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# Investment needs and gaps for the sustainability transition in Europe: Rethinking the European Green Deal as an EU industrial strategy

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Stefan Speck (EEA) and Roberto Zoboli (SEEDS) coordinated the research and reporting work. Although the report results from a common effort by the authors, they have differently contributed to the different sections, namely: Alessio D'Amato (Section 3.1), Andrea Pronti (Section 3.2), Susanna Paleari (Sections 1, 2, 4.1 and 5.1), Giulio Romaldi (Section 4.4), Stefan Speck (Sections 2.2, 4.2 and 4.3), Simone Tagliapietra (Introduction and Section 5.3), Roberto Zoboli (Executive summary, Section 5.2 and Main conclusions).

The data presented in Section 1 (implementation state of the EGD) and Section 4.1 (EU funding) are updated to April 2024. Data in Sections 3.2 (clean tech capacity) and 4.4 (cost of capital for companies) are updated to September 2024. Data presented in Section 3.2 (clean tech capacities) are original elaborations of the data from the Bruegel's 'European Clean Tech Tracker'. We thank Cecilia Trasi for facilitating us in the use of the Bruegel's dataset. Data presented in Section 4.4 (cost of capital for companies) are original elaborations of data from Blumberg accessed under contract by researchers of Catholic University (partner of SEEDS). These data have been managed and elaborated solely for research purposes in a way that assures the full anonymity of the companies. Only the authors are responsible for what presented in the report.

# Executive summary

***Section 1***

The implementation process of the European Green Deal Strategic Framework (EGDSF) and its many legislation provisions was slowed down during the last two years. In some areas, like climate and energy, most of the policy initiatives have been implemented whereas in other areas, like pollution and chemicals, the process is lagging behind. The slowing down of the process is due, among other factors, to the oppositions that some policy provisions have stimulated by some Member States and by stakeholders in some of the sectors more deeply involved in the EGD-driven transformation. Some legislative proposals have been adapted to take into account these oppositions.

The new European Commission is expected to confirm major targets and objectives of the EGD, in particular the pathways towards the Net Zero and its intermediate targets at 2030 and 2040.

***Section 2***

All the official and non-official estimates of the investments needed to achieve the key EGD-related targets and objectives as well as the sustainability transition in general, bring to very high figures. In spite of the uncertainties affecting the different estimates, the additional investment need is about €520 billion per year in the present decade with respect to the average level of the last decade, of which €392 billion/year for climate and energy. Additional investments needed to boost EU manufacturing capacity in some strategic net-zero technologies are estimated at around €92 billion over the period 2023-2030. For the period 2031-2050, the average annual investments are needed to be close to €660 billion (equivalent to 3.2% of EU GDP) for the energy system and to €870 billion (equivalent to 4.2% of EU GDP) for the transport sector. Estimated needs across Member States are highly differentiated.

***Section 3***

The investment gaps, as the difference between the estimated needs and the present level of investments, are very large in key transition sectors, like clean energy and mobility. The gaps are relatively large in the wind, electrification (in particular for transport) and buildings renovation sectors. For example, the EU 2030 targets for the building sector can be achieved if at least €335 billion are invested (from private and public sources) between 2024 and 2030. In the transport sector, achieving the targets requires that investments pass from €106 billion in 2022 to an average of €253 billion per year in 2024-2030.

At the same time, the picture on European domestic manufacturing capacity in selected clean tech for energy and mobility - compared to the deployment of those same technologies in EU countries - shows a mixed picture. The manufacturing capacity is high and internationally competitive in some sectors (e.g. wind technologies) but very problematic in others, like solar technologies and batteries, the latter expected to have a huge increase in demand with the electric mobility trajectory. This domestic manufacturing gap, which is already a source of high import dependency for some clean tech areas, has to be seen vis à vis the self-sufficiency targets of the Net-Zero Industry Act (NZIA) and the Critical Raw Materials Act (CRMA) and the expected growth of domestic deployment required by the targets and objectives for renewables and mobility. At present, the development of domestic industrial value chains in clean techs is still too weak. Furthermore, the geographical distribution of the cleat tech manufacturing capacity, existing and planned, is very uneven across the EU countries, which could bring to an industrial divergence across Member States.

***Section 4***

The EU-level funding potential is dominated by the combination of Multiannual Financial Framework 2021-2027 (MFF) and Next Generation EU (NGEU). The wide allocations of the MFF to sectors linked to climate change and the requirements on allocating 30% of NGEU (37% of Recovery and Resilience Facility (RRF)) to climate-related investments and expenses, seem to offer a large potential. However, in front of the estimated needs and gaps, these resources are largely insufficient to cover the gaps.

As a consequence, resources from the private sector, and in particular private industrial investments, are called into the fore as a force that is necessary to complement public funding. The estimated ratio, or desired leverage effect, is 2 Euros and up to 5 Euros of private investments (companies and households) for each Euro of public resources. This leverage effect on private investments cannot be taken for granted and can be instead highly uncertain because it depends on the profitability of the investments.

An often-disregarded but key factor for mobilizing investments is the cost of capital. High costs of capital in the financial market can make only few investments to pass the test of profitability. The cost of capital is very different across Member States and regions. This difference can favour the companies located in certain countries in accessing finance to make investments, thus possibly contributing to an industrial divergence in key transition areas like clean tech. Therefore, the financial system, in parallel to playing a key role in 'sustainable finance', is called into the fore to support a transition that requires huge industrial investments, especially by the private actors.

***Section 5***

The difficulties faced by the EGD-triggered transition in the EU suggest to look at the space it can have within the evolution of the EU macro policies.

Within the overarching strategy of 'open strategic autonomy', the Union seems to be subject to a fundamental oscillation. On the one hand, there is a return, in particular through the new Stability and Growth Pact (SGP), to requirements of fiscal discipline in the Economic and Monetary Union. This can exacerbate the 'fiscal competition' in allocating national public budgets to social spending, military spending, and sustainability transition spending. On the other hand, there is the need, well highlighted by the Draghi report (2024), that the Union will boldly pursue a fundamental change in which, to recover competitiveness in the global systems, major investments in innovation have to be carried out also exploiting the capacity of the EU to attract resources from the global financial system. In this framework, the climate and sustainability transition remain one of the major innovation and industrial opportunities in the EU portfolio, on which Europe should do massive investments.

Pursuing the latter pathways requires redesigning the EGD as an EU-level industrial strategy. First steps in this direction are NZIA and CRMA and the announcement of a Green Deal Industrial Plan as one of the first acts of the new European Commission. However, a broader and more complete industrial strategy is required by the investment needs and gaps presented in this report, by the disparities in the industrial capacity and speed of transition across EU countries, and for the achievement of 'open strategic autonomy' through a higher industrial self-sufficiency. Among the ingredients of a true green industrial strategy there are major EU-level initiatives to achieve the needed European scale in clean tech industrial investments and the redirection of the policy instruments to go beyond a central role of the regulatory approach. A European industrial policy and a 'New EGD' must go hand in hand.

# Introduction

The European Commission pivoted the European Union towards climate neutrality. With the European Green Deal, it settled clear and ambitious climate targets for 2030, 2040 and 2050. To get there, it unleashed a wave of legislation, both strengthening traditional EU climate, energy and environmental policy instruments – such as the Emissions trading system (ETS), emissions standards for cars, and renewable energy and energy efficiency targets – and introducing brand-new instruments – such as the Just Transition Fund, the ETS-2 covering buildings and road transport, the Social Climate Fund, and the world-first Carbon Border Adjustment Mechanism (CBAM).

All of this happened as the world went through one of most convulse periods in recent history. As the pandemic led to Next Generation EU at its climate-relevant investment prime focus, and Russia's war in Ukraine led to REPowerEU and its focus on accelerating green alternatives.

However, clouds are looming on the horizon of the green transition in Europe. A number of voices support the slowing-down of the process, driven by (often misplaced) fears on trade-offs between decarbonisation and economic competitiveness. As decarbonisation gets faster and deeper, the marginal cost of adjustment will increase, and distributional implications will become more evident and complex to manage. As a result, the politics of the green transition seems to become more difficult. All of this brings under the spotlight the macroeconomic dimension of the green transition, and the need of adequate policies to handle it moving forward.

New challenges also arise: the need to boost Europe's industrial competitiveness – starting with clean tech – in an international landscape characterized by more aggressive industrial policies, and the need to safeguard Europe's resilience – or 'strategic autonomy' – as dependencies on China and possibly unreliable international partners in a wide range of strategic technologies and critical raw materials have reached levels now considered as alarming. At the core of this macroeconomic dimension of the green transition lies a difficult dilemma for Europe: how to square the circle between different political goals such as climate neutrality, industrial competitiveness, social sustainability and fiscal discipline?

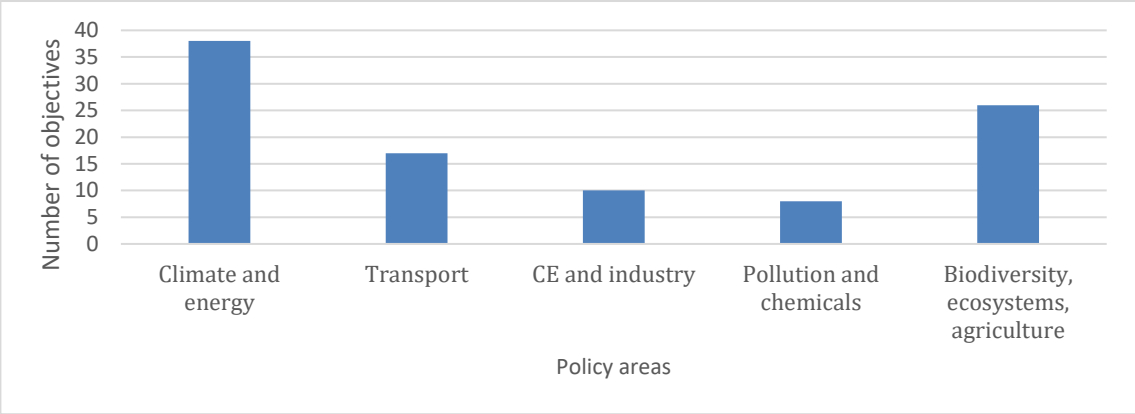
This report, which further develops the analysis of the EGD presented in EEA (2020) and Barbieri et al. (2021), addresses the evolution of these emerging constraints and the possible ways out, in particular through a new industrial policy as a vehicle for a successful transition led by a 'new' EGD.

Section 1 provides a picture of the status of implementation of the EGD strategic framework. Section 2 provides a systematic reconstruction of the different estimates of the investment needs for the EGD-led sustainability transition. Section 3 explores the investment gaps in key sectors of the transition (energy and transport) and the manufacturing capacity gap in Europe for clean tech in the same sectors. Section 4 presents the picture of financial resources available from the EU budget and the NGEU, discusses the key issue of investments from the private sector, and addresses the role of the cost of capital for the feasibility of public and private investments in key sectors. Section 5 explores the macroeconomic space for transition investments, and in particular the possible constraints emerging from the new phase of public finance the EU countries are entering vis à vis the need of huge strategic investments in innovation to relaunch the EU competitiveness. In the same section, the development of an EU-level industrial policy as a possible lever for stimulating the industrial system to undertake significant transition investments is proposed.

# 1. The EGD strategic framework: Status of implementation

The EGD was presented by the European Commission (EC) in 2019 as the new growth strategy that aims to transform the EU into a resource-efficient and competitive economy, where there are no net emissions of greenhouse gases (GHGs) in 2050 (EC, 2019). The seven strongly interconnected key EGD policy goals are: achieving climate neutrality; supplying clean, secure and affordable energy; promoting sustainable mobility; encouraging the transition to a circular economy (CE); creating a toxic-free environment; preserving Europe's natural capital; and designing a fair, healthy and environmentally friendly food system. Building on the EGD, about 40 strategic documents have been adopted so far (hereinafter referred to as European Green Deal Strategic Framework; EGDSF), which establish ambitious objectives and schedule the related implementing measures.

**Figure 1.1 Strategic goals of the EGDSF per policy area**




Note: the total number of objectives does not correspond to their sum across different policy areas, since a few of them have been double counted (as they are relevant to more than one policy area).
Source: own elaboration based on Annex 1 (updated to April 2024)

Figure 1.1 shows the number of strategic goals set by the EGDSF in five main environmental policy areas, namely climate and energy (excluding GHG emissions from transport), transport (including both pollution and GHG emissions), CE and industry (including pollution generated by waste), pollution and chemicals (excluding pollution generated by transport and waste, but including chemical pollution from agriculture), and biodiversity, ecosystems and agriculture (excluding chemical pollution from agriculture). Overall, 99 strategic goals have been established, which mostly belong to the policy areas of 'climate and energy' (38 objectives) and 'biodiversity, ecosystems and agriculture' (26 objectives). The objectives pertaining to the 'climate and energy' policy area are deeply integrated into the EGDSF, since they are set by 18 different strategies/action plans.

The box below summarises the most important goals within each policy area (the full list of strategic goals is provided by Annex 1) and the main related legislative initiatives that have been/are in the process of being adopted.

### Box 1.1 Main EGDSF strategic goals and related legislative initiatives

| Policy area | Summary of the most relevant strategic goals and of the related legislative initiatives that have been/are in the process of being adopted |
|---|---|
| **Climate and energy** | The EGDSF sets 38 strategic objectives related to the climate and energy policy areas to be reached between 2019 and 2050.<br>The achievement of climate neutrality by 2050 is at the core of the EGD and has already been converted into a binding target by the EU Climate Law (EU, 2021a), which also requires, as an intermediate step, that GHG net emissions are reduced by 55% by 2030 compared to 1990 levels. The EC has recently recommended to cut 90% of GHG net emissions by 2040 compared to 1990 levels (EC, 2024a). The objective of climate neutrality has also been stated and should be applied to selected sectors (e.g. the EU fisheries and aquaculture sector should have a neutral footprint by 2050). In order to achieve climate neutrality, specific objectives have been established to increase the EU land and forestry sink; cut methane emissions; and capture, transport, use, and store carbon dioxide. The EU's Emissions Trading System (EU ETS) has been reformed (EU, 2023a). Moreover, a new separate emission trading system (ETS 2) covering fuel combustion in buildings (as well as road transport) will be launched in 2027 to achieve 42% emission reductions compared to 2005 by 2030 (EU, 2023b). Revenues from the auctioning of emission allowances in ETS 2 will supply the Social Climate Fund, which supports vulnerable groups of society (EU, 2023c). The Regulation establishing the carbon border adjustment mechanism (CBAM) has also been adopted (EU, 2023d) to ensure the carbon price of imports is equivalent to the carbon price of domestic production.<br>In the energy sector, a 45% goal by 2030 was shaped for RES by REPower EU (EC, 2022a) and was translated into the new binding target (EU, 2023e) of at least 42.5% of RES in the EU's gross final energy consumption by 2030 (from the previous 32% target; EU, 2018). To this end, a set of objectives will strengthen the role of offshore RES, renewable hydrogen, solar energy, wind, and biomethane. REPower EU has also increased the EU-level target for energy efficiency to 13% by 2030 compared to the 2020 reference scenario. The recast Energy Efficiency Directive was amended accordingly (EU, 2023f) and establishes that energy consumption shall be reduced at EU level by 11.7% compared to projections of the expected final energy consumption in 2030 (based on 2020 reference scenario).[1] The improvement of energy efficiency will mainly rely on buildings renovation, which should accelerate, as required by the new EGDSF objectives. According to the text of the revised Energy Performance of Buildings Directive adopted in March 2024 by the European Parliament (which will now have to be formally endorsed by the Council of Ministers, in order to become law), each Member State will adopt its own national trajectory to reduce the average primary energy use of residential buildings by 16% by 2030 and 20%-22% by 2035, ensuring that at least 55% of this decrease is achieved through the renovation of the 43% of worst-performing buildings (European Parliament website a).<br>Finally, with regard to climate adaptation, the EU should be climate-resilient and make adaptation smarter, more systemic and swifter by 2050. This should be achieved, inter alia, through improved national adaptation strategies and plans (EC, 2021a). |
| **Transport** | The EGDSF sets 17 strategic objectives related to the transport policy area to be reached between 2030 and 2050. The sector is expected to reduce its emissions of 90% below 1990 levels by 2050. The reformed EU ETS (EU, 2023a) establishes that all aviation allowances will be auctioned by 2026. Based on Directive (EU) 2023/959 (EU, 2023b), in January 2024, the EU ETS will be extended to cover $CO_2$ emissions from all large ships (of 5,000 gross tonnage and above) entering EU ports, regardless of the flag they fly. Moreover, a new separate emissions trading system (ETS 2) covering road transport (as well as fuel combustion in buildings) will be launched in 2027 to achieve 42% emission reductions compared to 2005 by 2030. The EC is also committed to achieving zero $CO_2$ emissions from new cars and vans by 2035 compared to the 2021 targets (which has been already translated into binding targets; EU, 2023g) and zero emissions from nearly all buses and new heavy-duty vehicles by 2050. With regard to new heavy-duty vehicles, the provisional agreement, reached by the European Parliament (EP) and the Council in January 2024, maintained the following $CO_2$ emission reduction targets set by the EC in its proposal: 45% for 2030-2034, 65% for 2035-2039, and 90% for 2040, compared to 2019 levels (EC, 2023a and EC website b). Moreover, zero-emission ocean-going vessels and large zero-emission aircraft should become market-ready by, respectively, 2030 and 2035. Other objectives concern the enhancement of more sustainable transport modes (e.g. by shifting road freight to railways and increasing transport by inland waterways and short sea shipping by 50% by 2050) and the reduction of noise pollution (EC, 2020a). |

[1] This translates into a primary energy consumption target of 992.5 million tonnes of oil equivalent (Mtoe) and a final energy consumption target of 763 Mtoe by 2030, compared to the previous targets of 1128 Mtoe for primary energy and 846 Mtoe for final energy (EC website a).

