public opposition grew significantly; according to a survey conducted at the

[52] https://espanadigital.gob.es/en/measure/perte-strategic-projects-economic-recovery-and-transformation
[53] Plans for a 50 GWh LFP gigafactory in Figueruelas and Pedrola are moving forward – pv magazine España
[54] https://pcblog.atlatszo.hu/2021/02/09/lengyel-litiumion-akkumulatorok-mozgathatjak-europat/

end of 2024, 62 per cent of the Hungarian population rejected the battery factories (Policy Solutions, 2024), and the issue of polluting battery factories, for example, also played an important role in the 2026 parliamentary election campaign (Ricz & Éltető, 2026). According to the new Hungarian government's pledges, inspections and penalties in this sector will be tightened. As the companies in Hungary's battery value chains are almost entirely owned by Asian entities (Szunomár, 2025), this does not represent a move towards genuine strategic autonomy for the EU, but merely shifts dependence from finished products to raw materials and processed chemicals.

7. Conclusions

As the study sets out, reconciling decarbonisation, competitiveness and strategic autonomy is a persistent problem – a point reinforced by the case studies presented. Several of Rittel and Webber's criteria are evident: there is no uniform definition of a critical raw materials strategy (companies, governments and local communities understand the concept of 'green mining' in radically different ways); the decisions taken are irreversible (the relocation of Kiruna, the construction of mines or greenfield battery factories); and there is no objective yardstick for a 'good' solution, only the competing truths of differing interest groups – as demonstrated by the conflicting priorities of the Sami communities, Andalusian farmers, or airport users in France and the local unemployed.

Based on the cases presented, the answer to the paper's research question – whether the EU can manage this wicked problem with minimal damage – is, on the whole, negative. The EU's strategy typically does not follow the adaptive, collaborative, 'clumsy' solutions proposed by Head and Alford, or by Verweij and his co-authors, but rather the opposite: the opaque process surrounding the drawing up of the list of Strategic Projects, the political overriding of expert recommendations, and the exclusion of local communities from decision-making demonstrate precisely that the EU is applying a technocratic, top-down logic to a type of problem which – as the lessons from Endl (2017) and Freeman (2000) also show – can only be effectively addressed through genuine, early and equal social involvement.

A further structural problem is that the EU's response is based almost exclusively on technological substitution: domestic mining, recycling, battery production – whilst the absolute reduction of actual material and energy consumption (the necessity of which has been highlighted in several reports and articles) still does not feature as a substantive EU objective. In line with the Jevons paradox, this means that improving efficiency alone will not solve the problem, and may even, in the longer term, perpetuate raw material dependency and the associated socio-ecological conflicts – be it the habitats of Scandinavian indigenous communities, disputes over water use around French and

Spanish factories, or the pollution and autocratic organisation of the battery industry in Hungary.

The failures in the European battery industry highlighted here (Northvolt, Britishvolt, Freyr, Morrow) also indicate that the cost of strategic autonomy is extremely high, and that the EU's current toolkit (IPCEI, Net-Zero Industry Act, IAA) is as yet unable to counterbalance the technological and economies-of-scale advantages of Asian – primarily Chinese – players. This further narrows the scope for manoeuvre: the EU is attempting simultaneously to remain competitive, become greener and achieve independence, whilst the pursuit of all three objectives undermines one another, as foreshadowed by the trilemma outlined in the introduction.

In light of all this, the creation of new EU legislation and funding instruments is not sufficient to tackle this wicked problem. What is needed is: (1) genuine transparency in the selection of strategic projects and the early involvement of local communities at the decision-making level; (2) the setting of binding EU targets for reducing absolute material and energy consumption; and (3) iterative, regular feedback mechanisms within the regulatory framework, as proposed by Endl (2017) and Lazarus (2009) for tackling similar 'super-wicked' problems. Without these, the EU's industrial policy will continue to reproduce the paradox indicated in the introduction: the goal of being green, competitive and self-sufficient cannot be achieved whilst consumption patterns remain unchanged – the problem can only be postponed at the cost of ever more local conflicts.

Looking beyond Europe, it is evident that whilst the fight against climate change would require decarbonisation and a technological transition, energy consumption data show that global fossil fuel consumption (coal, crude oil, gas) remains enormous, and the energy requirements of new technologies (AI, cryptocurrencies) are leading to the opening of further coal mines around the world. Recalculations of the Club of Rome's 1972 'The Limits to Growth' model (Nebel et al., 2024) continue to indicate that, on a planet with finite resources, models based on infinite industrial and consumption growth are reaching their physical limits.

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