BARRIERS TO CLEAN ELECTRIFICATION SERIES
SUPPLY CHAINS

EU Policy Toolkit

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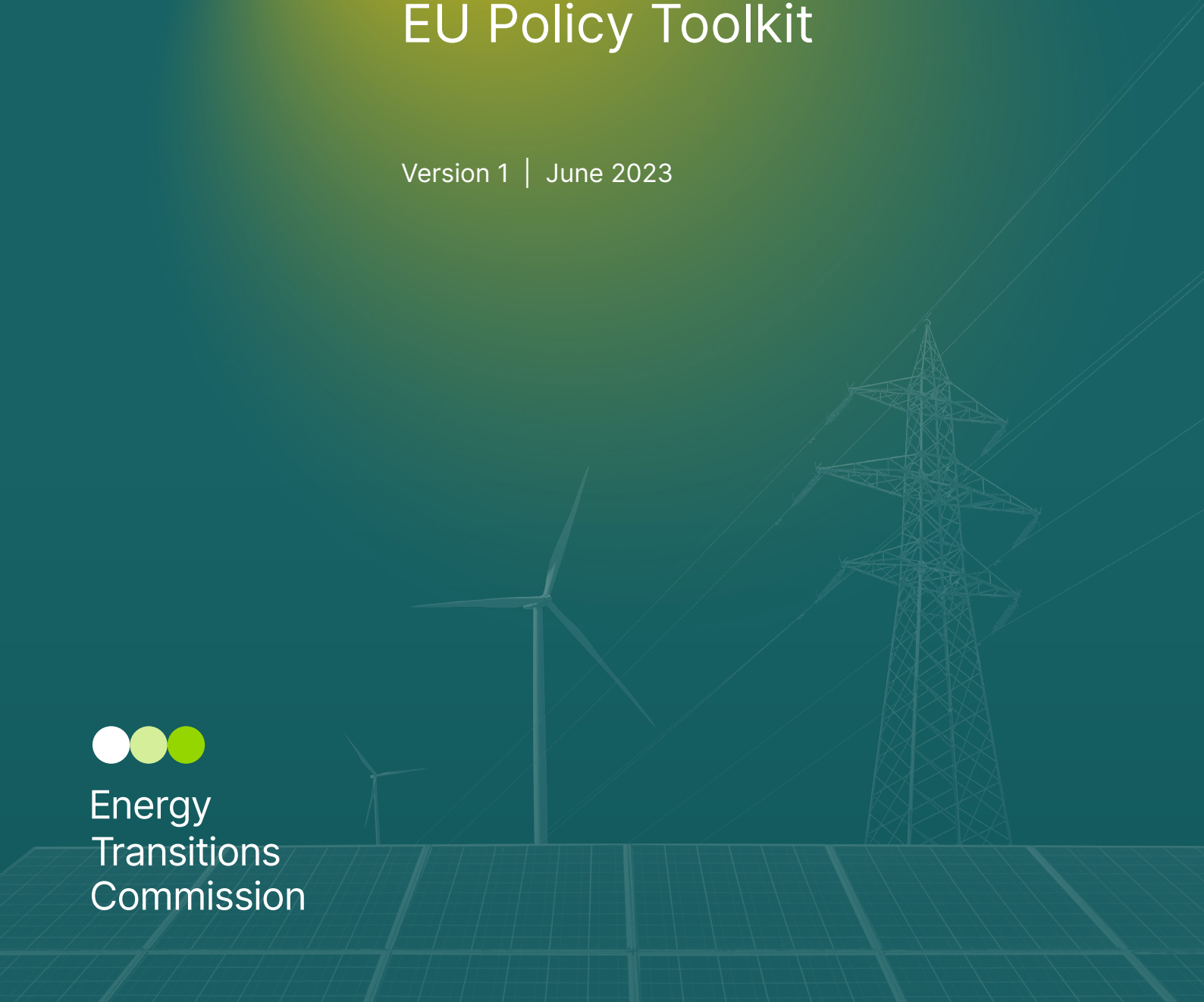

Energy
Transitions
Commission

Overview and contents

This *EU Policy Toolkit* presents a summary of the EU's position in key clean energy supply chains, and outlines major policy priorities. The Toolkit is an accompanying document to the ETC's global Insights Briefing *Better, Faster, Cleaner: Securing clean energy technology supply chains*, part of the ETC's *Barriers to Clean Electrification* series.

The Insights Briefing reviews supply chain risks across major "backbone" technologies for energy sector decarbonisation (solar photovoltaic (PV), wind, lithium-ion batteries (for electric vehicles, and storage), grids, domestic heat pumps, and electrolysers), presents an overview of cross-cutting risks, and outlines key actions and recommendations for global policymakers and industry to address major risks and opportunities.

This *EU Policy Toolkit* focuses on analysing the European perspective, provides an overview of Europe's energy transition goals and current landscape for clean energy supply chains, and defines key priorities for EU policymakers to navigate risks and opportunities.

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Barriers to Clean Electrification Series

The ETC's *Barriers to Clean Electrification* series focuses on identifying the key challenges facing the transition to clean power systems globally and recommending a set of key actions to ensure the clean electricity scale-up is not derailed in the 2020s. This series of reports will develop a view on how to "risk manage" the transition – by anticipating the barriers that are likely to arise and outlining how to overcome them, providing counters to misleading claims, providing explainer content and key facts, and sharing recommendations that help manage risks.

An Insights Briefing will be developed for each barrier, covering the context and major challenges, and assessing the impact of deploying key solutions. These Insight Briefings will be accompanied by a series of Solution Toolkits, which lay out a set of key actions that need to be taken by the most important group of stakeholders (e.g., governments, renewables developers, grid operators, civil society) and outlines supporting case studies.

Introduction

The climate crisis is accelerating Europe's focus on the energy transition. In 2021, the EU announced the European Green Deal, including a commitment to reaching climate-neutrality by 2050, and reducing EU emissions by at least 55% by 2030. To underpin this objective, in 2021 the EU set out the Fit for 55 package. Russia's invasion of Ukraine has given further urgency to Europe's turn away from fossil fuels; as a response to the Ukraine invasion in 2022, Europe set out a series of more ambitious targets to 2030 in its REPowerEU plan.

It is critical for the energy transition in Europe to remain on track and respond to a number of potential barriers. As discussed in the accompanying Insights Briefing, the issue of supply chain resilience has become central. Since the Covid-19 pandemic, clean energy technologies' supply chains have faced multiple disruptions, resulting in higher prices for wind and batteries.[1] Europe is particularly exposed to supply chain shocks, given a significant dependency on imports of both raw materials and components.

In parallel, many countries and regions – including Europe – are re-thinking the strategic importance of supply chains, as an opportunity to increase both energy security and industrial competitiveness. In February 2023 the EU announced a "Green Deal Industrial Plan", setting out targets for domestic production from raw materials through to components for key clean energy technologies.[2] The Net-Zero Industry Act (NZIA), as one of the centrepiece proposals of the package, lays out targets for 40% domestic production for EU needs by 2030, whilst the Critical Raw Materials Act (CRMA) includes targets across mining, refining and recycling.[3] As set out in our main Insights Briefing, measures to address supply chain challenges, especially by near-shoring manufacturing, will likely involve trade-offs across different objectives.

Building on the conclusions and assessments in the accompanying Insights Briefing, this *EU Policy Toolkit*:

1. **Provides an assessment of the state of play of the EU across clean energy supply chains.**
2. **Defines key priorities for EU policymakers to navigate risks and opportunities across clean energy supply chains.**

[1] ETC (2023), *Better, Faster, Cleaner: Securing clean energy technology supply chains*; BNEF (2022), *Lithium-Ion Battery Price Survey*; BNEF (2022), *1H Global Wind Market Outlook*; BNEF (2022), *1H Wind Turbine Price Index*.

[2] EU Commission (2023), *The green deal industrial plan: putting Europe's net-zero industry in the lead*.

[3] EU Commission (2023), *Net zero industry act*.