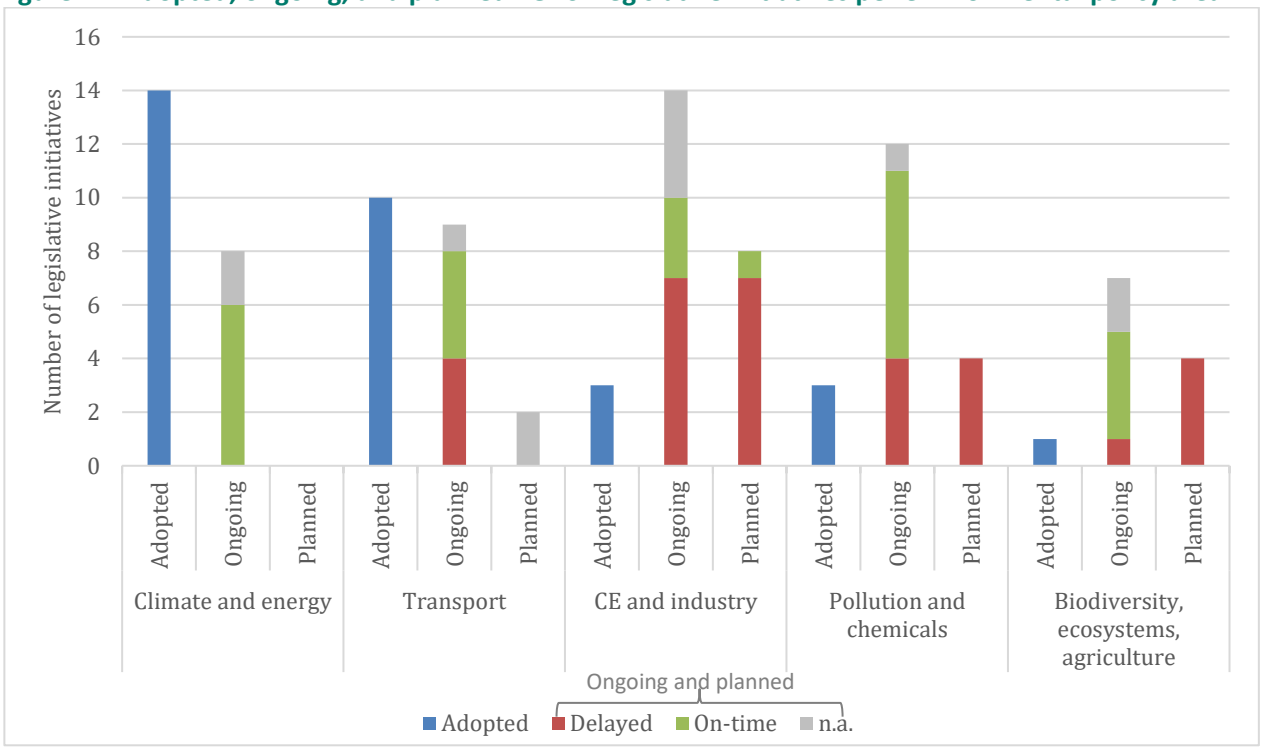
| | |
|---|---|
| **CE and industry** | The EGDSF sets 10 strategic objectives related to the 'CE and industry' policy area to be reached in 2030. The 2020 Circular Economy Action Plan (CEAP; EC, 2020b) highlights that the EU should reduce its consumption footprint and double its circular material use rate in the coming decade. In order to prevent waste, by 2030, total waste generation should be significantly reduced (but a baseline has still to be defined; EC, 2021b) and per-capita food waste should be halved at retail and consumer levels (EC, 2020c). A legislative proposal has been put forward by the EC (EC, 2023b) to amend the Waste Framework Directive (EU, 2008a) and reduce food waste. Moreover, the EU should, by 2030, decrease by 50% the amount of residual (non-recycled) municipal waste (again no baseline has been defined; EC, 2021b) and reduce by 50% plastic litter at sea and by 30% microplastics released into the environment (compared to 2016; EC, 2021b). New legislative initiatives have been also adopted/launched to address the problem of microplastic (EU, 2023h and EC, 2023c). Finally, the Strategy for sustainable and circular textiles (EC, 2022b) establishes that by 2030: textiles should be long-lived, recyclable, and free of hazardous substances; reuse and repair services for textiles should be widely available; and the incineration and landfilling of textiles should be minimised. The abovementioned EC proposal, amending the Waste Framework Directive (EC, 2023b), also introduces the extended producer responsibility for textile waste.<br>As at the EU level, most CE legislation currently regulates waste management. New legislative initiatives, which are in the process of being adopted, have been shaped by the EC to address also the other phases of the value chain (such as the proposal for a new Regulation on eco-design and the proposals aimed at empowering consumers and public buyers for the green transition; EC, 2022c; EC, 2022d; EC, 2023d; EC, 2023e). In addition, several directives that focus on specific waste streams (such as packaging waste, waste batteries, and end-of-life vehicles) have been/are being revised and transformed into comprehensive regulations setting provisions which concern the whole related value chains (EC, 2022e; EC, 2023f; EU, 2023i). Moreover, this policy area is widely affected by the ongoing adoption of the Net-Zero Industry Act (NZIA; EC, 2023g) and the Critical Raw Materials (CRMs) Act (EC, 2023h). |
| **Pollution and chemicals** | The EGDSF sets 8 strategic objectives within the 'pollution and chemicals' policy area, which are mostly to be reached by 2030. With regard to the use of chemicals in agriculture, nutrients losses from fertilizers, the risk/use of chemical pesticides, and the overall EU sales of antimicrobials for farmed animals and in aquaculture should be halved by 2030 (EC 2020d and 2021b). Moreover, within the same deadline, no chemical pesticides should be used in sensitive areas (EC, 2020d). In 2030, at least 75% of EU soils should be healthy and in 2050, soil pollution should be reduced to levels no longer considered harmful to human health and natural ecosystems (EC, 2021b and 2021c). Moving to air pollution, by 2030, the related health impacts (premature deaths) should be reduced by more than 55% and the EU ecosystems where air pollution threatens biodiversity should decrease by 25% (in both cases compared to 2005; EC, 2021b). No objectives have been established for water pollution.<br>Most of the above objectives have not been translated into binding targets, but in order to achieve them, several pieces of EU legislation addressing chemicals and pollution are being amended/revised, such as the ambient air quality legislation (EC, 2022f), the directives on water management (EC, 2022g), and the regulations on toys safety and detergents (EC, 2023i and 2023j). The attempt to make it compulsory for farmers halving the use of more hazardous plant protection products by 2030 has failed, following the withdrawal of the EC proposal to revise the related Regulation (EC, 2022h). Moreover, contrary to what planned by the EC, the REACH Regulation has not been revised yet (EU, 2006a). |
| **Biodiversity, ecosystems and agriculture** | The EGDSF sets 26 strategic objectives within the 'biodiversity and agriculture' policy area, which are mostly to be reached by 2030. The headline goal of the EGDSF is to ensure that, by 2050, all of the world's ecosystems are restored, resilient, and adequately protected (which should be applied at least at the EU level; EC, 2020d). Several key commitments underpin the above goal. For instance, by 2030, we should legally protect at least 30% of the EU's land area, strictly protect a third of the EU's protected areas, plant three billion trees (the Communication on Sustainable Carbon Cycles specifies the expected contribution of carbon farming to GHG emission removals; EC, 2021d), halve the number of Red List species threatened by invasive alien species, and reverse the decline of pollinators (EC, 2020d and 2021e). With regard to agriculture, by 2030, 10% and 25% of the agricultural area should, respectively, be under high-diversity landscape and under organic farming management (EC, 2020d). Moreover, between 2030 and 2050 the EU needs to meet a significant number of soil-related objectives (e.g. combat desertification, restore degraded land, make substantial progress in the remediation of contaminated soils, achieve land-based climate neutrality, reach no land take, reduce soil pollution, and ensure that all soil ecosystems are in healthy conditions; EC, 2020d, 2021b, 2021c). Finally, both marine and freshwater biodiversity/ecosystems are addressed by many objectives, such as restoring 25,000 km of free-flowing rivers, legally protecting a minimum of 30% of the EU's sea area, eliminating or reducing the by-catch of species, and phasing out mobile bottom fishing in all marine protected areas (EC, 2020d, 2021f, 2023k).<br>Currently, only one legislative proposal within this policy area has been adopted (the Regulation to minimise the risk of deforestation and forest degradation associated with products placed on the EU market; EU, 2023j), while others are still ongoing (in particular, the proposed Regulation on nature restoration and the Directive on soil monitoring and resilience; EC, 2022i and 2023l). The proposed Regulation on nature restoration aims at converting some of the above-mentioned strategic biodiversity into binding targets to be achieved by the Member States through the measures set by national restoration |

| | |
|---|---|
| | plans. The legislative initiative on food systems (which is also relevant to the 'CE and industry' policy area) has not been launched yet. |

Source: own elaboration based on Annex 1 (updated to April 2024).

In order to achieve its strategic goals, the EGDSF plans an impressive number of implementation measures, making an extensive use of legally binding tools, by both revising current legislation and proposing new one (Paleari, 2022). Focusing on environmental legislation and non-environmental legislation that directly affects EU environmental policy, based on available information, as of April 2024, about 30 legislative initiatives scheduled by the EGDSF have already been adopted (they were six in March 2023) and 50 are ongoing (see Figure 1.2). More than half of the adopted and ongoing legislative initiatives belong to the policy areas of 'climate and energy' and 'transport'. The launch of the ongoing legislative initiatives by the EC mostly complied with the EGDSF timetable (with the exception of the 'CE and industry' and 'Transport' policy areas, where about half of the legislative proposals were published late compared to the initial schedule). The decision-making process has been generally speeded up with the approach of the EU elections. On the revision of the Energy Taxation Directive, however, there has been no progress for the last six months (EC, 2021g). About 20 legislative initiatives are still to be launched. A few of them are expected to be put forward in 2024 or 2025. However, in most cases, no information is available on whether and when they will be published. In particular, the fate of the planned legislative initiative on food systems (which was considered as a main pillar of the 'Farm to Fork' Strategy; EC, 2020c) and the revision of the REACH Regulation (EU, 2006a) are quite uncertain. 'CE and industry' is the policy area with the highest number of planned legislative initiatives still to be tabled (eight) . Overall, more than 80% of the legislative proposals that have still to be presented have been delayed compared to the original schedule (see Figure 1.2).

**Figure 1.2 Adopted, ongoing, and planned EGDSF legislative initiatives per environmental policy area**




Note: as of April 2024. 'n.a.' means that a legislative measure has been planned by the European Commission, but without providing a deadline (year) for the adoption of the related legislative proposal. Please note that the total number of ongoing and planned proposals referred in the text does not correspond to their sum across different policy areas, since a few of them have been double counted because they are relevant to more than one policy area.
Source: own elaboration based on Annex 2.

Within each environmental policy area, some legislative initiatives proved to be quite divisive, as they have been/are being strongly opposed by groups of Member States/stakeholders. This has sometimes resulted in their radical amendment and in the subsequent adoption of weak provisions compared to those included in the initial EC proposals. In other instances, these conflicts have slowed down the related decision-making processes (which, in a few cases, will be probably stalled until after the next EU parliamentary elections in 2024) or have even prevented some legislative proposals to be launched by the EC. The Box 1.2 below provides a short overview the main 'critical' EGD legislative initiatives (adopted, ongoing and planned), as of April 2024, within each policy area.

### Box 1.2 Synthesis of the main critical EGD legislative initiatives (adopted, ongoing and planned) by policy area

| Policy area | Synthesis of the main critical legislative initiatives (adopted, ongoing, planned) |
|---|---|
| **Climate and energy** | • Following the energy crisis, the **role to be played by natural gas and nuclear energy in the energy transition** has emerged as contentious issue. Based on a complementary delegated act on sustainable activities for climate change adaptation and mitigation objectives (EU, 2022), gas power plants and nuclear plants were considered as a 'transitional' sustainable technology under the **EU Taxonomy Regulation** (EU, 2020), which was heavily supported by pro-nuclear and pro-gas countries (like, respectively, France and Poland; Euractiv website a). In the 'CE & industry' policy area, the proposed **Net-Zero Industry Act** (EC, 2023g) did not initially list nuclear among the 'strategic' net-zero technologies that, because of their significant contribution to decarbonisation, enjoyed specific benefits.[2] However, after the final inter-institutional negotiations (trilogues of February 2024), the distinction between 'strategic' and 'non-strategic' net-zero technologies was deleted from the text and a single list of relevant technologies was adopted, which included all existing and future nuclear technologies, fission, fusion, as well as their fuel cycle (Euractiv website b). On the same line, the **Renewable Energy Directive III** (EU, 2023e) establishes that 42% of hydrogen used in the industry sector should come from renewable liquid and gaseous transport fuels of non-biological origin (RFNBOs) by 2030 and 60% by 2035. Member States may benefit from a 20% rebate on the contribution of RFNBOs in industrial use if they comply with specific conditions.[3] This derogation creates the possibility of a role for hydrogen produced from nuclear power to replace some, but not all, of the hydrogen produced from renewables meeting the RFNBO criteria, which was a key objective for France (Robisnon and Larencin, 2023).<br>• The energy efficiency requirements shaped by the proposed revision of the **Energy Performance of Buildings Directive** (EPBD; EC, 2021h) have been heavily criticised by some countries (e.g. Italy, Poland and the Czech Republic) during the decision-making process, because of insufficient flexibility and funding to mitigate their economic and social impacts (Euractiv website c, d, e). The text of the revised EPBD, adopted in March 2024 by the EP (which will now have to be formally endorsed by the Council of Ministers in order to become law), only marginally reflects the content of the original EC proposal, especially with regard to residential buildings. According to some stakeholders, instead of a coherent approach and a rigorous plan to systematically renovate the bloc's worst-performing buildings, the new legislation turns into a vague set of targets, placing on the Member States the responsibility to effectively implement them (Euractiv website c).<br>The revision of the **Energy Taxation Directive** (EC, 2021g) also deserves special attention. The Directive (which was lastly amended almost 20 years ago) is not in line with the EGD ambition and the EC has proposed a new structure of tax rates for energy products based on their energy content and environmental performance (instead of their volumes). Revising the Directive, however, has proved to be politically difficult, because it requires unanimity among the Member States and some (such as Czechia and Poland) have already expressed reservations (Euractiv website f and g). There has been no substantial progress in the decision-making process since six months.[4] The Belgian EU Presidency has tried to break the deadlock with a proposal bringing further exemptions from the Directive (e.g. by excluding wood, charcoal, and municipal waste used as fuel from the scope of the Directive; shaping total or partial exemptions for energy used for: small-scale coastal fishing and maritime transport |

[2] Advanced technologies to produce energy from nuclear processes with minimal waste from the fuel cycle, small modular reactors, and related best-in-class fuels were, instead, considered net-zero technologies, although not strategic.

[3] The following two conditions have been set: a) the Member State has met the 42.5% renewable target for the full economy; b) fossil hydrogen is not more than 23% in 2030 or 20% in 2035.