The EU's clean energy deployment targets

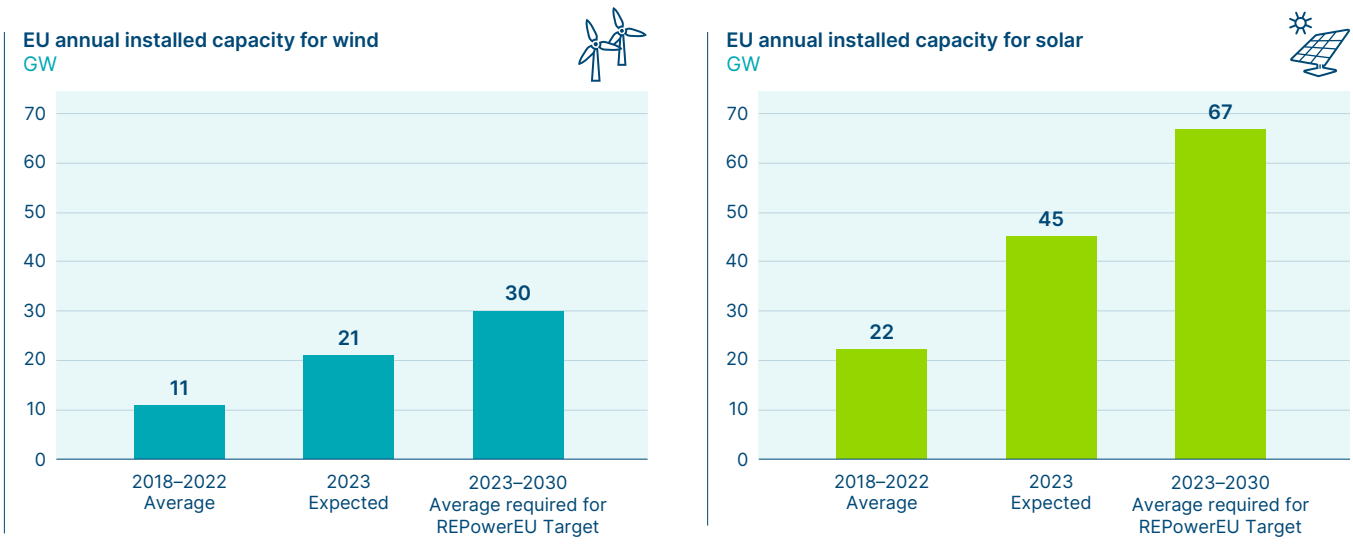
In 2022, the EU laid out a vision for scaling clean energy under the REPowerEU plan, building on the objectives set out in the 2021 Fit for 55 package. REPowerEU set out dual objectives of reducing dependence on Russia's fossil fuels (by moving away from Russian gas entirely by 2027) and diversifying gas and energy supplies, as well as setting a more ambitious trajectory for clean energy deployment to 2030. As a headline, the plan commits the EU to reach a 45% share of renewable energy across final energy consumption by 2030 (up from 40% in the Fit for 55 package).[4] Key targets underpinning this objective include:[5]

- Growing the share of renewables in the electricity sector from 40% today to 69% by 2030, and from <10% today to 32% in the transport sector by 2030.
- Growing installed solar capacity from approximately 210 GW in 2022 to 740–750 GW by 2030.[6]
- Growing installed on- and off-shore wind capacity from approximately 200 GW in 2022 to 440 GW by 2030.[7]
- Growing electrolyser production from <1 GW in 2022 to 17.5 GW by 2025, to deliver 10 million tonnes of domestic EU green hydrogen production by 2030.
- Growing the share of renewable energy in heating and cooling by 2.3% per annum to 2030, supported by a doubling of heat pump deployment from approximately 20 million units today to over 40 million by 2030.

Under these targets, deployment of clean energy technologies will require acceleration. While the targets are within reach – particularly for solar – critical policies need to be put into place to ensure the required acceleration. Exhibit 1.1 highlights the wind and solar installed capacity trajectories required to meet the targets, compared with current levels.

Annual installations of wind and solar needs to grow rapidly to meet EU targets

Exhibit 1.1



Source: BNEF (2023), *Interactive data tool – global installed capacity*; Ember (2023), *Wind and solar deployment in the EU*.

4 EU Commission (2022), *REPowerEU: affordable, secure and sustainable energy for Europe*.

5 While REPowerEU sets the headline target, the estimates for each sector are based on modelling done by individual organisations; therefore, estimates may vary. BNEF (2023), *Interactive Data Tool – Capacity & Generation*; Ember (2023), *Wind and Solar Deployment in the EU*; BNEF (2022), *Global Electrolysers outlook 2030*; IEA (2022), *Is the European Union on track to meet its REPowerEU goals?*

6 Assuming a DC:AC conversion factor of around 1.25, which is applied to the stated target of 600 GW-AC by 2030.

7 This could include larger-than-expected growth in offshore wind, following a recent target of 300 GW of offshore wind in the North Sea by 2050. See e.g., Ember (2023), *Wind and Solar Deployment in the EU*; Reuters (2023), *Europe targets 120 GW Offshore Wind by 2030; US wind pledges create thousands of new jobs*; Euractiv (2023), *North Sea countries aim for 300 GW of offshore wind energy by 2050*.

EU current landscape and policy across supply chains

As the Insights Briefing lays out, the required growth in clean energy deployment for a net-zero trajectory represents a significant opportunity. The growing size of the clean energy system means that countries can all grow their footprint across key clean energy supply chains. However, to ensure the energy transition can proceed at pace and low cost, it will be critical to address three potential supply chain challenges, spanning raw materials to transport inputs:

1. **Risks relating to market tightness, or the ability of supply to meet demand.**
2. **Risks relating to specific environmental and social issues around production.**
3. **Risks relating to high concentration of production in specific geographies.**

Over the past year, Europe has pushed forward policies focused especially on addressing the third dimension. Despite ambition on deployment, Europe currently faces a deficit of domestic production. As such the EU is heavily reliant on imports for the mining and refining of materials, as well as for many components and for manufacturing. Recent policy responses have therefore focused on measures to increase domestic production. On 1st February 2023, the EU Commission put forward a package of policy proposals under the Green Deal Industrial Plan (GDIP), aimed at relocating key supply chains within Europe. The plan is positioned as a response to the United States' efforts on domestic clean energy manufacturing contained in the Inflation Reduction Act passed in August 2022 [Box A and Exhibit 1.2].[8]

Key measures of the proposals, which will take 1–2 years to legislate, include:

The **Critical Raw Materials Act** which aims to strengthen Europe's resilience across raw materials supply chains. Key provisions include:[9]

- Setting a list of Strategic Raw Materials (SRM) comprising 16 raw materials.[10]
- Setting targets by 2030 for domestic capacities of SRMs, as follows:[11]
  - EU domestic mined supply is able to meet 10% of EU demand in 2030.
  - EU domestic refined supply is able to meet 40% of EU demand in 2030.
  - EU recycling capacity is able to meet 15% of EU domestic demand in 2030.
  - Ensuring that no more than 65% of EU's demand in 2030 for each SRM at any stage of processing comes from a single third country.
- Putting forward a series of resilience measures to secure global supply, such as monitoring supply, coordinating strategic stocks, creating networks with other countries and strengthening trade frameworks.

The **Net-Zero Industry Act** (NZIA), which aims to improve Europe's competitiveness by growing domestic investment into net-zero technologies and manufacturing. Key provisions include:

- A headline policy of setting benchmark targets for domestic production across key components, laying out that "the manufacturing capacity in the [European] Union… approaches or reaches at least 40% of the Union's annual deployment needs."[12] These targets include not only end-products, but also specific intermediate components across eight key technologies.[13]
- A series of enabling policies, such as:
  - Streamlining planning and permitting for "net-zero strategic projects".
  - Measures to boost resilience and sustainability criteria in auctions and public procurement procedures, with some caveats (e.g., the auction criteria on these measures will be ignored if they raise total costs of technologies by over 10%).
  - Setting up Net-Zero Industry Academies to support skills deployment.
- A series of other sector-specific provisions, such as:
  - Setting a CO_2 injection capacity target to incentivise CO_2 capture and storage.
  - Setting up a European Hydrogen Bank.
  - Creating regulatory sandboxes to help test innovative technologies.

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8 See e.g., Bipartisan Policy Center (2022), *Inflation Reduction Act Summary: Energy and Climate Provisions*.

9 EU Commission (2023), *Critical raw materials act*.

10 Bismuth, Boron (metallurgy grade), Cobalt, Copper, Gallium, Germanium, Lithium (battery grade), Magnesium metal, Manganese (battery grade), Natural Graphite (battery grade), Nickel (battery grade), Platinum Group Metals, Rare Earth Elements for Magnets, Silicon metal, Titanium metal, Tungsten.

11 It should be noted that it is unclear whether these figures apply to each individual materials, or collectively. In our analysis included in [Exhibit 1.3], we have assumed the former.

12 EU Commission (2023), *Net zero industry act*.

13 Eight key technologies are: solar power and solar thermal; onshore and offshore wind power; batteries and energy storage; heat pumps and geothermal energy. electrolysers and fuel cells; sustainable biogas/biomethane; carbon capture and storage (CCS); grid technologies.

Box A **The US Inflation Reduction Act**

The EU's Green Deal Industrial Plan is positioned as a response to the United States' Inflation Reduction Act passed in August 2022, together with a broader suite of energy transition and infrastructure spending announced by the US (including through the IRA New Loan and Loan Guarantee Authority, the Infrastructure Investment and Jobs Act, and the CHIPS & Science Act).

The Inflation Reduction Act has been one of the most significant announcements of recent years to accelerate climate and energy policy; together with wider federal and state programs, this amounts to a $1 trillion public investment in the energy transition over the next decade [Exhibit 1.2].[1] The IRA takes a strong government-subsidy driven approach to scale both deployment of clean energy, and to prioritise domestic manufacturing. Prior to the announcement of Europe's Green Deal Industrial Plan, a clear divergence of US policy *via* the IRA was the introduction of protectionist measures to support decarbonisation objectives, and support for decarbonisation primarily through funding support instead of regulation.

Key incentives of the IRA include production subsidies for batteries, wind turbine parts and solar technology components, as well as for materials like aluminium, cobalt and graphite. Across IRA subsidies, a key provision is the link to local content requirements. The EV subsidy, for example, which provides up to $7,500 in consumer subsidies for EV purchases, will only be applicable if supply chains for critical minerals, batteries and vehicles meet certain local content or free-trade partner agreements.[2] A key point is that there is no upper limit to spending through tax credits, for both manufacturing or electricity generation – meaning spending by the federal government could be much larger than anticipated.

The US has recently been involved in discussion with the EU in order to clarify whether certain IRA subsidies would be available to European companies or to supply from Europe, under the specification that these are available to countries with free-trade agreements with the US.[3]

[1] Kaya Advisory/Inevitable Policy Response (2022), *The US discovers its climate policy: A holistic assessment and implications.*
[2] The full credit is split in two halves: EV manufacturers must meet a threshold for sourcing critical minerals from North America and free trade agreement countries for half of the credit (requirement rises from 40% in 2024 to 80% in 2026), and must meet a threshold for sourcing battery components only in North America for the other half (requirement rises from 50% in 2024 to 100% in 2028).
[3] See e.g., American Enterprise Institute (2023), *The US-EU Inflation Reduction Act patch-up*.

Although available funding is similar across the US and EU, there is a lack of access, coherence and clarity for European spending

Exhibit 1.2

US: $1trn of spending across federal and state govs.

- Overall funding could reach **~$1trn** across various packages
- Total of **~$35bn available for clean energy manufacturing**
- Significant **tax credits for investment and production**, across electricity and hydrogen
- Strong consumer credits available (e.g., for EVs, heat pumps)
- **Clear, easy-to-access incentives** and a technology-neutral approach

EU: Similar spending level, but more complex/fragmented

Green Deal Industrial Plan

Net-Zero Industry Act
- 40% of 2030 clean tech capacity additions met by domestic manufacturing
- Enabling policies to streamline permitting and finance

Critical Raw Materials Act
- 10% of 2030 materials demand met by domestic mining
- 40% met by domestic refining
- 15% met by recycled materials
- Max 65% of supply from one country

Other EU and member-state level policy
- REPowerEU
- InvestEU
- Introduction of CBAM
- Ongoing debate on use of ETS revenues
- Member-state EV tax credits, subsidies etc.

- Overall funding available could be up to **~€800bn**, comparable to US
- Total of **~€37bn available for clean energy manufacturing**
- **Sources of funding are more fragmented and disparate**
- **Lack of coherent vision** and messaging across policy packages

Note: IRA = Inflation Reduction Act; CHIPS = Creating Helpful Incentives to Produce Semiconductors.

Source: Kaya Advisory/Inevitable Policy Response (2022), *The US discovers its climate policy: A holistic assessment and implications*; Bipartisan Policy Center (2022), *Inflation Reduction Act Summary: Energy and climate provisions*; Bruegel (2023), *How Europe should answer the US Inflation Reduction Act.*

Measures to ensure faster access to sufficient funding, including at the national and EU-level:

- **On the national level**, the Green Deal Industrial Plan's main proposal is a revision to state aid rules via a new **Temporary Crisis and Transition Framework**, which would grant Member States more power to provide subsidies and aid to key sectors for the net-zero transition (via domestic financing).[14]

  A previous version of the proposal included a push for member states to allocate a share of carbon pricing revenues from the European Emissions Trading Scheme (ETS) into clean energy manufacturing, though this was then removed. BNEF estimates annual ETS revenues could be in the order of €80 billion per year by 2030 (€600 billion between 2022–2030), making it a sizeable pot of financing.[15]

- **At the EU-level**, there are proposals to increase alignment across existing EU funds. Short-term, this involves working with member states with a focus on additional funding via the Recovery and Resilience Facility (RRF) for net-zero projects, as well as greater alignment of other funding pots (InvestEU and the EU Innovation Fund) to orient this funding to strategic net-zero industries.[16] Over the medium-term, the key provision is the creation of a dedicated European Sovereignty Fund to increase strategic autonomy across critical sectors, including but not limited to clean energy.[17]

Overall, it should be noted that significant funding does currently exist in the EU for clean energy deployment, as well as manufacturing. Bruegel estimate that existing policies in the EU are comparable in magnitude to measures in the US' Inflation Reduction Act [Box A and Exhibit 1.2].

- Spending across renewable energy subsidies in the EU could total up to around €800 billion – similar in magnitude to the around $1 trillion across US federal and state spending.[18]
- EV subsidies are approximately €6,000 per car in EU vs $7,500 per car in US.
- Clean energy technology manufacturing support from 2022–2030 would total $37 billion in the US vs €35 billion in the EU.[19]

However, Europe's funding landscape is significantly more complex – for example, manufacturing subsidies are split across the EU Innovation Fund, EIB, InvestEU and other instruments. The EU's flagship climate policy to date has been the EU's Emissions Trading Scheme. Though this does incentivise clean energy take up (and associated supply chains) it is not as direct an incentive as subsidies. The recently agreed Carbon Border Adjustment Mechanism will further support this. While most US support is in the form of tax credits, which provide certainty to industry and investors, in the EU there is no flagship green subsidy scheme, and funding is allocated through a mix of national and EU-level instruments – meaning EU funding faces challenges of access, coherence and clarity.[20]

14 EU Commission (2023), *Temporary Crisis and Transition Framework*.

15 BNEF (2023), *Europe's Bid to Reshore Clean Tech Pulls its Punches*.

16 The Recovery and Resilience Facility (RRF) makes available to member states €723.8 billion in loans (€385.8 billion) and grants (€338 billion) to support the European economic recovery in the wake of the Covid-19 pandemic, to be implemented until end-2026. On 18 May 2022, the Commission proposed to make targeted amendments to the RRF Regulation to integrate dedicated REPowerEU chapters in Member States' existing Recovery and Resilience Plans. The InvestEU Fund aims to mobilise more than €372 billion of public and private investment through an EU budget guarantee of €26.2 billion between 2021–2027 that backs the investment of implementing partners such as the European Investment Bank (EIB) Group and other financial institutions. The EU Innovation Fund is a funding programme that will provide around €10 billion of support over 2020–2030 for the commercial demonstration of innovative low-carbon technologies.

17 EU Commission (2023), *Green Deal Industrial Plan*.

18 Bruegel (2023), *How Europe should answer the US Inflation Reduction Act*.

19 Ibid.

20 Ibid.

Assessing the EU's position

Meeting the objectives laid out in the Green Deal Industrial plan will require a significant push and investment for European industry. As laid out in Chapter 4 of the Insights Briefing, there are two key areas of potential trade-offs to scaling domestic supply chains:

- There are trade-offs between achieving political priorities across jobs, manufacturing, trade and energy security, and increased costs (e.g., capex for a battery plant, or higher energy prices).
- There are feasibility challenges to building new projects, covering: more stringent environmental and social standards, quotas on local content, slower permitting, difficulty accessing finance and a general lower investment risk appetite. Rapidly scaling domestic supply chains may require trade-offs across some of these dimensions.

Together with the fact that scaling domestic supply chains often means (re-)starting manufacturing or mining from a low base, efforts to move production to the EU could risk slowing deployment of clean energy technologies, or making it more expensive. For some raw materials and technologies, the challenge around growing domestic EU production targets is more feasible than others.

Raw materials

Europe faces a particular challenge in terms of supply of energy transition materials, given its historical lack of a large-scale mining sector. Across four key energy transition materials – copper, lithium, nickel and cobalt – EU demand in 2030 would greatly exceed EU-based supply, both of raw materials and refined supply [Exhibit 1.3]:

Copper: The EU copper mining industry produces approximately 0.8 Mt of copper each year (less than 5% of global production[21]), supplying up to 14% of current domestic demand.[22] With no new investments in capacity, output is expected to gradually decrease. Domestic refining capacity is somewhat higher at approximately 2.5 Mt, over 50% of EU demand (much of the input is from scrap or recycled copper).

Expanding lithium mining and refining will be biggest challenge to meet Europe's Critical Raw Materials Act domestic supply targets

Exhibit 1.3

European demand and supply forecasts in 2030
Copper = Million metric tonnes; Lithium, Nickel = Thousand metric tonnes

Note: Demand is from all sectors, including both energy transition and non-energy transition sectors. Ranges indicate medium/high demand scenarios and base/optimistic supply scenarios from Eurometaux (2022) report. High demand scenarios assume aggressive policy action is taken to accelerate the energy transition, i.e. including and beyond REPowerEU and similar programmes.

Source: Systemiq analysis for the ETC; Eurometaux (2022), *Metals for clean energy: Pathways to solving Europe's raw materials challenge.*

[21] Global copper mined production in 2022 was approximately 22 Mt – US Geological Survey (2023), *Mineral commodity summaries*.