[4] Talks on the revision are ongoing, but latest proposals are still blocked in September 2024. For further information see: https://www.vatcalc.com/eu/2022-eu-to-reform-tax-on-energy-to-hit-net-zero-emissions/ and https://www.politico.eu/article/european-union-fuel-tax-energy-taxation-directive/

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| | under certain conditions, military/security/aircraft search and rescue operations and aerial firefighting; and providing exemptions for 20 years for Member States, like Bulgaria and Romania, whose average GDP per capita is half the EU-27 combined; Euractiv website h). |
| **Transport** | • The **legislation setting $CO_2$ emission performance standards for new passenger cars and vans** was adopted in April 2023 (EU, 2023g; European Council website a). Pursuant to the Regulation, new cars and vans must achieve, respectively, 55% and 50% $CO_2$ emission reductions from 2030 to 2034 compared to 2021. From 2035, all cars and vans sold in the EU must have 100% $CO_2$ emission reductions. As required by Germany (which blocked the final adoption of the text until its demands were met), new cars with internal combustion engines can still be placed on the EU market after 2035 on condition that they run 'exclusively on **$CO_2$ neutral fuels**' (i.e. on carbon neutral e-fuels*). The EC should now put forward a proposal for a delegated act (which, in theory, can be approved or rejected by the EP) to define this category of cars. However, an internal dispute has now emerged on this issue within the EC. Indeed, in the draft proposal of DG Growth '$CO_2$ neutral fuels' are defined as 'renewable fuels of non-biological origin' (RFNBOs) pursuant to the RED III (EU, 2023e), but within this Directive RFNOs must only provide for a 70% reduction in $CO_2$ emissions compared to fossil fuels. DG Clima, on the other hand, fears that this will water down the EU's climate ambition and risks creating a precedent for considering as 'carbon neutral' technologies reducing only 70% emissions, as compared to fossil fuels (Euractiv website i).<br>• The legislative proposal on **Euro 7 emission standards for cars, vans, lorries and buses** (EC, 2022j), which originally envisaged stricter standards for pollutants (such as nitrogen oxides and carbon monoxide), represents another critical dossier. Many Member States (including the Czech Republic, France, Germany, Slovakia, Poland, and Italy) expressed concerns that the new standards would have made cars more expensive for consumers and discouraged investments needed for developing electric vehicles. In March 2024, the EP formally approved the provisional political agreement achieved in January with the European Council, but, according to several stakeholders, the approved text has been substantially weakened compared to the original draft (Euractiv website j). In particular, emissions limits for passenger cars are the same as those in Euro 6, while stricter ones have been introduced only for buses and trucks. Particulate emissions from brakes and tyres have been also limited and some requirements have been set with regard to electric vehicle battery durability (mainly reflecting the performance guarantees car manufacturers currently voluntarily pledge). Moreover, the application of the Regulation has been delayed. |
| **CE and industry** | Within this policy area, three major legislative initiatives are gaining attention by stakeholders and the Member States.<br>• The first one is the proposal for a **new Regulation on packaging and packaging waste** (EC, 2022e), which should replace the existing Directive (EU, 1994). The Regulation introduces requirements over the entire life-cycle of packaging as regards its environmental sustainability and labelling, as well as for the extended producer responsibility (EPR), collection, treatment, reuse, and recycling of packaging waste. A provisional political agreement was reached by the EP and the Council on March 2024, but the EC threatened to veto it and withdraw the proposal, since the Council had introduced a 'mirror clause' provision in the law, holding firms exporting to the EU to the same standards of recycled content as domestic producers of plastic packaging. In the agreement, reuse and refill targets, which have been considered 'disproportionate' by some Member States during the decision-making process, have been softened: binding targets for selected types of packaging have been set only for 2030 (along with indicative ones for 2040) and several derogations/exemptions have been shaped. Other requirements of the EC proposal (such as the packaging waste prevention targets, the 2030 and 2040 targets for minimum recycled content in plastic packaging and the obligation to set up by 2029 deposit-and-return systems for single use plastic beverage bottles and single use metal beverage containers) have been kept unchanged (Euractiv website k; European Council website b).<br>• The other two relevant legislative initiatives are the **Net-Zero Industry Act** (NZIA; EC, 2023g), which is part of the Green Deal Industrial Plan (EC, 2023m; see Box 1.3), and the European Critical Raw Materials (CRMs) Act (EC, 2023h). These proposals are strictly interlinked. Indeed, the NZIA aims at expanding the EU's clean technology manufacturing capacity, with the ambition of covering at least 40% of EU's annual deployment needs for net-zero technologies by 2030. The objective of the European CRMs Act, instead, is to ensure the secure and sustainable supply of CRMs to the EU (which are essential to develop new green technologies), strengthening all key activities in their value chains. A provisional political agreement was reached by the EP and the Council on the NZIA in February 2024. In the agreed Regulation, the distinction between strategic and non-strategic net-zero technologies |

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| | (which was proposed by the EC)[5] was deleted and a single broader list of 19 net-zero technologies (also including those that were previously classified as 'strategic') was shaped (European Council website c).[6] This decision highlights the lack of analytical capacity and political will by the EU to identify clear industrial priorities, as 'an industrial strategy that aims to do everything, is unlikely to achieve much' (Redeker, 2024, p. 2). Despite social and environmental concerns (Paleari, 2024), time limits have been established for delivering a permit for constructing or expanding net-zero technology manufacturing projects and shorter deadlines will be introduced for strategic projects identified according to specific criteria. Basically, it will be up to each Member State to decide which technology they want to consider as 'strategic' and finance the deployment (WWF EU website a). Apart from speeding bureaucratic procedures, the agreed NZIA provides for few regulatory tools to support clean tech investments, among which a more strategic use of public contracts (i.e. procurement processes and auctions) has to be mentioned. Another relevant shortcoming of the NZIA is that there is no new EU-level funding accompanying the EGD Industrial Plan, which repurposes current EU programs to fund the green transition, so that EU industrial ambitions do not seem to be backed up by adequate financial resources (Paleari, 2024; Redeker, 2024; Tagliapietra et al., 2023a).<br>The **CRMs Act**, was signed by the European Council and the EP in April 2024. Contrary to the NZIA, the adopted text reflects most of the content of the initial proposal by the EC. It sets up a list of 34 CRMs 17 of which are strategic (including bauxite/aluminium, not covered by the EC proposal). In particular, the agreed benchmarks specify that the EU should have the capacity to extract 10%, process 40%, and recycle 25% (which has been raised from the proposed 15%) of its annual consumption of strategic raw materials by 2030. Moreover, the EU should diversify its imports of strategic raw materials, so that it does not rely on a single source of supply for more than 65% of its consumption. To strengthen the EU domestic capacities, the EC with Member States will identify strategic projects along the value chain that will benefit from facilitated access to financial support and shorter permitting timeframes (27 months for extraction permits and 15 months for processing/recycling permits, which have been slightly lengthened compared to the EC proposal). The agreed text also extends the scope of strategic projects to those allowing the production of materials that substitute strategic raw materials (Euractiv website l; European Parliament website b). The main shortcomings of the Regulation are related to the following: 1) it largely focuses on faster permitting, which is cause of environmental and social concern and is unlikely to substantially speed up the development of strategic projects; 2) along with the EGD Industrial Plan, it does not provide for additional public financial resources, which is key, especially with regard to high-risk projects, to mobilizing private investments (Paleari, 2024; Findeisen and Wernert, 2023). |

[5] The initial proposal by the EC set a benchmark for the manufacturing capacity of strategic net-zero technologies to meet at least 40% of the EU's annual deployment needs by 2030. The net-zero technologies that were considered to be strategic were: solar photovoltaic and solar thermal technologies; onshore wind and offshore renewable technologies; battery/storage technologies; heat pumps and geothermal energy technologies; electrolysers and fuel cells; sustainable biogas/biomethane technologies; carbon capture and storage (CCS) technologies; grid technologies. Member States could identify Net-Zero Strategic Projects that basically had to be: i) Granted priority status at national level; ii) Fast-tracked in permitting procedures, also to be given pre-set time limits by the EU; iii) Fast-tracked in other administrative procedures, also through the identification of a one-stop-shop national authority in charge of these projects; iv) Evaluated in public procurement procedures and auctions to deploy renewable energy sources also in view of a 'sustainability and resilience' criteria, to be given 15-30% award criteria weighting (EC, 2023g).

[6] 'Net-zero technologies' means all technologies identified under Article 3a, which are final products, specific components or specific machinery primarily used for the production of those products. The single list includes the following: solar technologies, onshore wind and offshore renewable technologies, battery and energy storage technologies, heat pumps and geothermal energy technologies, hydrogen technologies, sustainable biogas and biomethane technologies, carbon capture and storage technologies, electricity grid technologies, nuclear fission energy technologies, sustainable alternative fuels technologies, hydropower technologies, other renewable energy technologies (such as biomass or landfill gas technologies), energy system-related energy efficiency technologies, renewable fuels of non-biological origin, biotech climate and energy solutions, transformative industrial technologies for decarbonization, $CO_2$ transport and utilisation technologies, Wind and electric propulsion technologies for transportation, other nuclear technologies (European Council website c).

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| **Pollution and chemicals** | • The revision of the **Regulation on the sustainable use of plant protection products** proved divisive since its inception. The EC proposal (EC, 2022h) provided for a 50% reduction target by 2030 for the use of more hazardous plant protection products, but many Member States and the EP warned about the risk for an increase in the costs of agricultural products, given that CAP funds are not enough to support farmers in the transition to a toxic free environment (Euractiv website m and n). The initiative was first rejected by the EP and, then, despite lacking an EP position, was discussed within the Council. Firstly, the leadership of the Spanish Presidency of the Council changed the EC original text in an unsuccessful attempt to foster compromise (by getting rid of the national reduction targets). Then, the Belgian Presidency proposed to save at least parts of the Regulation (in particular those related to biocontrol products, i.e. the alternatives to chemical pesticides) without any result. Following Europe-wide farmer protests of January 2024, the EC decided to withdraw the proposal and to task the new Commission with submitting a new draft (Euractiv website o and Euronews website).<br>• After more than two years of delay, the revision of the **REACH Regulation** (EU, 2006a), planned by the Chemicals Strategy for Sustainability (EC, 2020e), was removed from the EC 2024 work programme, and no clear indication has been provided of when an eventual proposal will be tabled (Euractiv website p). The process has been the target of substantial corporate lobbying. A political moratorium was invoked by the centre-right European People's Party (EPP website) stressing that, due to high energy prices and the Ukraine war, any unnecessary costs and regulatory burdens should be avoided to preserve industry's competitiveness. |
| **Biodiversity, ecosystems and agriculture** | • The proposed **Regulation on nature restoration** (EC, 2022i) is approaching its final line, although its adoption remains very uncertain. Indeed, after the text was endorsed by the European Parliament, its approval by the Council was 'paused' in April 2024 (The Club of Rome website). Many key provisions originally proposed by the EC have been kept unchanged. In particular, the EU shall restore at least 20% of the EU's land and sea areas by 2030 and Member States shall: a) restore at least 30% of habitats covered by the new law (from forests, grasslands and wetlands to rivers, lakes and coral beds) from a poor to a good condition by 2030, increasing to 60% by 2040, and 90% by 2050; b) restore at least 30% of organic soils used in agriculture that constitute drained peatlands by 2030, 40% by 2040 and 50% by 2050; and c) remove barriers with the objective of restoring at least 25,000 km of rivers into free flowing rivers (European Parliament website c). According to some stakeholders (WWF EU website b), however, the draft Regulation has been watered down during negotiations and lacks the ambition of the EC proposal. For instance, an 'emergency stop' clause has been included in the text to allow targets for agricultural ecosystems to be suspended in exceptional circumstances, which could be activated when the availability of land is no longer sufficient to ensure agricultural production that meets European food consumption (Euractiv website q).<br>• The EC new **legislative initiative on soil monitoring and resilience** (EC, 2023l) falls behind the initial ambition of giving soil a protected status similar to that of air or water. Indeed, it mainly establishes a monitoring framework to assess soil health and contains some obligations regarding the management of contaminated sites, without introducing any binding target. Moreover, within the decision-making process, Member States are holding different opinions on several issues, such as the amount of soil sampling and monitoring that should be required under the new Law, what constitutes 'healthy soil', and the need to exempt the historical contamination of certain soils belonging to old industrial sites from the 'polluter pays' principle (this point has been raised by the former communist countries of Eastern Europe; Euractiv website r)<br>• The legislative initiative introducing new **rules on new genomic technologies** (NGTs; EC, 2023n) is highly controversial. Two categories of NGTs have been created by the draft Regulation: gene-edited plants that are considered equivalent to conventional plants, despite their genetic modification (NGT 1), which would be exempt from the requirements of the GMO legislation, and those with 'more complex modifications' (NGT 2), which would still have to follow stricter rules. While the European seeds industry Euroseeds and EU farmers association COPA and COGECA welcomed the EC proposal, arguing that it is a significant step forward for agricultural innovation, climate adaptation and sustainability, green NGOs claim that it loosens existing rules for genetically modified plants, jeopardizing environmental and social protection (Euractiv website s; Greenpeace website). In the first reading (February 2024), the EP plenary approved the text with 307 votes in favour to 263 against and 41 abstentions (Euractiv website s). The EP decided, contrary to the EC proposal, that all products from NGT plants (not only seeds) have mandatory labelling and agreed to introduce a full ban on patents for NGTs to avoid legal uncertainties, increased costs and new dependencies for farmers and breeders (this issue was not addressed by the EC proposal). Whitin the Council, EU Member States are still divided over the patentability of NGTs and this could prevent the draft legislation from being approved before the EU elections in June 2024 (Euractiv website s).<br>• The **Sustainable Food Systems Law**, which was supposed to make up the backbone of the 'Farm to Fork' Strategy (EC, 2020c), is mentioned neither in the EC work programme for 2024 nor in the tentative agenda for forthcoming Commission meetings. It remains, therefore, uncertain whether and when this proposal will be tabled (European Parliament website d). The EC provided an inception |

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| | impact assessment and a public consultation was opened from April to July 2022. According to rumours, the focus of the legislative proposal under preparation has progressively shifted from sustainability to food security/resilience (Euractiv website t). |

Note: as of April 2024, unless otherwise specified.
* E-fuels are synthetic fuels which are carbon neutral if made with renewable electricity and carbon extracted from the atmosphere. These synthetic alternatives to fossil fuels, made from hydrogen and $CO_2$, can be used in traditional combustion engines and are permitted under the Euro 6 legislation on vehicle pollution (Social Europe website).
Source: own elaboration, based the sources quoted within the Box.

When adopted, ongoing, and planned proposals are added together, it emerges that an extensive and swift reform of the whole EU environmental legislation is taking place under the EGDSF. Some significant differences, however, can be highlighted across the five environmental policy areas:

- In the 'climate and energy' and 'transport' policy areas, the planned initiatives are well underway (only two of them, belonging to the 'transport' policy area, have not been presented yet). The most important strategic objectives related to climate mitigation, energy efficiency, renewable energy, and $CO_2$ emissions from vehicles have been or are in the process of being translated into binding targets. Apart from targets, further regulatory tools and market-based instruments are being strengthened and innovated (e.g. $CO_2$ emission standards for vehicles, EU ETS, energy taxation, etc.). The role of gas/nuclear energy in the energy transition and that of e-fuels/biofuels in the transition towards zero-emission vehicles represent very sensitive and divisive issues. Moreover, the revision of some pieces of legislation, such as the Regulation on $CO_2$ emission performance standards (EU, 2023g) and the Energy Performance of Buildings Directive (EPBD; EC, 2021h) has been heavily criticised by some countries because of the related economic and social impacts. The EPBD (which is in the final stage of the legislative process) and the legislative initiative on Euro 7 emission standards for cars, vans, lorries and buses (whose legislative process is ongoing; EC, 2022j) have been watered down compared to the initial EC proposal. The revision of the Energy Taxation Directive (EC, 2021g) is currently in stalemate.
- In the 'CE and industry' policy area, only 12% of the planned legislative initiatives have been adopted and 32% have not been published yet. Half of the ongoing legislative initiatives have been presented in 2023 (i.e 'recently'). The EC is putting forward new legislative proposals to improve the sustainability of the production and consumption phases, which are both currently under-regulated compared to waste management. In the production phase, the extension of the eco-design requirements is one of the most interesting measures. However, based on the EC proposal (EC, 2022c), their definition and application will take some time, as they will be established through delegated acts, at the end of a process starting with the adoption of an indicative list of product groups that the EC intends to tackle over a certain period.

  Most waste legislation is also being revised and some directives covering specific waste streams (e.g. the Waste Batteries Directive, the End-of-Life Vehicles Directive, and the Packaging Waste Directive; EU, 2006b, 2000, and 1994) are being transformed into complex regulations addressing the whole product life-cycle though extensive sets of new targets and requirements. The highly contested provisions of the proposed Regulation on packaging (EC, 2022e), which is still at the decision-making stage, have been softened and some derogations/exemptions have been shaped.

  This policy area is also expected to be significantly affected by two legislative proposals (the NZIA and the CRMs Act; EC, 2023g and 2023h), which are aimed at reinforcing the Union's open strategic autonomy. The CRMs Act was signed by the European Council and the EP in April 2024. The adopted text of the CRMS Act (European Parliament website b) reflects most of the content of the initial EC proposal (EC, 2023h): it sets up a list of 34 CRMs, 17 of which are strategic and establishes that the EU should have the capacity to extract 10%, process 40%, and recycle 25% (which has been raised from the proposed 15%) of its annual consumption of strategic raw materials by 2030. Instead, under the political agreement between the EP and the European Council for the NZIA (European Council website c), the distinction between strategic and non-strategic net-zero technologies (which was proposed by the EC) was deleted and a single broader list of 19 net-zero technologies was shaped. This decision highlights the lack of analytical capacity and political will by the EU to identify clear industrial priorities. Moreover,

both the CRMs Act and the NZIA (in their current forms) suffer from two main shortcomings: 1) they largely focus on faster permitting, which is cause of environmental and social concern and is unlikely to substantially speed up the development of strategic projects; 2) along with the EGD Industrial Plan (see Box 1.3), they do not provide for additional public financial resources, which are key, especially with regard to high-risk projects, to mobilizing private investments.

- In the 'pollution and chemicals' policy area, only 16% of the legislative initiatives planned by the EGDSF have been adopted so far and 63% is ongoing. With regard to the legislative proposals that are still to be presented, the revision of the REACH Regulation (EU, 2006a), which is the milestone of the EU chemical legislation, is of special relevance. Currently, there is no clear indication of whether and when the revision, which has been opposed by the EU chemical industry and postponed several times, will be tabled (Euractiv website p).

In the meantime, many other pieces of legislation, such as the Regulation on classification, labelling and packaging of substances and mixtures (EU, 2008b), the Industrial Emissions Directive (EU, 2010), and air and water quality directives (EU, 2004, 2006c, 2008b, and 2008c) are being updated and made more stringent. The revision process is, however, driven by a few strategic objectives, which show a low level of ambition, as they generally mirror the pre-EGD ones (Paleari, 2022). The main notable exception is the goal of reducing the use of chemicals in agriculture, which has been incorporated into the proposed revision of the Regulation on the sustainable use of plant protection products (EC, 2022h). However, following the Europe-wide farmer protests of January 2024, the EC decided to withdraw its draft and to task the new Commission with submitting a new one.