[22] European domestic demand is approximately 4.3 Mt – Eurometaux (2022), *Metals for clean energy: Pathways to solving Europe's raw materials challenge*.

Lithium: Currently Portugal is the EU's only significant producer, supplying around 0.6 kt in 2022 – less than 1% of global production and barely 3% of current European lithium demand.[23] There are several projects in the pipeline in Finland, Serbia, Portugal and Germany, but these all need to begin production and some have faced local opposition.[24] There is also a need to expand battery-grade refining capacity in Europe as well (currently there is only one very small-scale refinery, not specialised in battery-grade lithium[25]), in order to supply future cathode and battery manufacturing plants.

Nickel: European mining capacity is around 75 kt per annum (around 2% of global production), and enough to meet up to 20% of current domestic demand – but future supply expansions might be challenging.[26] There is also significant refining capacity for nickel in Europe, including Talvivaara in Finland which can produce enough high-purity nickel sulphate for approximately 1 million electric vehicles (EU sales were 2 million EVs in 2022[27]).

Cobalt: EU domestic production only supplies around 10% of domestic demand, and current mines are projected to reduce output in the future.[28] The EU's refining operations are placed in Finland and Belgium, supplying approximately 70% of current domestic demand, but no expansion is currently planned.[29]

Currently forecast levels of mined and refined supply in 2030 should be sufficient to meet the CRMA requirements for copper and nickel, and some expansion would be needed in the case of cobalt [Exhibit 1.3]. However, there may be more of a challenge in the case of lithium mining and refining, where the future supply is highly uncertain: new mining projects in e.g., Portugal, Serbia and Germany would need to come online, and new lithium refineries would also need to be opened.

Mining projects have long lead times – ranging between 2–20 years, depending on the material type and project size and location – which means it takes longer for new projects to be able to meet fast growing demand.[30] Furthermore, there are some particular hurdles to expansion in Europe, including more restricted geological reserves across many energy transition minerals, higher environmental standards, more complex planning and permitting regulation, and a higher population density.

Components

Europe's market share across key components varies across technologies [Exhibit 1.4]:

For solar, while Europe has some capacity in polysilicon production in Germany, Europe's capacity for wafer, cell and module manufacturing is very low, coming in below 5% of the global market. Europe, therefore, imports mostly from China.[31] Even at the module level, where capacity is largest, Europe's production currently meets at most 18% of current EU demand.[32]

For wind, Europe has a much higher share of manufacturing, both for onshore and particularly for offshore. European wind manufacturing currently accounts for around 85% of domestic needs.[33] However, all new investment and announced investment in 2021 and 2022 for wind turbines came from the Asia-Pacific region,[34] and EU wind turbine manufacturers are citing major profitability concerns.[35]

For batteries. European capacity is virtually non-existent for cathode and anode production – especially for less material-intensive lithium-iron-phosphate cathodes.[36] However, there is some EU-based production of battery cells and packs, as well as a large EV manufacturing industry. European battery manufacturing capacity is currently 140 GWh, or enough for around 2 million EVs (sales in the EU were 2 million in 2022[37]).

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23 US Geological Survey (2023), *Mineral commodity summaries*; Eurometaux (2022), *Metals for clean energy: Pathways to solving Europe's raw materials challenge*.

24 See e.g., France24 (2022), *Europe joins the 'white gold' rush for lithium and faces an energy transition challenge*; Direct Industry (2022), *Lithium: What are the main mining projects in Europe?*

25 Leverton Lithium/BNEF (2023), *Europe's lone lithium refinery prepares for new wave of rivals*.

26 Eurometaux (2022), *Metals for clean energy: Pathways to solving Europe's raw materials challenge*.

27 BNEF (2023), *Interactive data tool – Electric vehicles*.

28 Eurometaux (2022), *Metals for clean energy: Pathways to solving Europe's raw materials challenge*.

29 Ibid.

30 IEA (2021), *The role of critical minerals in clean energy technologies*.

31 IEA (2023), *Energy Technology Perspectives*.

32 EU solar PV module manufacturing capacity is around 7 GW, and installed capacity in 2022 was approximately 38 GW, from BNEF (2023), *Interactive data tool – Equipment manufacturers/Capacity*.

33 EU Commission (2023), I*nvestment needs assessment and funding availability to strengthen EU's Net-Zero technology manufacturing capacity*.

34 BNEF (2023), *Europe's Bid to Reshore Clean Tech Pulls its Punches*.

35 Financial Times (2023), *Europe's wind industry flags further weakness in 2023 despite energy demand*.

36 The EU currently only has one lithium-iron-phosphate (LFP) cathode manufacturer. BNEF (2023), *Interactive data tool – Battery equipment manufacturers*.

37 BNEF (2023), *Interactive data tool – Electric vehicles*.

For heat pumps, the EU is well placed in terms of domestic manufacturing capacity; as discussed in the Insights Briefing, most heat pumps are produced regionally, with less international trade. EU domestic heat pump manufacturing covers well over 75% of today's EU heat pump needs.[38]

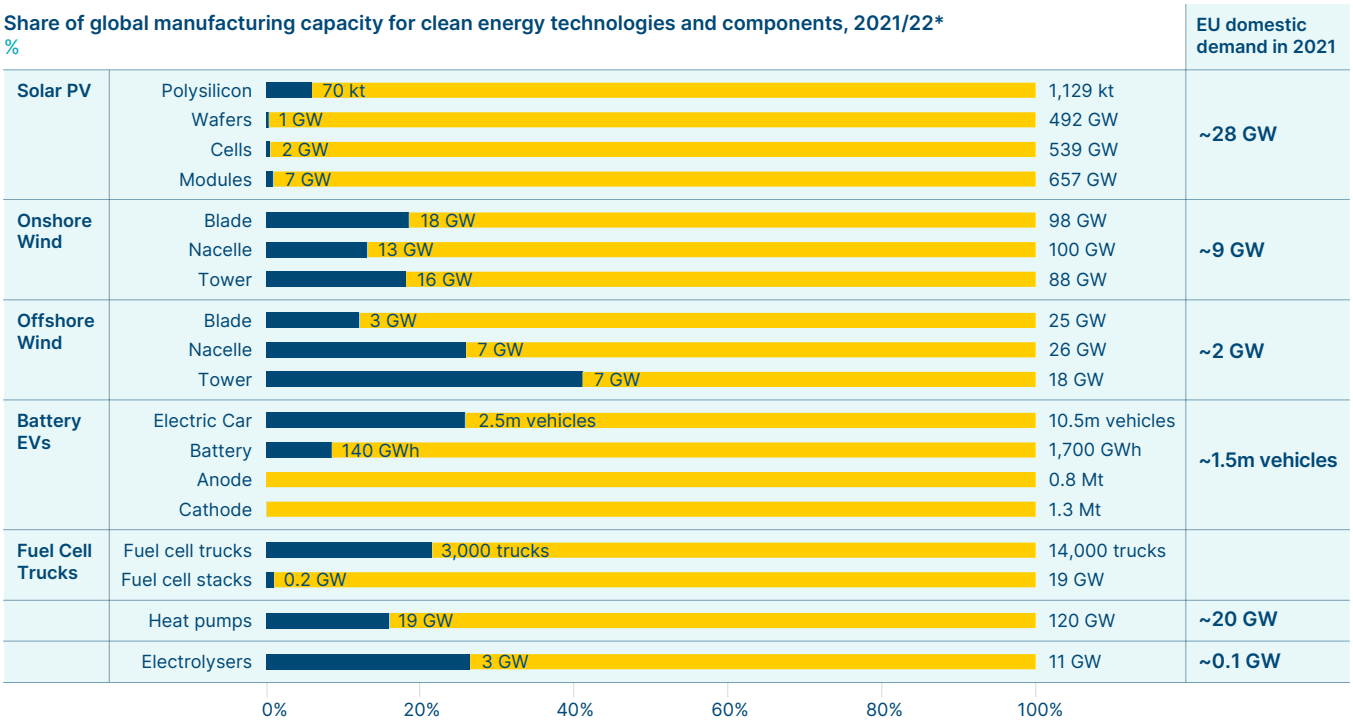
For electrolysers, a much earlier stage market, the EU currently has approximately 3 GW of manufacturing capacity (around 25% share of the global market), and is fully able to meet domestic needs (installations in Europe in 2022 were around 0.1 GW[39]). Europe is also well placed in terms of technology development in particular with a focus on PEM electrolyser manufacturing: currently Chinese manufacturing capacity is focused on Alkaline electrolysers, and future manufacturing capacity for PEM electrolysers will be mainly located in the US and Europe.[40] However, capex for electrolyser production in Europe is currently well above that in China. Some forecasts suggest that European electrolyser prices will still be in the range of $400–500/kW by 2030, compared with current electrolyser prices in China of $400/kW or lower today.[41]

The level of ambition of the NZIA target and its associated investment requirements vary across specific technologies and components. As discussed above, the EU is currently lagging particularly in solar and batteries:

- **Solar:** In the case of solar, while current EU capacity is low, announced new projects could bring Europe's domestic manufacturing capacity close to the 30–32 GW of annual production capacity needed to meet 2030 domestic production targets across polysilicon production and module assembly.[42] Including the investment requirements for announced projects, around **€13 billion** might be needed to meet NZIA

European domestic capacity is currently sufficient to meet domestic demand for wind, heat pumps and electrolysers

Exhibit 1.4



Note: *See also Exhibit 3.7 in the Insights Briefing for breakdown across further geographies.