**Box 1.3: The Green Deal Industrial Plan**

| Act | Synthesis of the content |
|---|---|
| Green Deal Industrial Plan COM(2023)62 | The Green Deal Industrial Plan, adopted in 2023 (EC, 2023m), aims at enhancing the competitiveness of Europe's net-zero industry, by creating a more supportive environment for scaling up the EU's manufacturing capacity for the net-zero technologies and products. The plan covers the following key pillars:<br>✓ A predictable and simplified regulatory environment: three initiatives are launched in order to create a simpler, faster and more predictable framework, secure the volumes needed for raw materials, and ensure users are able to benefit from the low costs of renewables, namely the proposals of a Net-Zero Industry Act and of a CRMs Act and the reform of the electricity market design.<br>✓ Faster access to funding: in order to speed up and simplify aid granting, the EC has adopted a new Temporary State Aid Crisis and Transition Framework (EC, 2023o) and revised the General Block Exemption Regulation (EC, 2023p). Moreover, it will facilitate the use of existing EU funds for financing clean tech innovation, manufacturing and deployment and set up the European Sovereignty Fund, as mid-term structural answer to investment needs.<br>✓ Enhancing the necessary skills: to develop the skills needed to make the green transition happen, the EC will propose to establish Net-Zero Industry Academies that will help roll out up-skilling and re-skilling programmes in strategic industries; consider how to combine a 'Skills-first' approach, recognising actual skills, with existing approaches based on qualifications; look at how to facilitate access of third country nationals to EU labour markets in priority sectors; look at measures to foster and align public and private funding for skills development.<br>✓ Facilitating open and fair trade: the EC will continue to develop the EU's network of Free Trade Agreements and other forms of cooperation with partners to support the green transition. It will also keep defending the single market from unfair trade practices. |

Source: own elaboration based on EC, 2023m.

- Finally, in the 'biodiversity, ecosystems, and agriculture' policy area a wide range of ambitious strategic objectives has been set by the EGDSF, but, currently, only one legislative proposal has been adopted (the Regulation on the placing on the Union market and the export from the Union of products associated with deforestation and forest degradation; EU, 2023j), seven have been put forward by the EC, and four are still to be presented. Moreover, many pieces of the ongoing/planned initiatives are problematic under different respects, especially with reference to agriculture. The fate of the legislative proposal on sustainable food systems, envisaged by the 'Farm to Fork' Strategy (EC, 2020c) as its main pillar, is uncertain: no information is available about whether and when it will be presented. Among the ongoing initiatives, the Regulation on nature restoration (EC, 2022i), with its binding targets, represents

an element of discontinuity in a policy area traditionally dominated by voluntary approaches (Paleari, 2022). Most of the key provisions originally proposed by the EC have been kept in the text approved by the EP, even if an 'emergency stop' clause has been included to allow targets for agricultural ecosystems to be suspended under specific circumstances (Euractiv website q). However, the final approval of the Regulation by the Council was 'paused' in April 2024 (The Club of Rome website), so that it is unclear whether it will be adopted (and also in case it is adopted, it will be up to the Member States to identify the measures to achieve the above-mentioned restoration targets within their National Restoration Plans). The proposed Regulation on plants obtained by certain new genomic techniques (NGTs; EC, 2023n) is highly controversial, as, according to some NGOs (Euractiv website s; Greenpeace website), it loosens existing rules for genetically modified plants, jeopardizing environmental and social protection. The proposed Directive on soil monitoring and resilience (EC, 2023l) falls behind the initial ambition of giving soil a protected status similar to that of air or water. Indeed, it mainly establishes a monitoring framework to assess soil health, without introducing any binding target.

It has to be added that, in March 2024, citing the crisis in EU agriculture caused by climate change and the Ukraine war, the EC proposed a simplification package to reduce the administrative burden of the Common Agricultural Policy (CAP; EC, 2024b), which loosens some environmental requirements and allows more flexibility for Member States in implementing the policy. The proposal establishes that farms of less than 10 hectares are exempt from checks on compliance with environmental requirements to receive CAP subsidies and amends six of the nine Good Agricultural and Environmental Conditions (GAECs) standards on which CAP payments depend. Amendments, which can be applied as of 2024, include, e.g., exemptions on compulsory soil covers, crop rotation, and fallow land rules. In a rush to approve the package before elections, the European Council in March 2024 endorsed the draft text, with minor adjustments made to the original version presented by the EC, and the EP approved it in April. The EU Council is now expected to give its final consent to the Regulation that could enter into force by June 2024. (Euractiv website t-u).

**Table 1.1: Changes in environmental conditionality within CAP**

| GAEC standard | 2021 Provisions (EU, 2021b and 2021c) | 2024 EC Proposal (EC, 2024b) |
|---|---|---|
| **1** | Maintenance of permanent grassland, 5% maximum decrease compared to the reference year 2018 | Member States (MS) can 'adjust' the 2018 reference ratio once in 2023-2027. Derogation from the obligation to replant grassland. |
| **2** | Minimum protection of wetland and peatland | No change |
| **3** | Ban on burning arable stubble, except for plant health reasons | No change |
| **4** | Establishment of buffer strips along water courses | No change |
| **5** | Cultivation techniques against soil degradation (e.g.: tillage management) | MS may exempt certain crops, soil types and farming systems |
| **6** | Minimum soil cover to avoid bare soil in sensitive periods | MS may exempt certain crops, soil types and farming systems. MS allowed to determine the main elements of the standard, to take into account crop, soil and climatic conditions |
| **7** | Crop rotation on arable land | MS may exempt certain crops, soil types and farming systems. Compliance also through crop diversification |
| **8** | Minimum share (4%) of arable land devoted to non-productive features, keeping existing landscape features | Obligation on the minimum share removed. MS must establish an incentive scheme instead. Protection of existing features remains |
| **9** | Ban on converting or ploughing environmentally sensitive permanent grassland in Natura 2000 sites | Ploughing to restore permanent grassland in Natura 2000 sites allowed in case it is damaged due to predators or invasive species. |

Source: Euractiv website u

It has, finally, to be noted that although the EGDSF makes a general statement on the opportunity to 'further promote tax systems and pricing that reflect environmental costs, including biodiversity loss' (EC, 2020d), there is no planned introduction of market-based instruments in this policy area.

# 2. The EGD investment needs

## 2.1 Total investment needs

*Period 2020-2030*

Making Europe climate neutral by 2050 and achieving all the other EGD ambitious goals will require substantial investments by both the public and private sectors.

According to 2022 EC's estimates (EC, 2022k), to deliver on the EGD objectives, we will need to increase the annual investments by around € 520 billion in the coming decade (2021-2030), compared to the previous one (2011-2020; see Tab. 2.1).

From those additional investments, €390 billion per year corresponds to the decarbonisation of the economy and, in particular, to the energy sector, including energy-related investments in the buildings and transport sectors. This increase of more than 50% of the energy investment needs, compared to the historical trend, will also support the EU efforts to ensure security of supply. With this regard, the Staff Working Document accompanying the NZIA (EC, 2023q) estimates that the accumulated investment needs associated with boosting EU manufacturing capacity for a part of strategic net-zero technologies (focusing on wind, solar PV, heat pumps, batteries, and electrolysers) amount to around €92 billion over the period 2023-2030, with a range between about €52 billion in the status quo scenario to around €119 billion in the scenario with no dependence on imports.

The existence of a current investment gap in order to achieve energy/climate targets also emerges from studies prepared by non-institutional actors. For instance, according to the 2024 Report by the Institute for Climate Economics (14CE, 2024), around €813 billion, or 5.1% of the EU GDP, would need to be invested every year until 2030 in the 22 sectors that are critical to the transformation of the energy, building and transport systems, to achieve the EU energy/climate targets. Private and public investments in those sectors in the EU economy have been growing by 9% between 2021 and 2022, reaching €407 billion in 2022 (or 2.6% EU GDP). The climate investment gap has, therefore, been estimated to be of at least €406 billion per year (or 2.6% of the EU GDP).

**Table 2.1 Additional annual investment needs 2021-2030 for delivering on EGD environmental goals, compared to 2011-2020 (€ bn 2015)**

| ***Climate and energy policy*** | | *Average 2011-2020 per year* | *Average 2021-2030 per year* | *Additional investment needs 2021-2030* per year* |
|---|---|---|---|---|
| *Sector* | *Sub-sector* | *€ bn* | *€ bn* | *€ bn* |
| Supply side | Power grid | 12.8 | 43.8 | 31 |
| | Power plants, incl. boilers and new fuels | 34.4 | 59.2 | 25 |
| Demand side | Industrial sector | 10.2 | 24.7 | 14 |
| | Residential | 87.8 | 180.1 | 92 |
| | Tertiary | 40.2 | 94.2 | 54 |
| | Transport sector | 474.3 | 649.3 | 175 |
| *Subtotal* | | *659.5* | *1.051.3* | *392* |
| *As a % of GDP* | | *5.4%* | *7.6%* | *2.2%* |
| ***Other environmental objectives*** | | | | *Additional investment needs 2021-2030* per year* |
| *Sector* | *Sub-sector* | | | *€ bn* |
| Protection of biodiversity and ecosystems | Biodiversity landscapes/nature restoration | | | 4 |
| | Management of forest resources | | | 2 |
| | Management of wild flora and fauna | | | 1 |

| | | |
|---|---|---|
| Circular Economy and Resource Efficiency | Management of materials and efficiencies | 10 |
| | Waste management | 10 |
| | Additional potential in 3 sectors (food, mobility and built environment) | 15 |
| Pollution prevention and control | Protection of ambient air and climate | 40 |
| | Noise and vibration abatement | 1 |
| | Protection against radiation | 5 |
| Water protection and management | Management of waters | 21 |
| | Wastewater management | 15 |
| Research and Development | Resource management R&D | 5 |
| | Environmental R&D | 2 |
| *Subtotal* | | *130* |
| **TOTAL** | | **522** |

* Numbers have been rounded.
Source: EC, 2022k and EC, 2021i

The additional investment needed to deliver on the other environmental objectives of the green transition (beyond climate and energy) is estimated by the European Commission to be about €130 billion per year until 2030. These objectives notably concern the protection and restoration of biodiversity and ecosystems, the transition to a circular economy, the sustainable use and protection of water and marine resources, and pollution prevention and control.

Based on the latest available estimates, overall additional annual investment needs for delivering on the EGD and REPower EU goals are even higher than the above-mentioned ones, e.g. €620 billion according to the 2023 Strategic Foresight Report (EU, 2023k).

It is worth noting that, since 2019, the EC has produced different estimates of the investment needs for achieving specific EGD environmental objectives or implementing selected EGD strategies (see e.g. Tab. 2.2). These estimates are affected by the rapid evolution of the macroeconomic context (e.g. COVID-19 and Russian aggression against Ukraine), have been calculated/expressed in different ways and apply to different time periods, so that it is very difficult (and sometimes impossible) to compare them.

**Table 2.2 Investment needs identified by EGD strategies/action plans**

| *EGD strategies and action plans (chronological order) and reference* | *Investment needs* | *Time period* |
|---|---|---|
| Hydrogen Strategy COM(2020)301 final (**EC, 2020f**) | €180-470 billion in production capacities | 2020-2050 |
| Biodiversity Strategy COM(2020)380 final (**EC, 2020d**) | €20 billion per year for spending on nature protection | 2020-2030 |
| Climate Target Plan COM(2020)562 final (**EC, 2020g**) | In the energy sector, the EU will need to annually invest €350 billion more than it did in the 2011-2020 period. | 2021-2030 |
| Renovation Wave COM(2020)662 final (**EC, 2020h**) | €275 billion a year for buildings renovation | 2020-2030 |
| Offshore Renewable Energy COM(2020)741 final (**EC, 2020i**) | €800 billion for the large-scale deployment of offshore renewable energy technologies | 2020-2050 |
| Sustainable Mobility COM(2020)789 final (**EC, 2020a**) | Additional investments (compared to the previous decade) of €130 billion per year for renewable and low carbon fuels infrastructure deployment + €100 billion per year to address the 'green and digital transformation investment gap' for infrastructure. | 2021-2030 |
| Zero Pollution Action Plan COM(2021)400 final (**EC, 2021b**) | Additional €100-150 billion every year to achieve environmental objectives beyond climate-related measures, a significant share of which for pollution prevention and control investments. | 2021-2030 |
| Solar Strategy COM(2022)221 final **(EC, 2022l)** | Additional investments in solar PVs (on top of the investments needed to achieve the objectives of the Fit for 55 proposals) amount to €26 billion. | 2022-2027 |

| | | |
|---|---|---|
| RepowerEU COM(2022)230 final (**EC, 2022a**) | Additional investments to deliver RepowerEU objectives (on top of the investments needed to realise the objectives of the Fit for 55 proposals) amount to €210 billion.<br>- € 10 billion investments to import sufficient LNG and pipeline gas by 2030<br>- €29 billion in power grid by 2030 to enable greater electricity use<br>- €37 billion to increase biomethane (i.e. a methane derived from biomass) production by 2030<br>- €41 billion for adapting industry to use less fossil fuels by 2030<br>- €56 billion for energy efficiency and heat pumps by 2030<br>- €113 billion for renewables (€86bn) and key hydrogen infrastructure (€27bn) by 2030<br>- €1.5-2 billion for security of oil supply. | 2021-2027 |
| Industrial Carbon Management Strategy COM(2024)62 final (**EC, 2024c**) | Achieving the proposed NZIA target (i.e. 50 million tonnes of annual $CO_2$ storage capacity by 2030) requires approximately 3€ billion investments in carbon storage facilities and between about 6.2€ and 9.2€ billion for transport infrastructure of pipelines and ships. | 2024-2030 |

Source: own elaboration based on the sources quoted in the Table.

Overall, the additional annual investment of €522bn needs to meet the EGD climate/energy/environmental objectives until 2030 would represent 3.3% of GDP when using the EU-27 GDP of 2022 amounting of € 15.9 trillion as the benchmark. It should also be kept in mind that Europe will be forced to make significant investments in climate change adaptation measures, but which be lower than for climate change mitigation (Finance Watch, 2024). However, these investment costs are projected to be still lower than the cost of inaction. Although the projections of the costs of inaction in terms of losses of GDP are highly uncertain and heavily depending on the underlying modelling methodologies they are estimated to be in the range of a loss of about 7% of the GDP of the EU by 2100 (EC, 2024a). Global projections in terms of economic losses are even higher as one study concludes that a 1 degree increase in global temperature would lead to a 12% decline in world GDP (Bilal and Känzig, 2024) and another study discloses a global GDP loss of up to 10% if the earth warms by 3 degrees (Waidelich et al., 2024). The EEA projects that the economic losses from coastal floods alone could be in the range of €1 trillion per year (EEA, 2024) and, therefore, makes the necessity of investing into climate change adaptation even more crucial.

*Period 2031-2050*

The EC Communication on Europe's 2040 climate target (EC, 2024a), published in February 2024, indicates a 90% net GHG emissions reduction compared to 1990 levels as the recommended target for 2040. According to the analysis in the impact assessment, this entails that the level of remaining EU GHG emissions in 2040 should be less than 850 MtCO2-eq and carbon removals (from the atmosphere through land-based and industrial carbon removals) should reach up to 400 MtCO2. Different options are considered for the 2040 target, which require a similar level of investment over 2031-2050 (although with different time profiles over the two decades and different sectoral composition).

Annual investments on average would amount to close to €660 billion (equivalent to 3.2% of GDP)[7] for the energy system and to €870 billion (equivalent to 4.2% of GDP)[8] for the transport sector. Energy and transport investments were equal to 5.4% of the average GDP in the 2011-2020 and are expected to increase to 7.6% of the average GDP in the 2021-2030 period (Table 2.1) and to 7.4% of the average GDP in

[7] Average real GDP for the 2021-2050 period (see EC, 2024d, Table 16).

[8] See previous footnote.

the 2031-2050 period (EC, 2024a). Additional investments (with respect to the 2011-2020 average)[9] would increase for the energy and transport sectors from €392 billion in the 2021-2030 period (of which €217 billion for the energy system and €175 billion for transport, see Table 2.1) to €665 billion in the 2031-2050 period (of which €410 billion for the energy system and €255 billion for transport; EC, 2024d and 2022k). Table 2.3 shows the annual average energy system investment needs under the three target options for 2040 elaborated by the impact assessment (EC, 2024d), namely:

- Option 1, a reduction of up to 80% compared to 1990, consistent with a linear trajectory between 2030 and 2050;
- Option 2, a reduction of 85-90%, compatible with the level of net GHG reduction that would be reached if the current policy framework were extended to 2040 and
- Option 3, a reduction of 90-95%.

**Table 2.3 Average annual energy system investment needs (€ bn 2023)**

| | **Option 1** | | | **Option 2** | | | **Option 3** | | | **2011-2020** |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2031-2040 | 2041-2050 | **2031-2050** | 2031-2040 | 2041-2050 | **2031-2050** | 2031-2040 | 2041-2050 | **2031-2050** | |
| Supply | 236 | 377 | **306** | 289 | 328 | **308** | 341 | 281 | **311** | **80** |
| Power grid | 79 | 88 | **84** | 88 | 81 | **85** | 96 | 75 | **85** | |
| Power plants | 97 | 187 | **142** | 128 | 157 | **142** | 151 | 133 | **142** | |
| Other | 59 | 102 | **81** | 72 | 90 | **81** | 94 | 73 | **83** | |
| Demand excl. transport | 332 | 377 | **354** | 355 | 357 | **356** | 372 | 338 | **355** | **169** |
| Industry | 38 | 31 | **35** | 46 | 24 | **35** | 48 | 22 | **35** | 7 |
| Residential | 225 | 250 | **237** | 237 | 242 | **239** | 248 | 230 | **239** | 116 |
| Services | 49 | 78 | **63** | 53 | 73 | **63** | 57 | 67 | **62** | 29 |
| Agriculture | 19 | 19 | **19** | 19 | 19 | **19** | 20 | 18 | **19** | 17 |
| Transport | 866 | 875 | **870** | 861 | 885 | **873** | 856 | 882 | **869** | **616** |
| *Total* | *1433* | *1629* | ***1531*** | *1505* | *1570* | ***1537*** | *1570* | *1501* | ***1535*** | ***863*** |
| *Total excl. transport* | *567* | *754* | ***661*** | *644* | *685* | ***664*** | *713* | *619* | ***666*** | ***248*** |

Source: EC, 2024d

[9] Please note that there is a slight discrepancy between the figures related to investments in the energy and transport sectors in 2011-2020 (both absolute amounts and percentage of the average 2011-2020 GDP) presented by the SWD(2021)621 1/2 (EC, 2021i) on which Table 2.1 and COM(2022)83 final (EC, 2022k) are based, and those reported by SWD(2024)63 Part 1/5 (EC, 2024d), on which Table 2.3 is based. In particular, according to the former, overall investments in the 2011-2020 period would amount to €695.5 billion (€185.2 billion for the energy system and €474.3 billion for transport, equal respectively to 1.5% and 3.9% of the average 2011-2020 GDP). According to the latter, investments in the 2011-2020 period would amount to €250 billion for the energy system (equal to 1.7% of the average 2011-2020 GDP) and to €615 billion for transport (equal to 4.1% of the average 2011-2020 GDP). Within the SWD(2021)621 1/2 (EC, 2021i) investments are expressed in bn € 2015, while in the SWD(2024)63 Part 1/5 (EC, 2024d) they are expressed as bn € 2023. It has also to be highlighted that SWD(2021)621 1/2 (EC, 2021i) and COM(2022)83 final (EC, 2022k) base the calculation of the investment needs for the energy system (for the 2011-2020 and 2021-2030 periods) exactly on same sub-sectors (Energy supply: - Power grids; -Power plants including boilers and new fuels; Energy demand: - Industry, - Residential, -Tertiary), which slightly differ from those taken into account by SWD(2024)63 Part 1/5 (EC, 2024d) to estimate the investment needs for the 2011-2020 and 2031-2050 periods (Energy supply: - Power grids; -Power plants, -Oher; Energy demand: - Industry, - Residential, -Services, -Agriculture).