Source: IEA (2023), *Energy technology perspectives*; BNEF (2023), *Interactive data tool – Equipment manufacturers*; BNEF (2022), *Localizing clean energy supply chains comes at a cost.*

[38] EU Commission (2023), *Investment needs assessment and funding availability to strengthen EU's Net-Zero technology manufacturing capacity*; IEA (2023), *Energy technology perspectives*.

[39] BNEF (2022), *Global electrolyzer outlook 2030*.

[40] BNEF (2022), *Electrolysis system capex by 2050 – Updated forecast*.

[41] Ibid.

[42] Representative of the 40% domestic production target set out in the NZIA, which is across all components – estimated at around 30–32 GW. For a list of announced projects by company, see McKinsey & Co. (2022), *Building a competitive solar-PV supply chain in Europe*.

targets across polysilicon, wafers, cells and modules [Exhibit 1.5]. The greatest gaps in capacity lie in mid-stream manufacturing for ingots, wafers and cells, and investments would therefore need to be focused at those stages.[43]

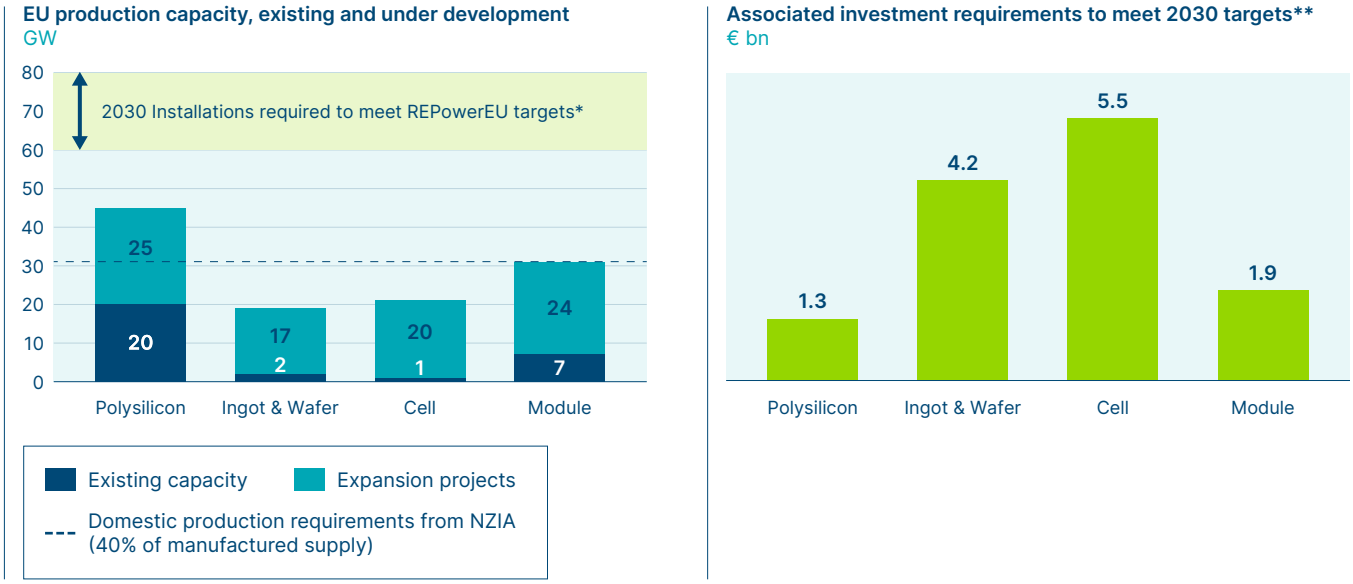
- **Batteries:** The situation for batteries is more mixed: a flurry of recent battery manufacturing project announcements means that upcoming European capacity for battery cells could be able to meet *all* European demand in 2030 [Exhibit 1.6]. However, many of these projects have only recently been announced and have not yet reached final investment decision; there is a risk that not all of this capacity will come online. The ETC estimates approximately **€44 billion** needs to be invested to secure sufficient capacity to meet the NZIA target by 2030. Further upstream there would be a much more significant gap in manufacturing capacity for cathode and anode materials in Europe, and meeting the NZIA requirements could require up to **€19 billion** to be invested by 2030.

In the case of European domestic manufacturing capacity for wind, electrolysers and heat pumps, the potential scale-up in manufacturing capacity is less of a challenge:

- **Wind:** Current European manufacturing capacity is 20–25 GW each year, and this would need to increase to 30–35 GW per year in order to meet 2030 domestic production targets[44] – a challenge that should be within reach of current manufacturers, provided they can overcome profitability challenges.
- **Electrolysers:** The current EU market is at a very early stage, but BNEF estimate around 11 GW of electrolyser manufacturing capacity should be online by 2024. This would then need to expand to 25–40 GW by 2030,[45] which should be feasible given the rapid growth of the industry.
- **Heat pumps:** Current EU manufacturing capacity stands at 14–20 GW, and this would need to approximately double in order to meet deployment targets for 2030.[46]

For the EU to meet 40% of domestic supply by 2030, €13 bn would need to be invested across the solar supply chain, with a focus on midstream manufacturing

Exhibit 1.5



Note: *Assuming REPowerEU 2030 target of ~600 GW-AC corresponds to ~750 GW-DC of total installed capacity in the EU. **Assuming an average capital investment requirement of: €115 M/GW for a polysilicon plant, €145 M/GW for ingot & wafer, €180 M/GW for cells, €80 M/GW for modules.

Source: Systemiq analysis for the ETC; McKinsey (2022), *Building a competitive solar-PV supply chain in Europe*; European Commission; BNEF (2023) *Interactive data tool – Solar.*

43 See also BNEF (2023), *Europe's bid to reshore clean tech pulls its punches*.

44 BNEF (2023), *Europe's bid to reshore clean tech pulls its punches*.

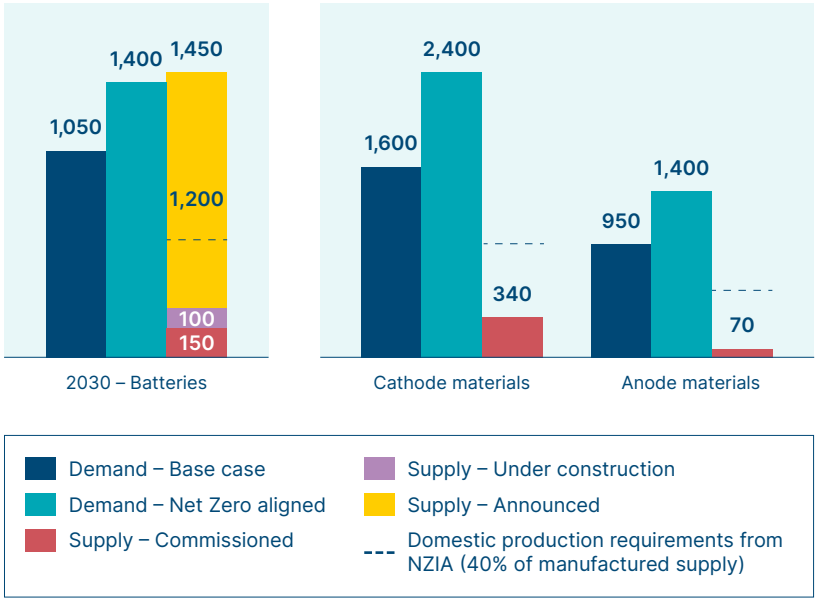
45 BNEF (2023), *Europe's bid to reshore clean tech pulls its punches*; EU Commission (2023), *Investment needs assessment and funding availability to strengthen EU's Net-Zero technology manufacturing capacity*.

46 IEA (2023), *Energy technology perspectives*; EU Commission (2023), *Investment needs assessment and funding availability to strengthen EU's Net-Zero technology manufacturing capacity*.

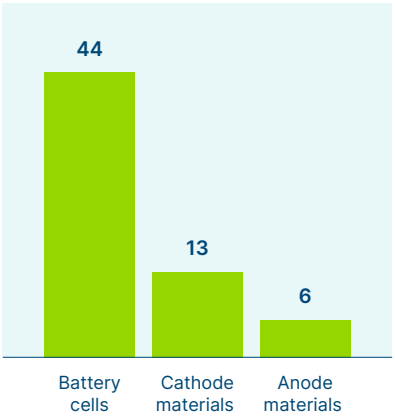
Current European battery manufacturing pipeline is more than sufficient to meet NZIA targets; €63 bn investments would be needed for required batteries and materials

Exhibit 1.6

European demand and supply forecasts for 2030*
EV battery cells (GWh); Anode/Cathode materials (kt)

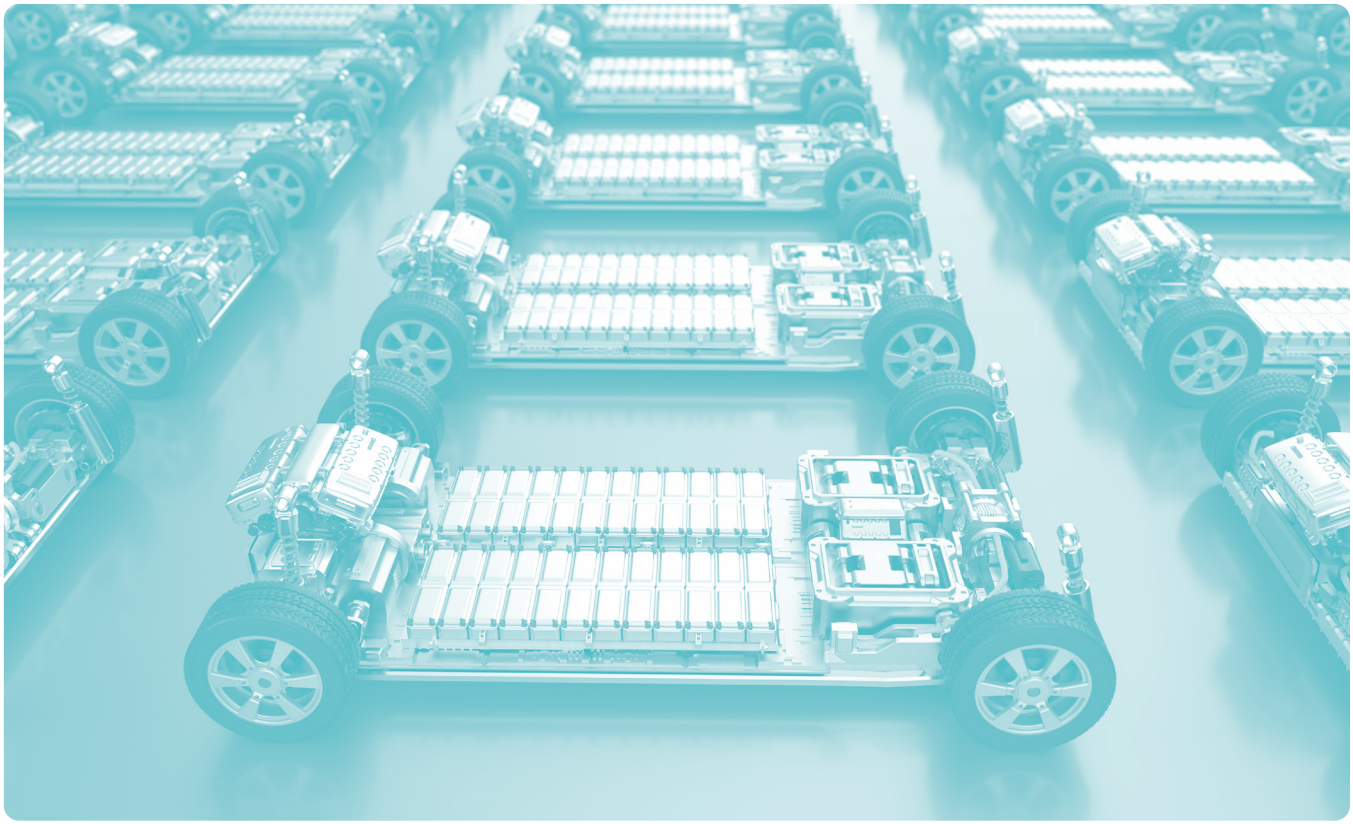


Associated investment requirements to meet 2030 targets**
€ bn



Notes: *Demand base case scenario is from T&E, data on supply pipeline from BNEF; EV categories included are passenger cars, vans, trucks, buses and coaches. **Investments calculated assuming no announced projects have yet reached final investment decision, and assuming an average capital investment of €140 M/MWh for batteries, €26 M/kt for cathodes, and €14 M/kt for anodes.

Source: Systemiq analysis for the ETC; Transport & Environment (2023), *A European Response to the US Inflation Reduction Act*; BNEF (2023), *Interactive data tool – Equipment manufacturers*.



Major policy priorities for the EU

2

The final section of this Toolkit summarises key policy priorities for EU policymakers to navigate risks and opportunities across clean energy supply chains. As discussed above, recent EU policy has been particularly focused on addressing issues around high concentration of production abroad – and in response, setting goals for domestic production. However, a balanced policy approach should also aim to realistically address competing trade-offs across all supply chain challenges, taking steps to address possible market tightness and developing environmentally and socially sustainable supply chains. As covered in the Insights Briefing, alongside governments, managing supply chain risks will also require action from industry and finance players.

To manage the spectrum of uncertainties across supply chains, the most important priority for EU policymakers is to set out a strategic vision for the energy transition, with clear targets for key sectors. The more that the broad shape and timeline of the future transition is clear, the greater the extent to which supply chain challenges will be solved by market competition and private investment. In addition, this Toolkit sets out three distinct sector-specific priority areas that Europe can pursue in order to boost its resilience across supply chains, acting on both supply and demand levers for critical aspects of supply chains.

EU policymakers should:

1. **Continue to set a clear strategic vision for the energy transition,** with sectoral deployment targets and appropriate supporting mechanisms.
2. **Fast-track clean, sustainable and diversified supply** at home and abroad.
3. **Identify and advance strategic opportunities** for domestic production.
4. Reduce the scale of the challenge via **action to increase circularity.**

Further details on these four pillars of action are laid out in the following pages.

In setting out key priorities for the EU, it must also be acknowledged that action taken at the EU-level should be complemented by action at the member state level. In particular, the EU can play a role to:

- **set targets and goals for member states to adopt.**
- **pass regulation on supporting mechanisms and enabling policies.**
- **enable access to EU-level finance and help de-risk private finance.**
- **provide guidance on member state funding possibilities and objectives.**
- **support coordinated action via taskforces and international engagements.**

The focus for member states should be to implement EU regulation in a timely and appropriate manner, as well as to develop complementary national strategies and financing plans.

We have set out below a series of recommendations for what strong EU policy should aim to achieve. We then comment briefly on what EU regulations and proposals include, and where they could be improved.

#1

Set a clear strategic vision for the energy transition, with sectoral deployment targets and appropriate supporting mechanisms.

Key actions

To provide a clear direction of travel and market certainty to scale and invest in supply chains at the required pace, it is critical for the EU to lay out a strategic vision for the energy transition, including through sectoral deployment targets, appropriate supporting mechanisms, and enabling infrastructure. It is also vital to effectively communicate the vision, providing a clear and widespread signal that the energy transition is underway. The EU should therefore build on its legislated 2050 net-zero target to:

- **Set clear and comprehensive sectoral deployment targets for clean energy technologies on the pathway to 2050** (e.g., power sector decarbonisation targets and GW capacity deployment targets for key technologies, targets for heat pump installation) for all key sectors, to underpin broader decarbonisation targets.

  Here, there may be trade-offs between explicitly technology-neutral targets (e.g., overall grid intensity targets), and deployment targets (e.g., GW of installed wind capacity). The former encourages innovation and competition across technologies, whilst the latter provides certainty to enable supply chains and manufacturing to scale up ahead of time.

- **Set clear phase-out dates for fossil technologies** (e.g., full ban of ICE vehicles by 2035, phase-out date for residential gas boilers).
- Ensure that sectoral deployment targets and fossil phase out dates are backed by **supporting mechanisms and enabling infrastructure**, including but not limited to:
  - Power market design that can support and de-risk the accelerated roll-out of wind and solar capacity at low-cost, by providing long-term revenue certainty via long-term contracts.
  - Auction mechanisms that can sufficiently de-risk the hydrogen market, as well as green demand incentives or mandates for consumers and industry, including necessary supporting funding (e.g., via European Hydrogen Bank).
  - Passenger and heavy-duty vehicle legislation on stringent CO_2 standards, that must align with ICE phase out dates.
  - Buildings regulation that should align with phase out dates for fossil technology (e.g., gas boilers) and funding for incentives.
  - Appropriate planning and permitting regimes that can de-bottleneck the installation of key infrastructure to support deployment targets, such as new grid connections.
  - Comprehensive strategies to enable the required development of skills for the energy transition.