**Table 2.4 Comparison of investment needs and additional investment needs in the energy system (% of GDP)**

| | Present investment | Investment needs | | Additional investment needs to the period (compared to situation of 2011/2020) | |
|---|---|---|---|---|---|
| | 2011/2020 | 2021/2030 | 2031/2050 | 2021/2030 | 2031/2050 |
| **In % of GDP** | | MIX - scenario | S1 – scenario | Difference between MIX- scenario and 2011/2020 | Difference between S1 – scenario and 2011/2020 |
| **Total** | 5.4 | 7.6 | 7.3 | 2.2 | 1.9 |
| **Total excluding transport** | 1.5 | 2.9 | 3.2 | 1.4 | 1.7 |
| **Transport** | 3.9 | 4.7 | 4.1 | 0.8 | 0.2 |

Source: EC, 2021i

The most efficient and effective option according to the impact assessment (i.e. option 3) requires higher annual investment needs in 2031-2040 and a faster deployment of decarbonisation technologies on the supply and demand side, but also comparatively lower investment levels in 2041-2050. The assessment also shows that progresses, for example on the circular economy, can reduce investment needs in the energy system by about 7% over 2031-2050 (representing yearly savings of €45 billion) and spending in transport by about 9% (€127 billion; EC, 2024a).

The projections show the pressing need to increase investments for achieving climate neutrality in Europe by 2050 based on the modelling framework done for the impact assessments for reaching the 2030 and 2040 GHG reduction targets. The increase of the share of the overall additional investments is comparable between the three decades until 2050. The projected investment needs of the transport sector amount to more than 50% of total investment needs and the demand for investment into road transport is the highest with 46% of total investment needs. However, about 80% of the transport investment is attributed to the road transport and the biggest share of this investment is for the purchase of private vehicles amounting to 59%. The classification of private vehicles is slightly misleading as it also includes company vehicles which for example account for about 60% of all newly registered vehicles in Germany. It is interesting to highlight that the annual additional investment needs differ between the 2021/2030 period and the 2031/2050 as it is projected that they amount to 0.9% during the former and 0.2% during the latter period compared to the 2011/2020 benchmark.

An update of the additional annual investment needs the public and private sectors have to face to achieve the green transition between 2021 and 2030 indicates that the figure is about €477 billion (in 2022 prices) covering investments of the energy system and transport system but excluding investments in infrastructure, such as road and railways (EC, 2023q). This figure is based on scenarios developed for the 'Fit for 55 package' (in 2022 prices) and corresponds to 3% of GDP of the EU-27 in 2022 and requires an increase in total investment in the EU-27 by 13% (based on the 2022 total investment figure for the EU-27).

The figures reported above are roughly in line with the estimates provided by the Institut Rousseau (Institut Rousseau, 2024). According to the latter, collective investment[10] required to achieve carbon neutrality by 2050 through a set of measures related to seven main sectors[11] is estimated at €40 trillion between 2024 and 2050, averaging €1,520 billion per year. This equals almost 10% of current EU-27 GDP and contrasts with the ongoing business-as-usual scenario, estimated at around €30 trillion between now and 2050,

[10] The definition of 'investments' used by the Report is broad, based on the notion of 'investment costs' in a project or asset. It refers to initial costs to implement a change (capital expenditure or CAPEX) and excludes so-called 'operational' or 'operating' costs that arise during the project (operational expenditure or OPEX).

[11] Transport, Energy production and infrastructure, Industry, Waste management, Agriculture, Carbon sinks (LULUCF), Buildings. Cross-sector levers have been also considered.

averaging €1,160 billion per year (7.3% of current EU-27 GDP). The difference, about €10 trillion or an average of €360 billion per year, represents the 'extra investment' needed for carbon neutrality, which corresponds a 31% increase compared to the baseline scenario and around 2.3% of current EU-27 GDP.

## 2.2 Investment needs across EU countries

When thinking about the implementation phase of the EGD, the investment needs of the Member States, as well as the question of how to finance the country specific investment needs (e.g. how high the financing costs will be, see below) are as relevant as the overall EU-27 investment needs. The economic and financial conditions vary between EU Member States as clearly visible, for example, from the share of renewable energy that varies from 66% in Sweden to 13% in Ireland in 2022[12], which reveals the different trajectories and investment requirements the countries will face for decarbonising their energy system.

The Institut Rousseau's report (2024) projects not only the investment needs as EU-27 level but also provides estimates of the investment needs of individual EU Member States. According to the methodology and sectors covered in this study, in front of additional investments of around 2.3% of the current EU-27 GDP to reach the Net Zero by 2050, there is a large variance between the analysed countries ranging from 1.4% of GDP in Germany to 3.6% of GDP in Poland (see Figure 2.1).

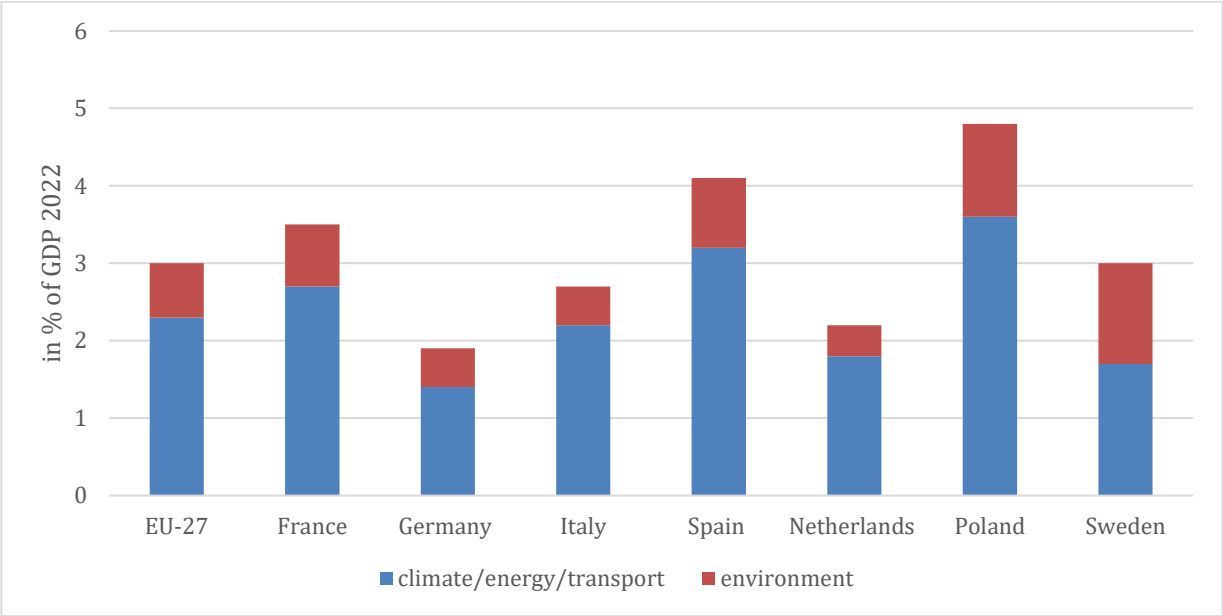
The EU-27 investment gap is regularly reported and can be seen as an appropriate benchmark for the overall analysis. However, more valuable is clearly to highlight the investment gaps at country level as the actual implementation challenge becomes evident because the projected additional annual investment gaps widely differ between countries, for example by a factor of 2.2 between Germany and Spain and a factor of 2.5 between Germany and Poland.

Although the climate transition obligations for reaching climate neutrality will entail the largest investments, significant investments are also required for reaching environmental objectives, such as zero pollution, circular economy and water. Environmental investment needs and gaps were estimated by the European Commission and published in the 2022 country reports as part of the environmental implementation review for the period 2021-2027[13]. In the 2014 - 2020 period, the EC estimated that overall environmental financing for investments is estimated to have been 0.6-0.7% of GDP in the EU and was financed by EU funds together with national financing schemes. An overall environmental financing gap of 0.6-0.8% of GDP at the EU level is projected for the period 2021-2027 as the EU environmental investment needs for this period are estimated to range between 0.9-1.5% of the projected GDP assuming unchanged financing levels. A 2023 update (EC, 2023r) of the investment needs of this period projects an EU-wide average investment gap of 0.7% of EU-27 2022 GDP average but with large differences between EU Member States ranging from about 0.3% of GDP of more than to 2% of GDP for countries like Bulgaria, Lithuania and Latvia.

[12] See for an overview of the share of renewable energy in all EU Member States: https://www.eea.europa.eu/en/analysis/indicators/share-of-energy-consumption-from

[13] See for further information and links to country reports: https://environment.ec.europa.eu/law-and-governance/environmental-implementation-review_en#country-reports

**Figure 2.1: Additional annual investment needs for climate, energy, transport and the environment for the EU-27 and selected EU Member States for the 2021-2027 period**




Note: data on annual investment needs for reaching Net Zero in 2050 are based on Figure 2.8 of Institut Rousseau (2024); data on additional annual investment needs for the environment is based on DG ENV update 2023 report and is shown as the investment gap as expressed as a share of GDP for the period 2021 to 2027 and calculated by the author using GDPs published by Eurostat.
Source: Institut Rousseau (2024) and EC (2023r)

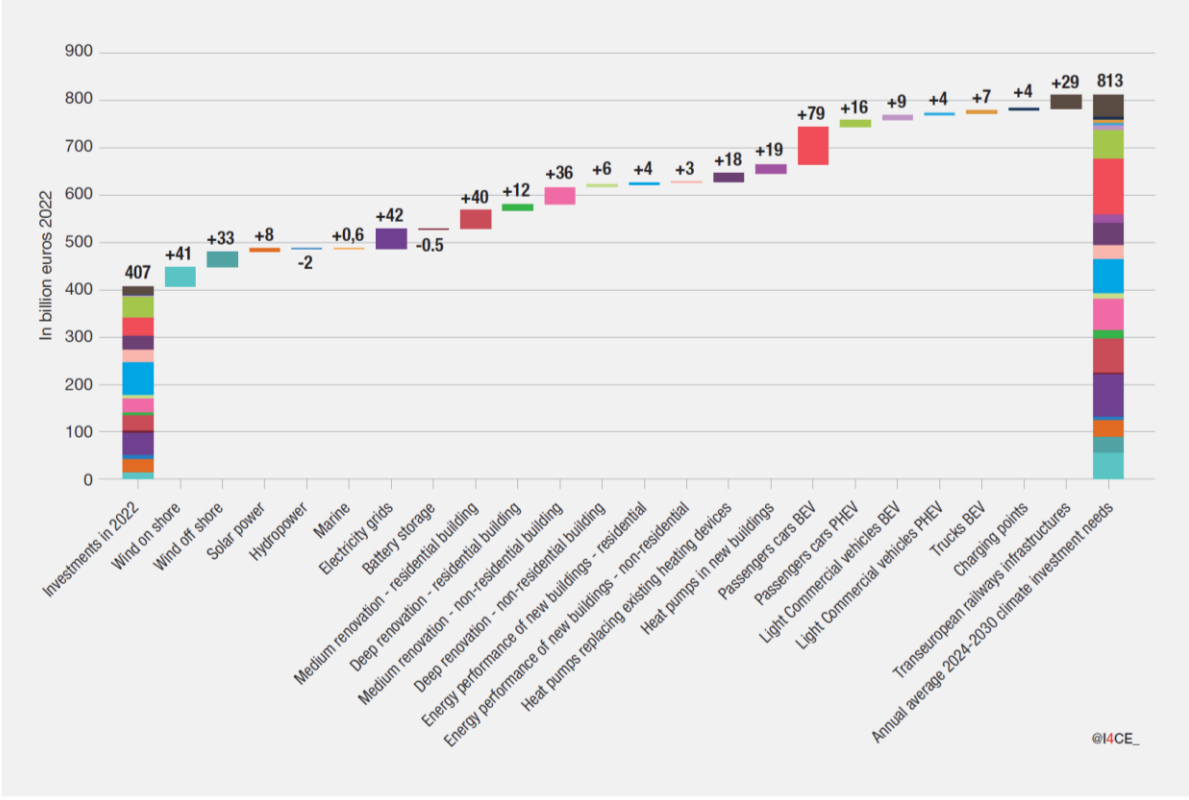
# 3. Investment and industrial capacity gaps in key sectors

## 3.1 Estimated investment gaps in energy production and transports

Recent reports produced estimates of the investments gaps as difference between the estimated investment needs and the present or projected investments levels.

On climate related investments, I4CE (2024)[14] shows public and private investments from selected sectors (renewable energy sectors, building relevant sectors, electric cars and others) that have a acritical role for the transition. These sectors have been significantly growing in terms of investments between 2021 and 2022 (+ 9%, up to €407 billion in 2022, i.e. 2.6% of EU GDP), although with heterogeneity across specific kinds of investments. The same holds in relation to existing investment gaps, which are presented in Figure 3.1.

**Figure 3.1. Breakdown of climate investment gaps in the energy, building and transport sector**




Source: reproduced from I4CE (2024), Figure 2, p. 3.

[14] Available at: https://www.i4ce.org/en/publication/european-climate-investment-deficit-report-investment-pathway-europe-future/ The assessment focuses on transport, energy and buildings, while it leaves out industry, agriculture, waste, and forestry. The investment needs for each technology 2024 to 2030 are based on legislative documents and action plans from the EU, and/or on the basis of EU scenarios. These are then compared with 2022 levels.

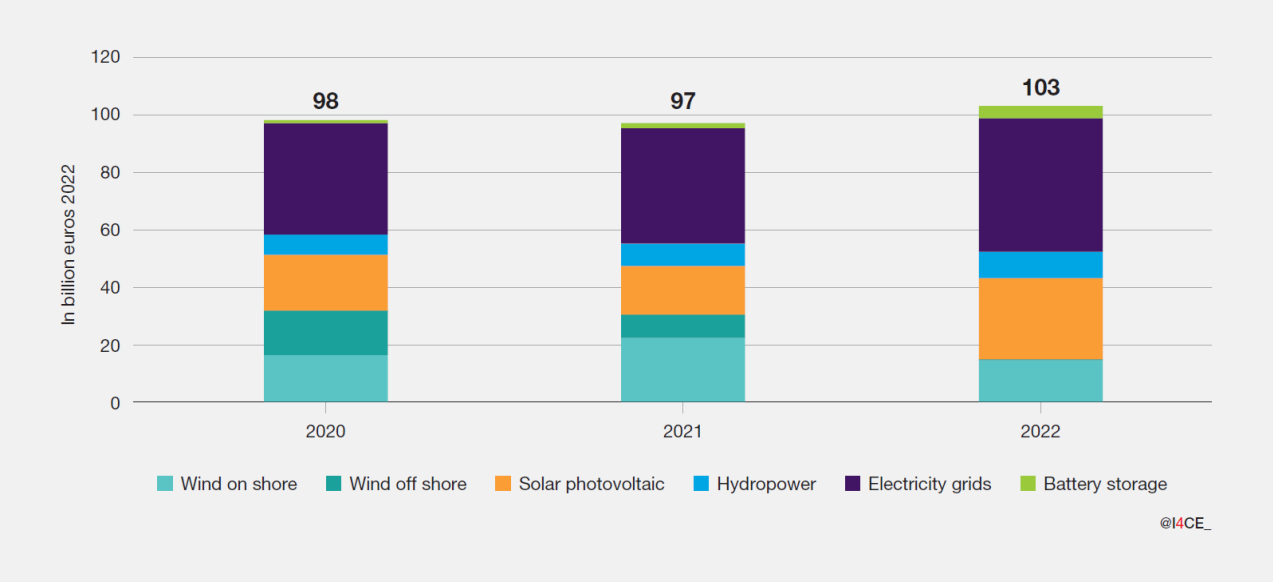
Figure 3.1 reports the investment needs that are expected, on average, to achieve an increase up to €813 billion per year between 2024 and 2030, and shows that in some sectors the gaps are relatively large, namely in the wind, electrification (in particular for transport) and buildings renovation sectors.

A more specific analysis shows that while investments in heat pumps, solar energy and electric vehicles increased significantly, wind power investments reached in 2022 their lowest level since 2009. According to I4CE, the wind sector is problematic due to the expected needed increase in installations, also accounting for replacements of existing plants, translating into a climate investment gap related to that sector of €74 billion per year between 2024 and 2030. Focusing instead on buildings, I4CE calculates that the EU 2030 targets can be obtained if at least €335 billion are invested (from private and public sources) between 2024 and 2030.

In relation to renewable energy, I4CE (2024) report highlights significant differences across energy sources. More specifically, from Figure 3.2 we can observe relatively stable investments between 2020 and 2022, although with solar PV and power grids counterbalancing a significant reduction in investments in wind energy.

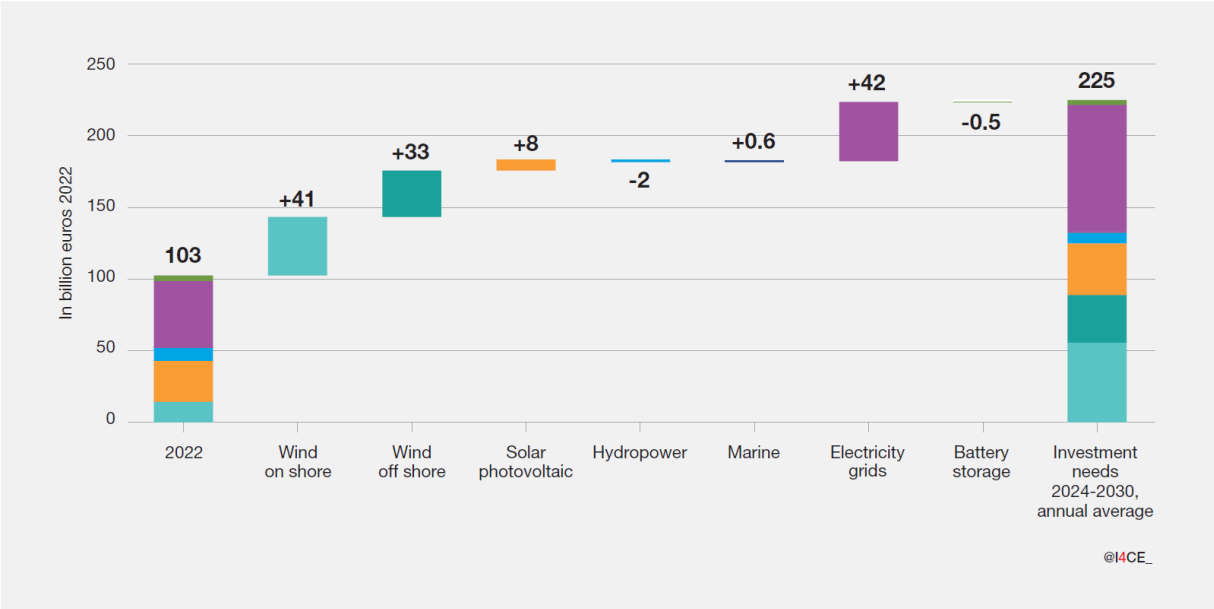
This assessment results in significant investment gaps not only in relation to electrification, but also to take the wind energy sector back on track for Net Zero ambitions (Figure 3.3).

**Figure 3.2. Climate investments in the renewable energy systems, 2020-2022**




Source: reproduced from I4CE (2024), Figure 19, p. 26.

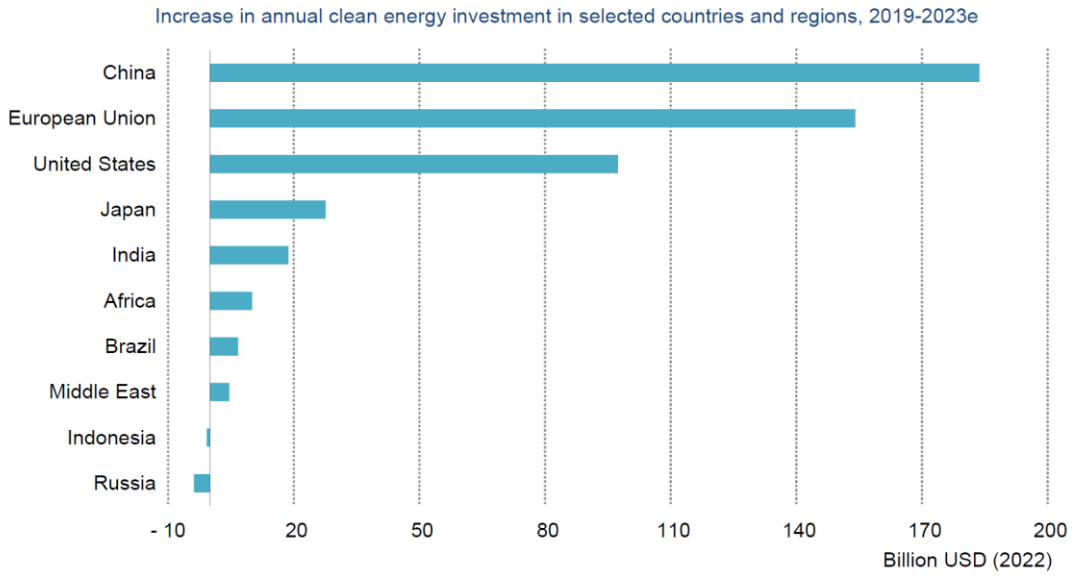
**Figure 3.3 Breakdown of climate investment gaps, renewable energy sector**




Source: reproduced from I4CE (2024), Figure 6, p. 14

It is interesting to note that the overall amount of clean energy investments (which also includes transportation modes) has increased significantly in recent years, although they appear to be concentrated only in a few countries (Figure 3.4).

**Figure 3.4 Increase in annual clean energy investments in selected countries and regions, 2019-2023**




Source: reproduced from IEA (2023), p. 14.

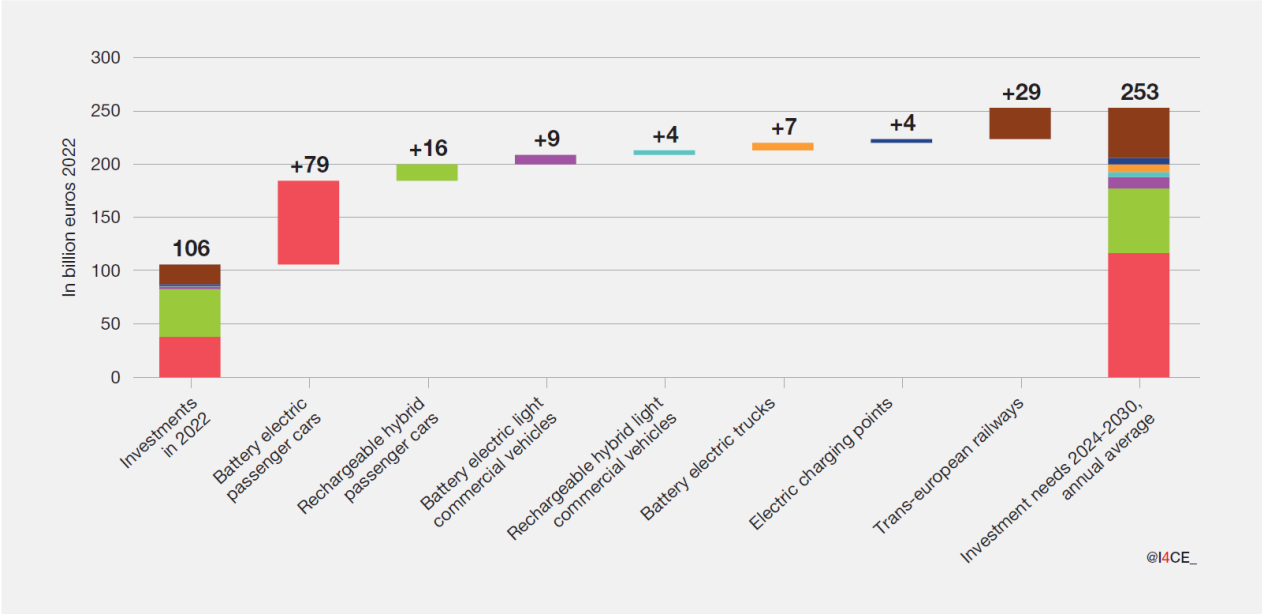
According to the World Energy Investments Report (IEA 2024), global energy investments are estimated to exceed USD 3 trillion in 2024 with investments into clean energy amounting to USD 2 trillion. The share of clean energy is increasing over time, and this is suggested to be linked to the high level and volatility of fossil fuel prices, to support in several countries or parts of the world, as well as a broad change in industrial policies and strategies in line with the green transition.

Loooking at transports, according to a recent report by Institut Rousseau (2024), the transport sector, which is the second greenhouse emitter in Europe, needs a redirection of existing investments but with a relatively

small increase (8%, up to €689 billion per year) to be on track for a Net Zero modelled scenario by 2050. Public funding sources are expected to account for just 20% of this investment needs. The objective of complete decarbonization is possible, but rather ambitious, requiring the transition to integrated transportation systems including "intermediate" vehicles (e.g. small urban electric vehicles), sharing services provision and, ultimately, a change in urbanization strategies. Such a complex picture necessarily requires also policies that complement (public and private) investment increases (possibly redirecting existing investments), including fiscal measures to improve the competitiveness of specific modes of transport (e.g. trains) and a broad confrontation is needed on the degree of acceptability of air traffic as a "green" option (depending, for example, on the covered distances).

Qualitatively similar conclusions are derived by I4CE (2024) – see Figure 3.5 – where specific measures and related investment gaps are identified. The needs are largely determined by increasing sales of electric vehicles, which are expected to increase from 3.3 million battery electric vehicles and 2.8 million plug-in hybrid vehicles in 2022 to 31 million battery electric vehicles and 14 million plug-in hybrid vehicles in 2030. Similar trends are expected for commercial vehicles and trucks. This evolution is challenging also under the perspective of the needed infrastructures, including the need to boost the availability of charging stations. Finally, the report underlines that investments on trans-European railways are slowing down, and this is expected to harm a low-carbon modal shift, along the lines also suggested by Institut Rousseau (2024).

**Figure 3.5 Breakdown of climate investment gaps, transport sector**




Source: reproduced from I4CE (2024), Figure 19, p. 26.

## 3.2 Gaps in clean-tech manufacturing capacity: energy and transport

The energy and transport sectors are the first and second largest emitting sectors in the EU, with 902 and 782 $MtCO_2$ equivalent respectively, which represent 26% and 23% respectively of the EU's total greenhouse gas emissions (GHG). The decarbonization of those two sectors is indispensable for achieving the EU objectives of net zero emissions in 2050.

A crucial point, and a major challenge, is the ability to self-sustain the green transition domestically, avoiding reliance on third countries for supply, as it has been the case in the past for gas and oil, and for strategic production factor (i.e. critical raw materials). For the former, this can be achieved through the decarbonization of the energy sector by 2050 and the push of renewables in the EU's energy mix; for the

latter, the challenge is even stronger because of the low level of self-sufficiency of key materials, such as lithium for batteries or gallium for solar panels, that are concentrated in non-EU countries.

In this section, some of the main aspects related to the gap between the deployment of clean tech in the EU, representing the size of the domestic market, and domestic production capacity in the manufacturing sector will be described with the aim of highlighting the gap towards EU self-sufficiency, and the challenges arising for the targets of NZIA and CRMA. Special attention will be devoted to the heterogeneity among EU countries.

We exploit data from Bruegel's European Clean Tech Traker[15]. These original data are based on different sources and allow us to highlight domestic deployment, manufacturing capacity and trade also in comparison with the US and China in selected sectors of the clean tech system. We will use the difference between domestic deployment and domestic manufacturing capacity as a proxy of domestic supply gap, as reflected in trade flows (see Box 3.1).

**Box 3.1. Bruegel data and elaborations**

| **Description** | |
|---|---|
| The Bruegel's European Clean Tech Tracker provides an overview of the trends in clean tech in Europe considering the trends in manufacturing and deployment for many green technologies for all EU members, Norway and the UK. Moreover, the Tracker provides information on EU's international trade of the main green technologies in comparisons with United States of America and China as main international competitors.<br>At present, the Tracker covers data for: solar photovoltaic systems (PV), wind energy, electric vehicles (EVS), electrolysers, heat pumps, nuclear energy, power grids, carbon capture and storage (CCS) and hydropower. The data are constantly updated to provide a timely and policy-relevant overview of the crucial sectors involved in the EU green transition. All the data are freely available at the website: *https://www.bruegel.org/dataset/european-clean-tech-tracker*<br>In this section, we exploit Bruegel's on solar energy, wind energy, heat pumps and EV and batteries. The elaborations provided in this section are made by the authors of this report and do not involve responsibilities of Bruegel. | |
| **Main indicators used and elaborated in this analysis** | |
| **Total installed capacity** | Total cumulated deployment of the specific technology measured in GW or in kw per capita, it can be considered the stock of that green technology. |
| **Total net installed capacity** | Annual deployment of the technology measured in GW or in kw per capita, it can be considered as the additional deployment for that technology. |
| **Total annual operational solar capacity** | The manufacturing production capacity for the technology, calculated as the sum of all potential power generation capacity associated to production of plants and equipments from the manufacturing facilities existing in the EU for that technology. It is measured in GW or in kw per capita. It can be considered as a proxy of the potential additional energy power generation in a year from EU's technology manufacturing. |
| **Gap between annual manufacturing capacity and annual deployment** | It is measured in GW or in kw per capita. If negative, it can be interpreted as a gap in terms of lack of domestic manufacturing supply of the technology, whereas, if positive, it can be considered as a surplus in manufacturing supply of the technology, since domestic manufacturing supply of the technology exceed domestic deployment for the same technology. |
| **Trade** | Import to Europe and Export from Europe related to the specific technology in billions of euros. Net exports have been calculated as the difference between Export and Import of the specific technology, also in this case Net Exports are measured in billions of euros. |

### *3.2.1 Renewable energy*

The energy sector has experienced a major decarbonization over the past three decades, reducing its greenhouse gases emissions by 44 percent since 1990 (Institut Rousseau, 2024). The decarbonization of the energy sector came mainly from a change in the primary energy mix, where the dependence on coal has

[15] https://www.bruegel.org/dataset/european-clean-tech-tracker

been significantly reduced, while the contribution of renewables has steadily increased over the years (Institut Rousseau, 2024).

Renewables and biofuels are now the predominant source of energy production in the EU providing 40.8% of total EU's energy production in 2021, whereas, in the same year, fossil fuels (oil and gas) and nuclear accounted for 25% for 32% of the energy mix respectively (Eurostat, 2024).

However, there is an important heterogeneity among EU countries: some countries still strongly rely on fossil fuels such as coal (e.g. Poland), gas (e.g. Netherlands), nuclear power (e.g. France, Belgium) whereas others with important contribution of renewable in the total energy mix (e.g. Portugal, Spain, Germany).

Despite the improvements in terms of energy decarbonization achieved during recent decades, the analysis made by Institut Rousseau (2024) suggests that the current investment trend will be enough to reach the Fit For 55 target in 2030, but that with the existing policy measures reaching the Net Zero objectives by 2050 will be unlikely.

Another important difficulty for the sector is that more than half of the energy consumed in the EU is imported from abroad. In fact, only 44% of the energy consumed in the EU is self-produced domestically, while the remaining 56% is imported and it is mainly based on fossil sources.

To achieve the Net Zero objectives it will be extremely important not only to decarbonize, but also to reduce energy imports from fossil sources, which is the aim of the Renewable Energy Directive adopted in 2023, which adopt a target of up to 42.5% of renewable energy in final energy consumption by 2030.

One of the most important actions to decarbonize the sector is the mass electrification of the economic system with a substantial increase of electricity from green sources. This means that, on one hand, the deployment of electric devices and green components for energy conversion, such as heat pumps, must increase. On the other hand, it means that the Europe's energy green transition will have been underpinned by rising the capacity renewable sources, whereby solar and wind power will make a major contribution to increase the EU's domestic self-sufficiency.

*Solar Energy*

In 2022, the total installed solar capacity in the EU was 200GW (Institut Rousseau, 2024). With the REPowerEU plan (2022) the European Commission has the objective to deploy 320 GW of solar photovoltaic by 2025 and 600 GW by 2030. The Institute for Climate Economics (I4CE) estimated a yearly average investment need of 36GW per year in order to stay in line with the REPowerEU's objectives for 2030 with a gap of additional 8GW from the total annual investments of 28GW in solar photovoltaic made in 2022 (I4CE, 2024).