Current measures

The existing suite of measures across the EU Green Deal Industrial Plan is comprehensive and the EU has strong buy-in for decarbonisation targets, including the Fit for 55 and REPowerEU packages. However, increased clarity and coherence could be achieved through:

- **Continuous assessment and 'ratcheting' of the ambition of targets**. For example, existing analysis suggests solar and wind deployment rates through to 2030 could exceed REPowerEU targets,[47] raising the possibility of further increasing ambition. In due course, deployment targets beyond 2030 will also be useful.
- **Avoiding mixed messages and carve-outs**, such as in the recent debate over the phase-out of combustion engine vehicles which ultimately leaves manufacturers still developing both electric vehicle and internal combustion engine supply chains, despite the expectation that EVs will be globally dominant.[48] Rather, policies on sustainable supply, circularity or near-shoring, including in the CRMA and NZIA, should be framed as part of a holistic climate and industrial strategy.
- **Communicate clearly the implications of the new CRMA and NZIA packages**. This could include estimated investment requirements for solar or batteries (totalling €75 billion), or domestic mining requirements for copper (up to 0.5 Mt per annum) and lithium (around 25 kt per annum) – as set out in our analysis above in Exhibits 1.3, 1.5 and 1.6. This should include acknowledging where trade-offs might be required (e.g., on pace of deployment vs. cost).
- **Develop simple centralised funding mechanisms for key decarbonisation challenges** (e.g., low-carbon power, hydrogen or CCUS) that incentivise the scale-up and use of clean energy infrastructure. This should seek to mirror the simplicity of funding mechanisms *via* tax credits in the US IRA, and could build on the EU Hydrogen Bank or the NER300 fund – at much larger scale.
- **Encourage member states to develop comprehensive support mechanisms for renewables, hydrogen and CCUS where needed and where gaps exist**. Whilst many member states already do this (e.g., via clean energy auctions, offtake agreements, first-of-a-kind support and other de-risking mechanisms), all member states should be pushed to go further and faster.

Key regulations

The table below provides a summary of major EU activities on this topic, where additional actions can be targeted:

Key actions	Key regulations
Sectoral deployment targets, fossil phase out dates	• REPowerEU • EU Save Energy • Fit For 55 package, including revisions to: – Renewable Energy Directive – Energy Performance of Buildings Directive – including discussions on the phase-out of gas boilers – Energy Efficiency Directive – ICE phase out/CO_2 standards for vehicles • Ecodesign Directive on sustainable products and appliances
Key supporting policies	• Reform of electricity market design (part of Green Deal Industrial Plan) • Fit For 55 package, including revisions to: – Emissions Trading System (ETS) – CO_2 standards for vehicles • Discussions around financing from Recovery and Resilience Facility and EU Sovereignty Fund • European Hydrogen Bank • Provisions around skills creation in the Green Deal Industrial Plan, including via the Net Zero Industry Act

[47] Ember (2023), *Wind and solar deployment in the EU*.

[48] Politico (2023), *Brussels and Berlin strike deal on 2035 combustion-engine ban*.

#2

Fast-track clean, sustainable and diversified supply at home and abroad

Key actions

To ensure that supply can keep pace with the EU's demand for clean energy deployment and avoid prolonged periods of market tightness and price spikes, EU policy should focus on enabling and prioritising new sustainable sources of production (from raw materials to components), both internationally as well as domestically. The EU should:

- **Implement stringent environmental and social standards for supply**, including to establish **strong regulation of life cycle carbon emissions** entailed in the production of key products entering the EU market across Scope 1, 2 and 3 emissions. This can include regulation to mandate that all tender processes in the EU should consider embodied carbon emissions assessments, such as the "Simplified Carbon Assessment" introduced in France.[49] These standards and regulations would also build on the EU's **Carbon Border Adjustment Mechanism** (CBAM), which aims to address carbon leakage into the EU market.

  Case study: The IEA estimates that shifting production of nickel from a high-carbon grid (e.g., Indonesia, >600 gCO_2/kWh) to a low-carbon grid could reduce the carbon intensity by 10–20%.[50]

- Implement measures to **streamline planning and permitting requirements for critical mines and factories** within the EU, while safeguarding social and environmental standards and ensuring appropriate consultation processes with local stakeholders. This includes measures to set clear timescales for approval, and simplify permitting requirements across relevant authorities, e.g., via "one-stop shops" (whereby a company can approach a single government agency in order to obtain all necessary permits).
- **Unlock financing** to support new projects, both domestically and abroad. For example, critical raw materials projects can struggle with financing due to market volatility, long lead times, high concentration, and market opacity, as well as the need for specialised knowledge among financial institutions. While private financing is critical, policy can provide funding support to enable key projects including via guarantees, loans, equity or quasi-equity investments. Furthermore, the EU and member states can work with other stakeholders to increase the scope for MDBs to partner with private capital on mining projects in lower-income countries.
- Manage and mitigate supply dependence by **developing strategic partnerships** with key supplier countries, for mining, refining and manufacturing.
- **Drive engagement and data sharing** to increase transparency on supply pipelines, through organisations such as the IEA or consumer clubs.

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[49] Ultra Low-Carbon Solar Alliance (2021), *Reducing the carbon footprint of solar: the French model*.

[50] For nickel produced via high-pressure acid leach or via nickel-pig iron – two of the most common approaches for production in Indonesia. IEA (2021), *The role of critical minerals in clean energy transitions*.

Current measures

There are various EU regulatory proposals that address these challenges (see table below). However, in certain cases a more unified, simpler approach could be beneficial, as could explicit acknowledgment of where trade-offs might be required:

- Measures in the CRMA and EU Battery Regulation, alongside updates to the Ecodesign directive for certain technologies and products, are intended to push for more sustainable supply chains (e.g., on carbon intensity of battery production). This is very positive, and **ensuring coherence and consistency** across these measures is key to avoid confusion for manufacturers and purchasers.
- The NZIA introduces sustainability and resilience requirements for tender processes, but these are not applicable if they increase costs by over 10% – rendering the additional considerations somewhat futile.[51] The environmental and resilience requirements should either be enforced strongly, in order to make domestic production fully competitive, be revised upwards (to better reflect the true additional cost of domestic supply chains), or be removed.
- Both the CRMA and NZIA plan to accelerate permitting for projects deemed "strategic", including through one-stop shops – a positive step, although this will rely on effective implementation by member states. This does not need to come at the expense of environmental and social standards, but might require some prioritisation: for example, **setting a shortlist of key actions for companies to address in new projects**, which could be rewarded by accelerated permitting.
- Current EU proposals on funding allocation for clean energy manufacturing in the Green Deal Industrial Plan should ensure that they **target key supply projects** (e.g., for particular industries facing bottlenecks). Alongside this, **increasing clarity and accessibility** to funding is crucial: the total volume of funding available is large and comparable to that in the US, but companies both small and large struggle to access this in an easy, timely manner.
- The CRMA proposes a Critical Raw Materials Club to bring together consumers and identify strategies to diversify away from single suppliers. This could go further, with explicit **funding or technology and capacity support to develop supply chains in lower-income countries**, to both diversify supply and aid economic development.

Key regulations

The table below provides a summary of major EU activities on this topic, where additional actions can be targeted:

Key actions	Key regulations
Implement stringent environmental and social standards for supply	• Revision to Regulation on Batteries and Battery Waste (part of European Green Deal) • Update to Ecodesign Directive • Corporate Sustainability Due Diligence Directive • Proposal from the EU Commission and the EU Parliament on prohibiting products made with forced labour on the Union market • Carbon Border Adjustment Mechanism
Streamline planning and permitting requirements for mines and factories	• Critical Raw Materials Act (CRMA) • Net Zero Industry Act (NZIA)
Unlock financing	• Review European Investment Bank (EIB) mandates • Temporary Crisis and Transition Framework
Drive engagement and data sharing (e.g., consumers and producers clubs)	• Critical Raw Materials Act (CRMA) • Net Zero Industry Act (NZIA)

[51] BNEF (2023), *Europe's Bid to Reshore Clean Tech Pulls its Punches*.

#3

Identify and advance strategic opportunities for domestic production

Key actions

Europe's current policy focuses on setting targets for domestic production across key technologies. To ensure that Europe can maximise efforts and investments to build up domestic industry and minimise trade-offs, especially around higher costs (as discussed in the Insights Briefing), it is critical for the EU – as well as individual member states – to carefully consider strategic advantages and priorities as a part of industrial strategy. Europe must also act to improve its overall economic competitiveness via improved fundamentals. Key actions for the EU are:

- Provide guidance to member states to **map strategies for domestic manufacturing and investment** to align with a) a country's distinctive energy transition pathway and/or b) natural comparative advantages.

  This includes, for example, taking into account the projected share of a country's power generation across technologies, or making use of competitive advantages such as a high share of clean grid electricity (e.g., Nordics with hydropower) and lower production costs (e.g., in Central and Eastern Europe) to boost low-carbon manufacturing.