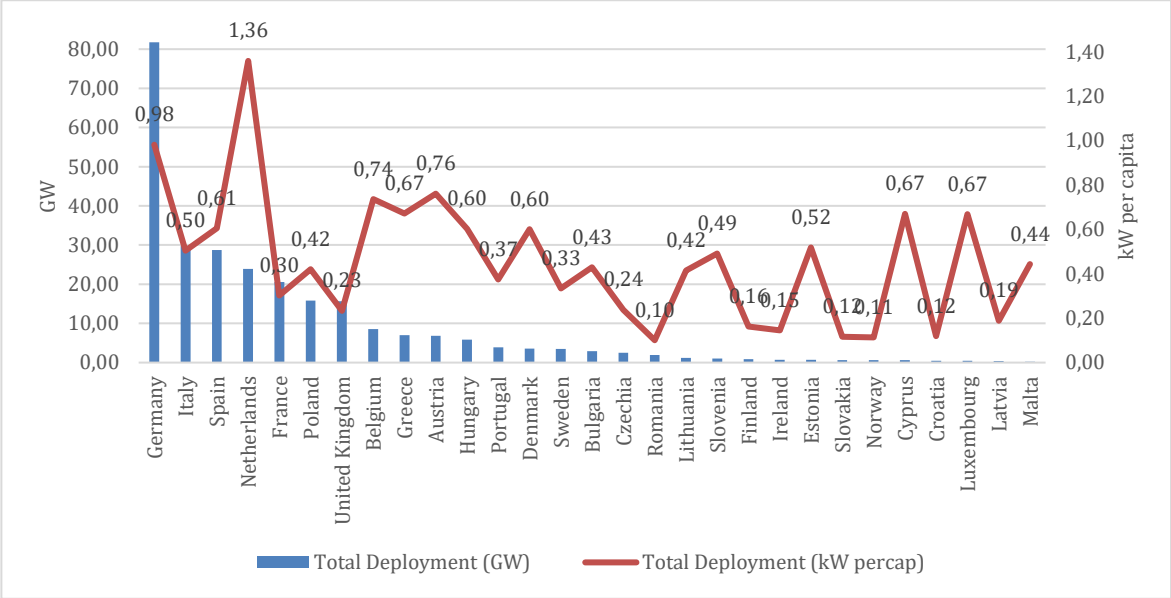
We can consider the gaps in the EU solar energy system by comparing the deployment of photovoltaic systems (PV) with their domestic manufacturing capacity. This last can be considered as the potential electricity generation capabilities of the solar PV systems that could be produced by EU industry (Bruegel, 2024). The difference between solar deployment and solar operational capacity can be a proxy of the gap in the EU solar system which are filled from non-EU facilities and operators mainly by imports.

In 2023, the total deployment of PV in the EU was 270.5 GW (considering also the UK and Norway), which correspond to a total deployment of 13.31 kW per capita. In terms of total cumulated deployment Germany has the highest level of solar power installed with 81.74 GW, followed by Italy with 29.8 GW, Spain with 28.7 GW, the Netherlands with 23.9 GW, France with 20.5 GW and Poland with 15.8 GW. All other countries have a total installed capacity below 9 GW (Figure 1).

A different picture emerges when comparing installed solar capacity deployment per capita. In Europe, 0.46 kW per capita are installed on average. Germany is the second country in the EU for deployment per capita with an installed capacity of 0.98kW per capita and is overcame by the Netherlands with 1.36 kW per capita, which is the EU leader of deployment. They are followed by Austria (0.76 kW per capita), Belgium (0.74 kW

per capita), Greece, Cyprus, Luxemburg, all with 0.67 kW per capita Spain (0.61 kW per capita) and Hungary (0.6 kW per capita) (Figure 3.6).

**Figure 3.6 Total installed solar capacity in 2023 in GW and kW per capita.**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

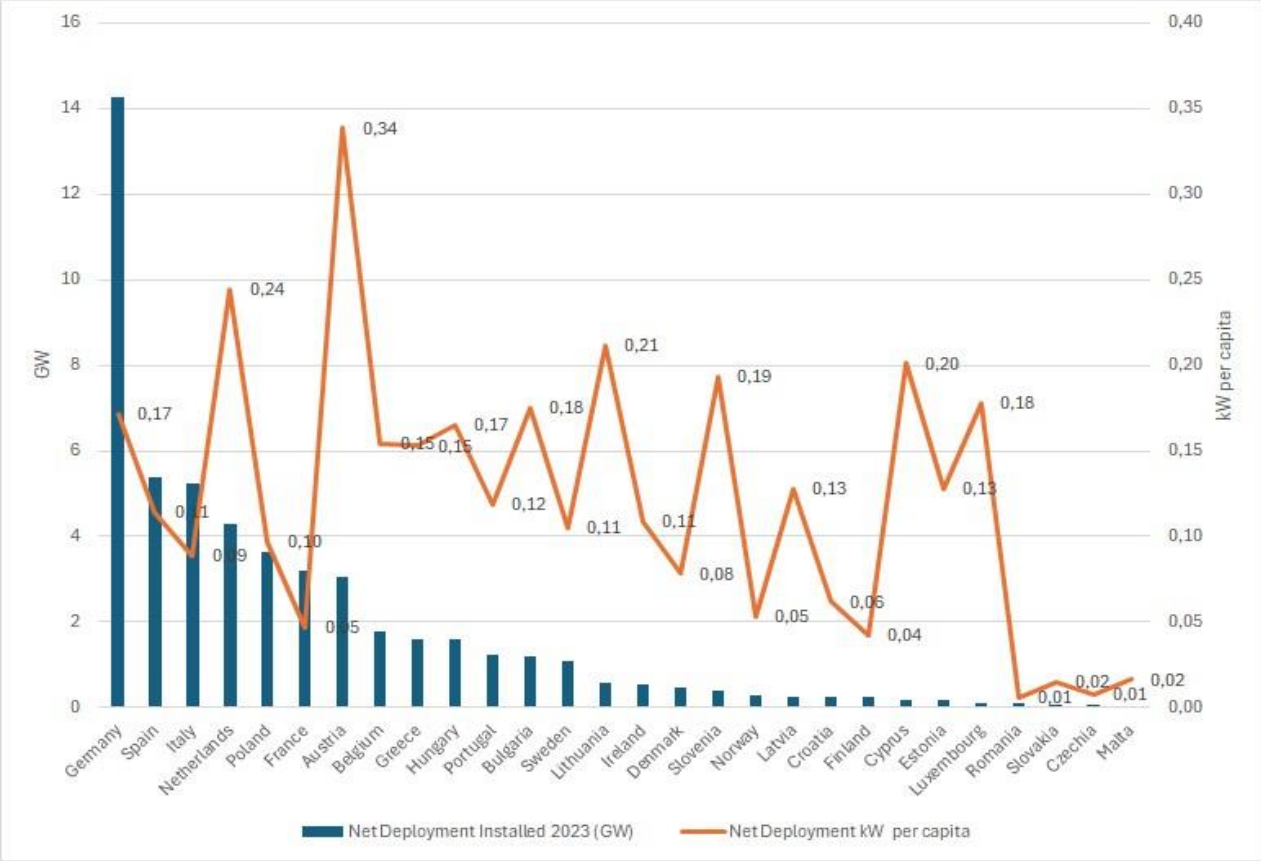
In terms of net PV installations, considered as the difference between the accumulated deployment (or the stock of PV) and the new deployed solar power during the last year, in 2023, in Europe have been totally deployed 51.36 GW of solar power generation. Germany is again leading the way with 14 GW followed by Spain and Italy with 5.4 GW and 5.2 GW respectively, the Netherlands with 4.3 GW and then Poland (3.6 GW), France (3.2 GW) and Austria (3 GW) (Figure 3.7).

When considering the net deployment related to the number of inhabitants, Austria lead the way with 0.34 kW per capita followed by the Netherlands with 0.24 kW per capita, Lithuania with 0.21 kWper capita, Cyprus with 0.2 kW per capita, Slovenia with 0.19 kW per capita, Luxemburg and Bulgaria both with 0.18 kW per capita (Figure 3.7).

In this analysis the total 'operational' capacity in the EU has been considered as the potential manufacturing solar capacity and it has been calculated adding up all the EU annual capacity by EU manufacturing solar facilities by country using European Clean Tech Tracker data from Bruegel. The total EU's annual operational capacity has been estimated to be 16.81 GW, which is equivalent 1.16 kW per capita.

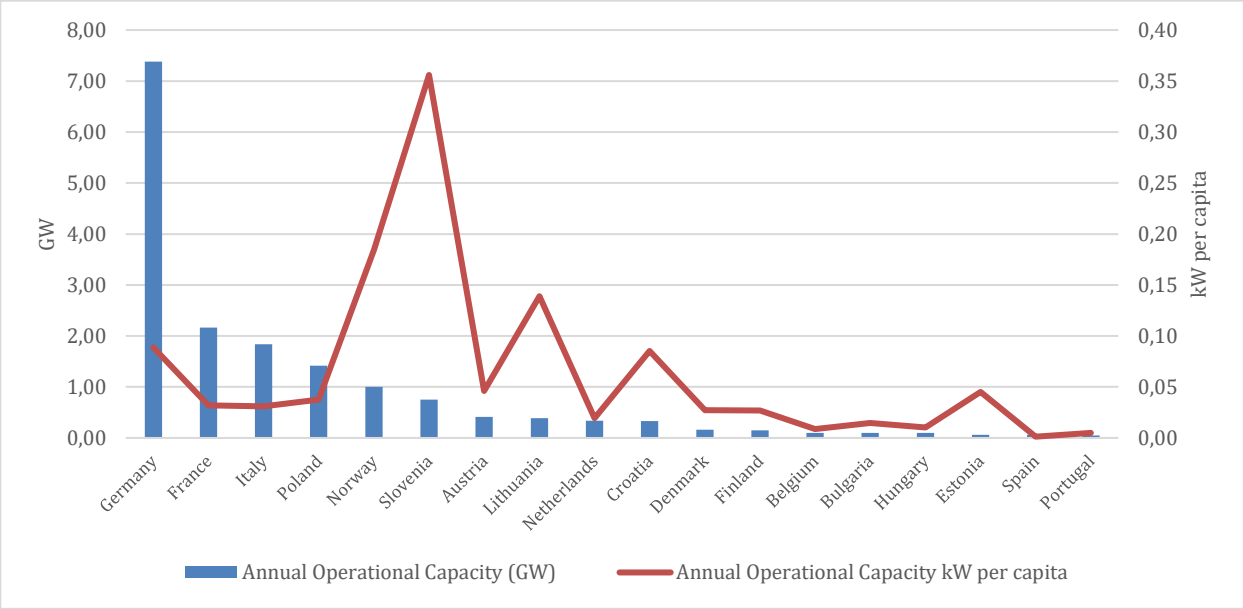
Also in terms of operational capacity, Germany lead the European scene with 7.38 GW of yearly solar manufacturing capacity, followed by France with 2.17 GW, Italy with 1.84 GW and Poland with 1.42 GW of potential solar production per year, whereas the rest of EU countries are below 1 GW of potential production. Considering the manufacturing capacity in terms of inhabitants, surprisingly Slovenia shows the highest level of capacity with 0.36 kW per capita, Norway and Lithuania show 0.18 and 0.14 kW per capita respectively and Croatia show the same level as Germany with 0.09 kW per capita. The rest of European countries are below 0.05 kW per capita (Figure 3.8).

**Figure 3.7 Total net installed solar capacity in 2023 in GW and kW per capita.**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

**Figure 1.8 Total and per capita annual manufacturing solar capacity in EU countries in 2023 in GW and kW per capita.**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

Although the EU's solar manufacturing capacity increased constantly during the last decade there is still an important gap between EU solar deployment and its domestic manufacturing capacity. Solar EU industry

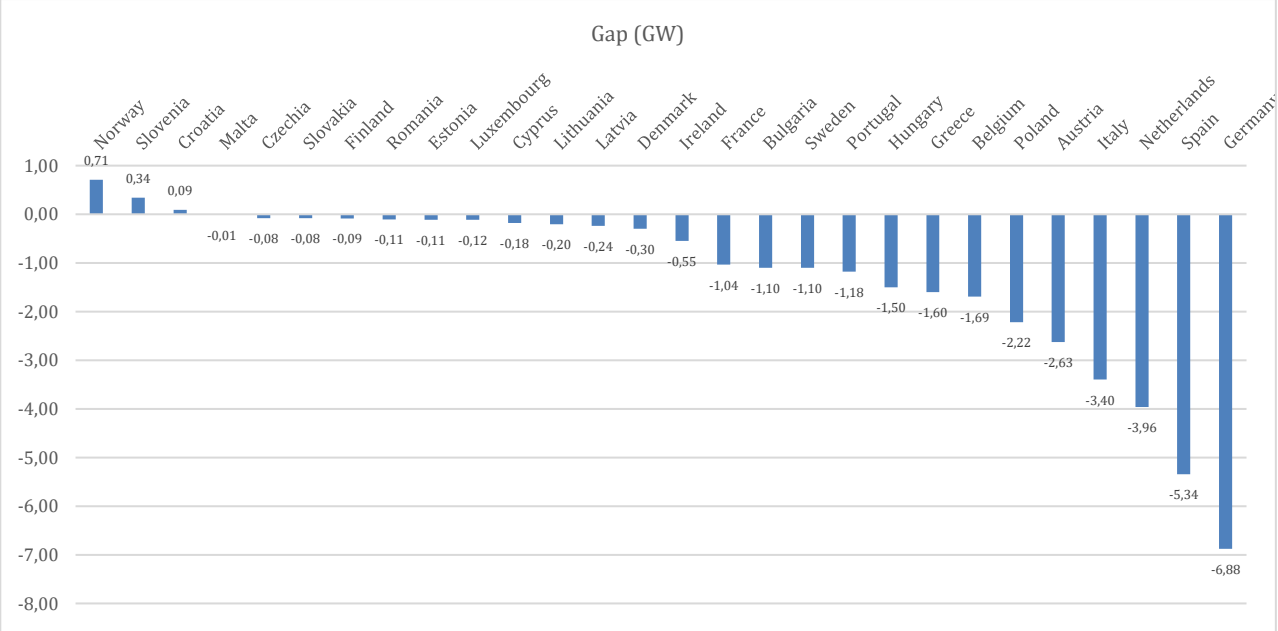
operational capacity in 2023 was 16.81 GW of potential solar production, whereas total EU solar deployment was 51.36 GW. Then the solar industry European gap is estimated to be 34.55 GW per year.

Comparing countries, the only three having higher levels of industrial capacity than deployment are Norway (0.71 GW), Slovenia (0.34 GW) and Croatia (0.09 GW). All other European countries show an important level of deficit in industrial solar capacity thus highlighting a structural imbalance between the solar manufacturing side and the final use of the technology. There are significant differences among countries. The countries leading the solar deployment in Europe show a significant domestic manufacturing deficit such as Germany (-6.88 GW), Spain (-5.34 GW), the Netherlands (-3.96 GW), Italy (- 3.4 GW), Austria (-2.63 GW) and Poland (-2.22 GW). All the rest of European countries exhibit an imbalance between deployment and solar domestic production under 2 GW with an average level of -1.23 GW (Figure 3.9).

The pattern is the same even when considering the solar gap per capita (Figure 3.10).

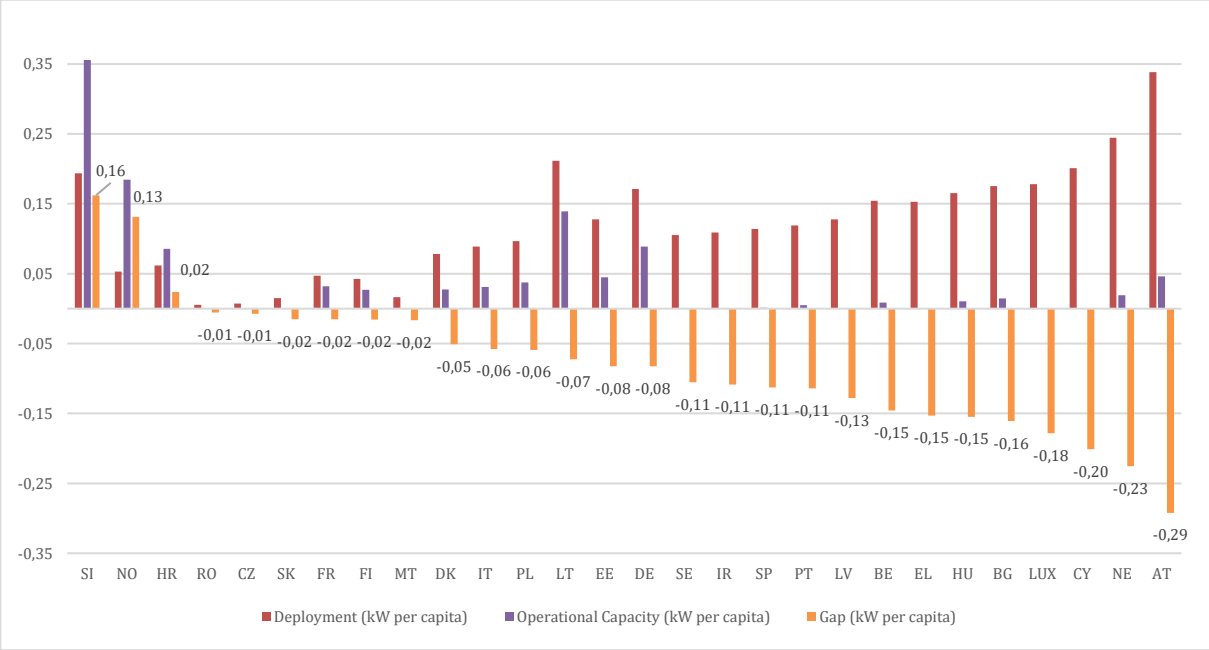
For each country deployment, operational capacity and gaps both in absolute and per capita are shown in Table 3.1.

**Figure 3.9. Gap between deployment and manufacturing capacity in solar technology in EU countries, in GW**




Source: author's calculation based on Bruegel's “European clean tech tracker” data.