  Case study: The UK's targets for offshore wind capacity deployment (revised in 2022 to 50 GW by 2030) have provided clear signals to scale domestic supply chains. For example, SeAH is investing £400 million in setting up a factory on the south bank of the River Tees to manufacture monopile foundations for projects in UK waters and for export worldwide.[52] Together with Associated British Ports, Siemens Gamesa has invited £310 million in wind turbine production and installation facility in Hull, Yorkshire, creating over 1,000 jobs.[53]

- **Identify existing European clean energy manufacturing sectors that might be at risk or present major new opportunities**, alongside resources that can be deployed to bolster their position. For example, Europe has a strong footprint in wind manufacturing, and could review support measures such as providing longer-term volume certainty.
- **Improve access to finance** for strategic projects in the EU, by increasing available funding for key projects, e.g., via ETS revenue allocation, streamlining access across EU funding instruments, as well as moving forward on the Capital Markets Union to ensure deeper capital pools for private finance.
- **Reform electricity markets** in particular to ensure low-cost low-carbon energy is available for industrial customers in Europe.

[52] RenewableUK (2022), *Offshore wind industry showcases opportunities for UK supply chain companies*.

[53] Green Port Hull, "*Siemens Gamesa*", https://greenporthull.co.uk/what-we-do/siemens-gamesa.

Current measures

The EU's Green Deal Industrial Plan addresses many of these issues, but could go further by:

- Domestic targets for mining and refining (in the CRMA) and manufacturing (NZIA) are positive first steps – but the **manufacturing volumes and investment requirements of these policy measures should be set out more clearly**.
- Linked to this, the EU could **facilitate or help tailor the setting of domestic production goals which are country or sector specific**, e.g., noting that some countries around the North Sea could focus on manufacturing opportunities around offshore wind, or countries with a strong automotive sector could target battery capacity expansions. The current proposal in the NZIA takes a non-distinctive approach across technologies.
- The NZIA could go further and **assess strategic sectors** where the EU is currently competitive (e.g., wind), or where future opportunities could lie (e.g., electrolysers) – in order to better target support and funding.
- While current EU proposals aim to streamline funding pots, it will be critical to **develop a clear, easily-accessible source of sizeable funding to aid manufacturing and deployment** e.g., via European Sovereignty Fund or re-direction of ETS revenues.
- Proposals to **reform electricity markets design** to accelerate renewables deployment are being debated – a positive step. More could be done here to consider support for industrial end-users, to render domestic manufacturing more competitive.

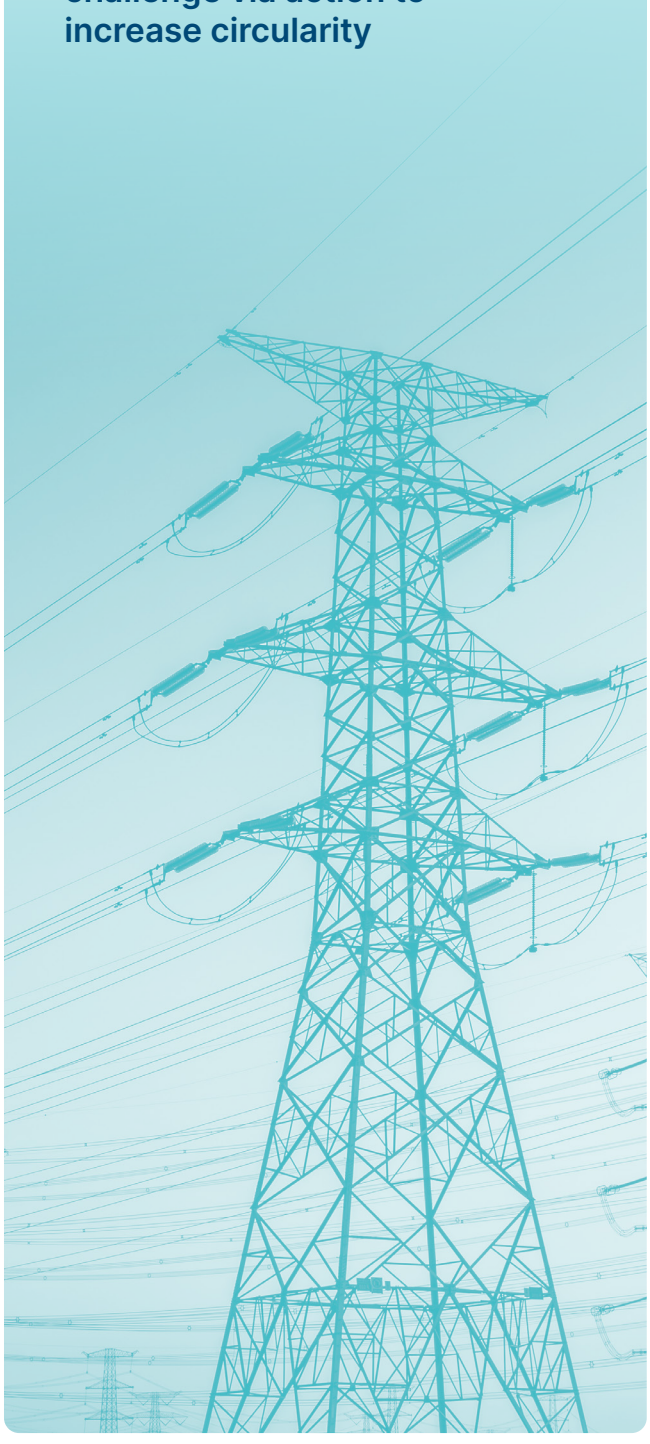
Key regulations

The table below provides a summary of major EU activities on this topic, where additional actions can be targeted:

Key actions	Key regulations
Provide guidance to member states on mapping industrial strategies to national energy transition goals	• Critical Raw Materials Act (CRMA) • Net Zero Industry Act (NZIA) • Revised guidance for Recovery and Resilience Facility (RRF)
Identify existing European clean energy supply chain "champions" that might be at risk or facing headwinds	• Net Zero Industry Act (NZIA)
Improving access to finance	• Streamlined access to finance provisions as part of Green Deal Industrial Plan • European Sovereignty Fund • Capital Markets Union
Reforming electricity markets	• Reform of electricity market design (part of Green Deal Industrial Plan)

#4

Reduce the scale of the challenge via action to increase circularity



Key actions

Comprehensive EU policy must also focus on reducing the scale of the challenge by acting on levers that can reduce demand for key raw materials and components, therefore reducing market tightness risks the environmental impacts of the transition. In particular, EU regulation should seek to maximise efforts on circularity, via improved efficiency as well as collection and recycling. Key actions for the EU are:

- **Introduce regulation or incentives to maximise technology efficiency** to reduce total capacity needed, as well as **material efficiency** to reduce material requirements. Policy tools could include targeted incentives, R&D support, and prizes for "breakthrough" improvements in performance.
- Encourage EU-wide or member-state policies that **address overall demand-side actions** – for example to encourage public transportation, incentivise smaller electric vehicles and batteries, or increase residential and industrial energy productivity measures to drive down total energy demand.
- **Set regulation to increase collection and recycling** for key technologies and raw materials via targets as well as supporting mechanisms.

Current measures

Whilst recycling measures are addressed in current EU legislation, these should be refined, and the CRMA and NZIA include little action on the two demand-focused actions:

- Proposals in the European Battery Regulation set targets for collection of batteries at end of life (reaching 73% in 2030), and recovery rates for specific materials (e.g., recovering 80% of lithium by 2031).[54] Similarly, the CRMA includes a requirement for 15% of domestic requirements in 2030 to be met by recycled supply.
  - **Recycling targets will likely require nuancing across materials** (where end-of-life recycling rates vary widely), and across **recycling approaches** (e.g., hydro- vs. pyro-metallurgy for battery materials).
  - The EU should **set out more clearly where new innovation and technological advances are required**, as opposed to where improved logistics, infrastructure and alignment of incentives are needed to increase recycling. The revision of the End-of-Life Vehicles Directive could provide an opportunity for this.
- There are also provisions in the CRMA for member states to implement measures such as financial incentives, discounts, monetary rewards, or deposit-refund systems to increase collection and recycling rates for waste streams with a high potential for

[54] EU Commission (2022), *Green Deal: EU agrees new law on more sustainable and circular batteries to support EU's energy transition and competitive industry*.

recovery. However, **the EU should set out more clearly where these should be focused, and any EU-level support available for implementation**.

- Initiatives such as the EIT-Raw Materials (which convenes industry, academia and investors to drive innovation across material supply chains) can help drive materials efficiency and circularity, and are a good accelerator for long-term action. However, wider **policies and targets should be developed in order to drive technology and materials efficiency at commercial scale**, such as tax credits for lower-impact or more available materials or technologies, to better address short-to-mid term constraints.

Key regulations

The table below provides a summary of major EU activities on this topic, where additional actions can be targeted:

Key actions	Key regulations
Improve materials and technology efficiency	• EU Climate-KIC • EIT RawMaterials • Horizon Europe (for university-level research) • European Investment Bank programmes for RD&D • Revision to Regulation on Batteries and Battery Waste • Update to Ecodesign Directive
Increase recycling and scaling secondary supply	• Revision to Regulation on Batteries and Battery Waste • Revision of the End-of-Life Vehicles Directive • Critical Raw Materials Act (CRMA) • Packaging and Packaging Waste Regulation • Waste Framework Directive

Energy
Transitions
Commission