**Figure 3.10 Solar manufacturing capacity, solar deployment and gap by country (kW per capita)**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

**Table 3.1 Deployment, manufacturing capacity and domestic supply gap for solar panels in the EU by country in 2023**

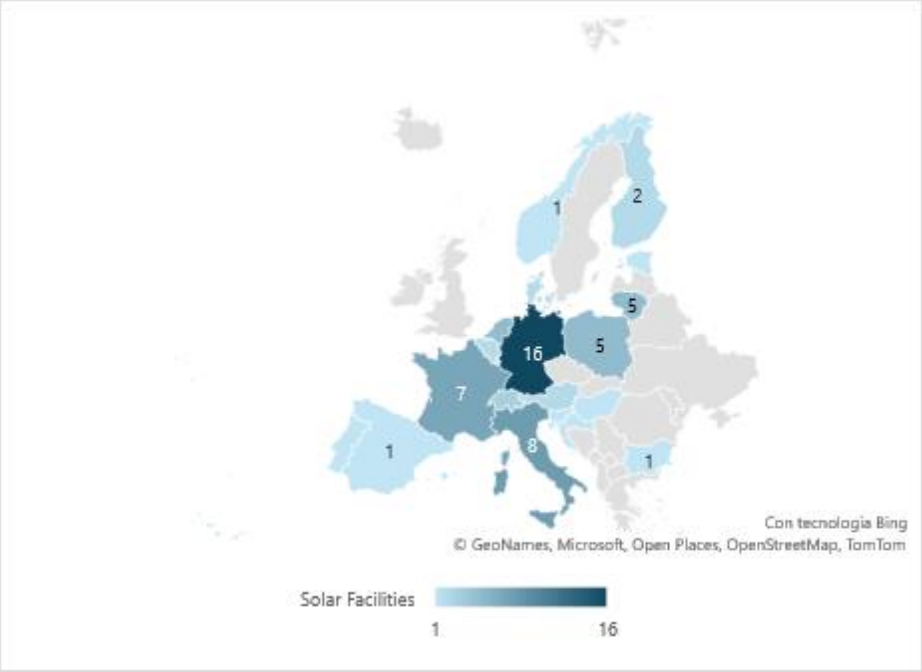
| | *Deployment Annual (GW)* | Annual operational Capacity (GW) | Gap (GW) | Annual net Deployment (kW per capita) | Annual industrial capacity (kW per capita) | Gap (kW per capita) |
|---|---|---|---|---|---|---|
| Austria | 3.04 | 0.42 | -2.63 | 0.34 | 0.05 | -0.29 |
| Belgium | 1.79 | 0.10 | -1.69 | 0.15 | 0.01 | -0.15 |
| Bulgaria | 1.20 | 0.10 | -1.10 | 0.18 | 0.01 | -0.16 |
| Croatia | 0.24 | 0.33 | 0.09 | 0.06 | 0.09 | 0.02 |
| Cyprus | 0.18 | 0.00 | -0.18 | 0.20 | 0.00 | -0.20 |
| Czechia | 0.08 | 0.00 | -0.08 | 0.01 | 0.00 | -0.01 |
| Denmark | 0.46 | 0.16 | -0.30 | 0.08 | 0.03 | -0.05 |
| Estonia | 0.17 | 0.06 | -0.11 | 0.13 | 0.05 | -0.08 |
| Finland | 0.24 | 0.15 | -0.09 | 0.04 | 0.03 | -0.02 |
| France | 3.20 | 2.17 | -1.04 | 0.05 | 0.03 | -0.02 |
| Germany | 14.26 | 7.38 | -6.88 | 0.17 | 0.09 | -0.08 |
| Greece | 1.60 | 0.00 | -1.60 | 0.15 | 0.00 | -0.15 |
| Hungary | 1.60 | 0.10 | -1.50 | 0.17 | 0.01 | -0.15 |
| Ireland | 0.55 | 0.00 | -0.55 | 0.11 | 0.00 | -0.11 |
| Italy | 5.23 | 1.84 | -3.40 | 0.09 | 0.03 | -0.06 |
| Latvia | 0.24 | 0.00 | -0.24 | 0.13 | 0.00 | -0.13 |
| Lithuania | 0.59 | 0.39 | -0.20 | 0.21 | 0.14 | -0.07 |
| Luxembourg | 0.12 | 0.00 | -0.12 | 0.18 | 0.00 | -0.18 |
| Malta | 0.01 | 0.00 | -0.01 | 0.02 | 0.00 | -0.02 |
| Netherlands | 4.30 | 0.34 | -3.96 | 0.24 | 0.02 | -0.23 |
| Poland | 3.64 | 1.42 | -2.22 | 0.10 | 0.04 | -0.06 |
| Portugal | 1.23 | 0.05 | -1.18 | 0.12 | 0.00 | -0.11 |
| Romania | 0.11 | 0.00 | -0.11 | 0.01 | 0.00 | -0.01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Slovakia | 0.08 | 0.00 | -0.08 | 0.02 | 0.00 | -0.02 |
| Slovenia | 0.41 | 0.75 | 0.34 | 0.19 | 0.36 | 0.16 |
| Spain | 5.40 | 0.06 | -5.34 | 0.11 | 0.00 | -0.11 |
| Sweden | 1.10 | 0.00 | -1.10 | 0.11 | 0.00 | -0.11 |
| Norway | 0.29 | 1.00 | 0.71 | 0.05 | 0.18 | 0.13 |
| United Kingdom | 15.64 | 0.00 | -15.64 | 0.02 | 0.00 | -0.02 |
| **Total EU27+Norway+UK** | **51.36** | **16.81** | **-34.55** | **3.42** | **1.16** | **-2.26** |

Note: Gap is calculated as the difference between deployment and per capita manufacturing capacity.
Source: author's calculation based on Bruegel's "European clean tech tracker" data.

In the EU, 62 solar industry facilities are based that produce different types of solar components mainly Cell, Module, Ingot and Wafer. The country with the highest number of solar facilities is Germany with 16 manufacturing plants, followed by Italy with 8, France with 7 and the Netherlands, Poland and Lithuania with 5 solar facilities respectively. As said in the previous section the total manufacturing solar EU annual capacity is 16.81 GW. In Figure 3.11 the concentration of solar facilities in EU countries is presented.

**Figure 3.11 Geographical distribution of Solar facilities among European Countries**



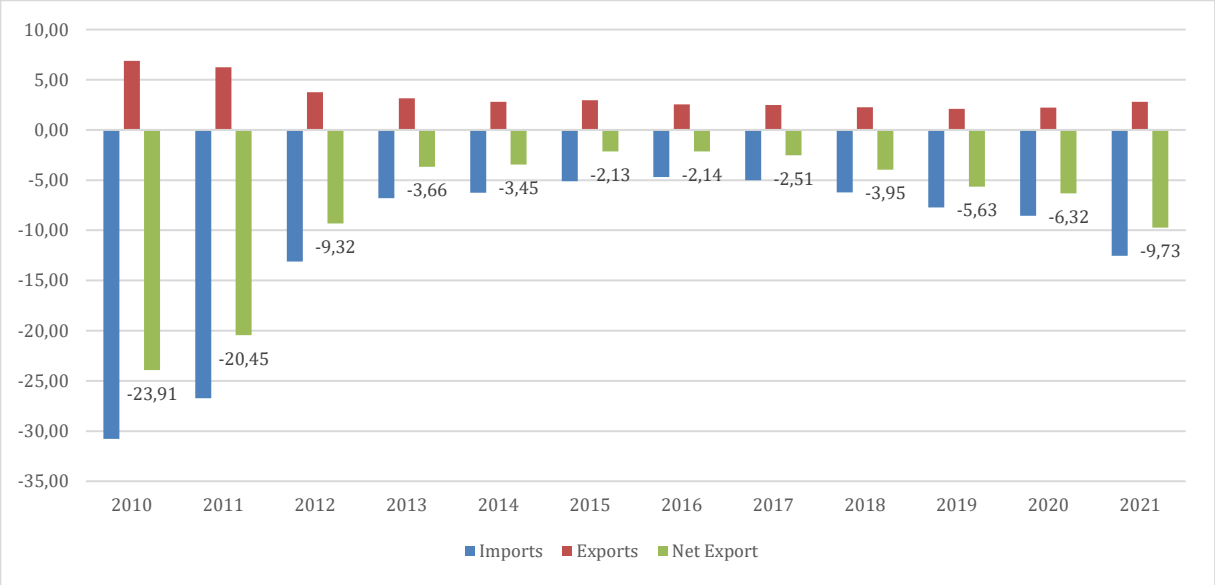

Source: author's calculation based on Bruegel's "European clean tech tracker" data.

The gap between solar operational capacity and solar deployment highlights the strong industrial imbalance in the sector, which might compromise the 'sovereignty' of the European green transition. Solar European demand, which is proxied by solar net deployment in 2023, is not totally satisfied by the domestic solar industry, which is proxied using the annual operational capacity of solar facilities (Bruegel, 2024). This solar gap has been compensated along the years by imports of solar components and solar systems from abroad.

The EU exposure on the international markets has been structural in the last decade and it is still present nowadays even if it experienced a strong reduction from 2010 to present. In 2010, imports of solar components were €30.70 billion against €6.87 billion of solar export resulting in a trade imbalance of €23.91 billion of net import. These imbalances have strongly reduced in the following years to an average yearly level of €6.98 billion of solar imports between 2013 and 2021. This resulted in a strong downsizing of the EU trade imbalance with a net import of €4.39 billion on average in the same period (Figure 3.12).

The trade imbalances of the EU in the international solar market are consistent with the above results on the gap between the domestic operational capacity of the EU solar industry and solar deployment.

**Figure 3.12 Import, Export and Net export of Solar products in the EU from 2010 to 2021 in € Billion**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

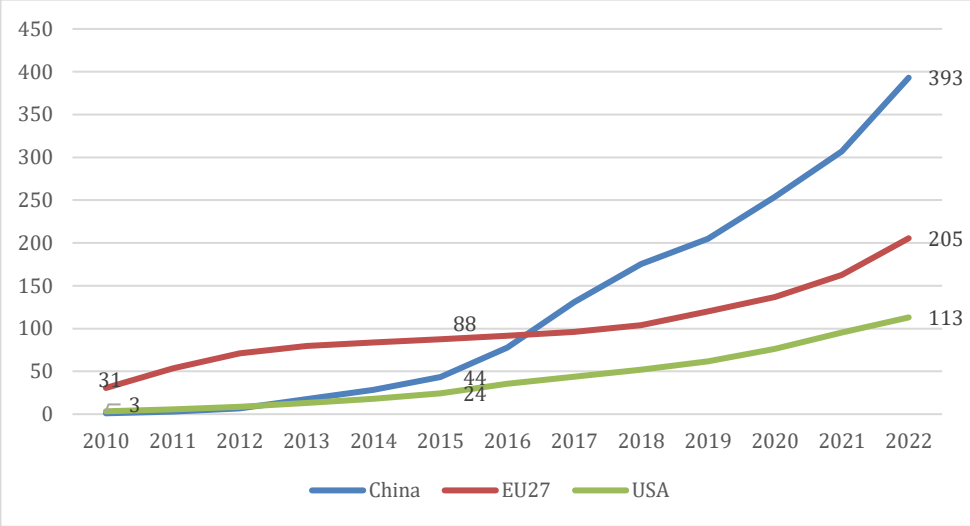
In terms of total solar deployment, the EU has dominated the scene until 2016 when China overcame it with an exponential increase becoming the undisputed leader of the solar sector in the world (Figure 3.13). The EU started in 2010 with a total solar deployment of 31 GW, which had increased at an average growth pace of 40% until 2013. The growth of solar deployment has slowed down from 2014 to an average growth of 5% reaching 92 GW of solar installed capacity in the EU territory in the same year. The growth of solar increased in the following years to an annual average rate around to 10% reaching 205 GW of total solar capacity deployed in 2022.

China during the same period has experienced an incredible level of growth with average rate of 162% per year between 2010 and 2013. This impressive level of solar deployment slowed down to an average growth of 64% between 2014 and 2016 reaching in that year 78 GW of total solar deployed in the country. After 2016 China continued to grow rapidly twice as much as the EU (33% China vs 15% the EU) deploying totally 393 GW of solar power in 2022 and becoming the solar leader in the world (Figure 3.13).

The US for all the last decade stayed behind the EU and China, but recently had increased its level of solar national deployment. In 2010 the total solar capacity installed in the US was 3 GW which had growth to a pace yearly average rate of 45% until 2016 reaching a total solar deployment of 35 GW in the same year. Between 2016 and 2022 the growth rate at which the solar deployment of the US declined to an average annual growth of 21% reaching in 2022 a total solar deployment of 113 GW (Figure 3.13).

The global picture from total solar deployment is clear: China leads the way followed by the EU with the US following behind. This reflects mainly the different policies to sustain the solar sector adopted not just recently but also in the last decade, when China started to decarbonize its economy becoming an 'electrified state' totally switching its energy mix toward electrification and implementing massive solar production (Institut Rousseau, 2024). In this set the EU appears to be a follower with an important level of solar deployment, but the EU experienced a slower solar capacity implementation during the previous decade than China which resulted in a lower level of total solar deployment nowadays. The US lag behind and apparently their solar deployment is far from the level of solar adoption of China and the EU (Figure 3.13).

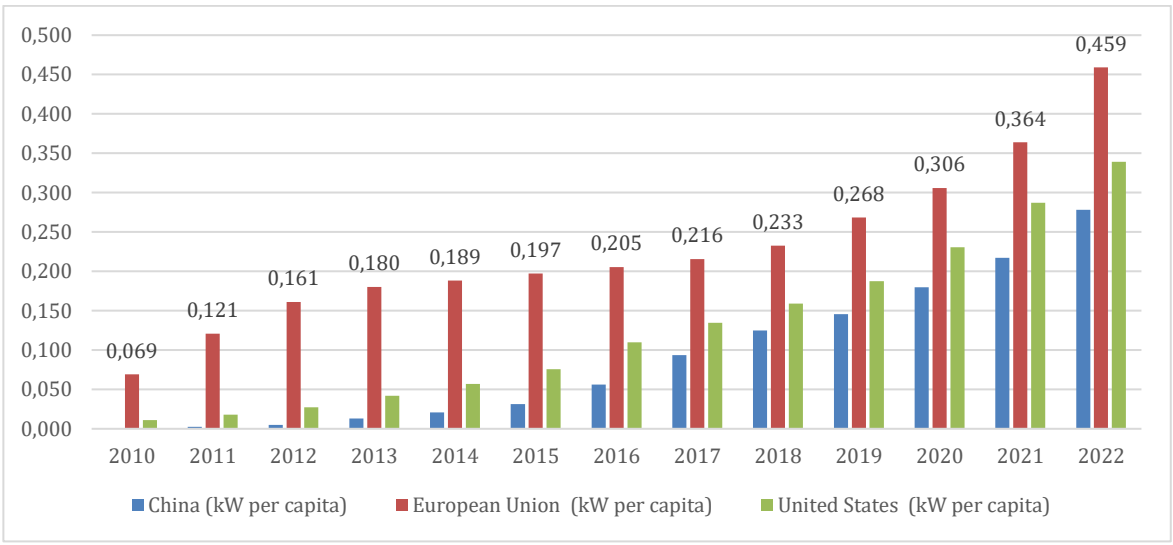
**Figure 3.13 Deployment of Solar Capacity from 2010 to 2022 in China, US and EU27, GW**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

This picture changes for solar deployment per capita. In the period considered (2010-2022), both the US and the EU show higher levels of solar deployment per capita compared to China. In terms of kW per capita, in 2022 solar capacity installed the EU is much higher than the one of China (0.46 kW per capita vs 0.28 kW per capita) and the US (0.32 kW per capita) (Figure 3.14).

**Figure 3.14 Deployment of solar capacity per capita from 2010 to 2022 in China, US and EU27, kW per capita**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

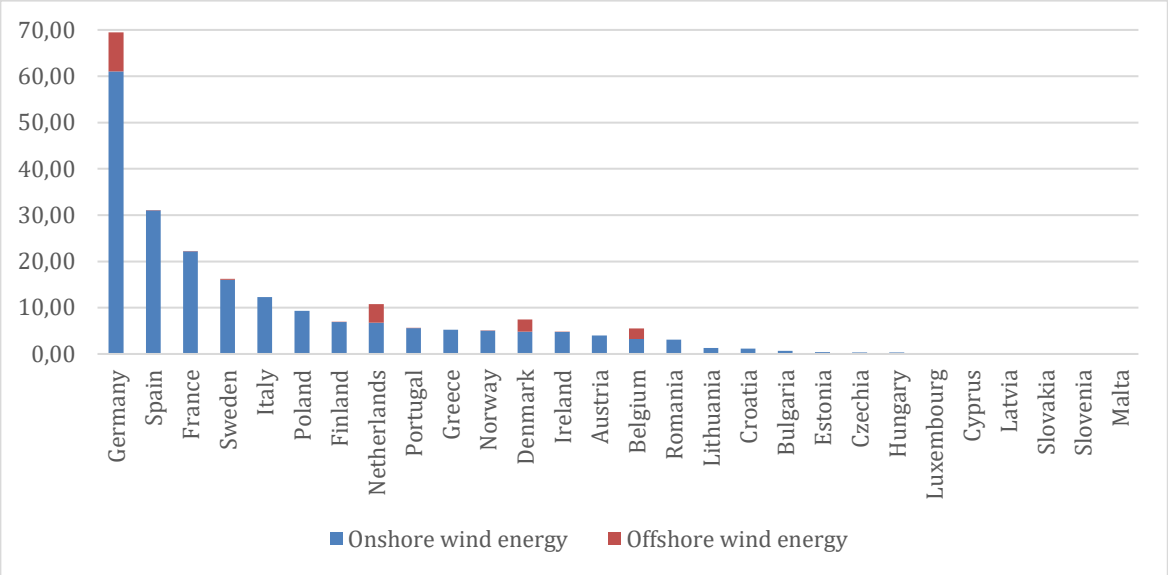
*Wind energy*

Wind energy production is another strategic and crucial sector for the green energy transition of the EU. The EU commission set the target of wind power total deployment to 500 GW in 2030 (both On-shore and Off-shore generation). Following the estimates of the I4CE, this means that the EU's annual average deployment should be 42 GW with €89 billion of average annual investments (I4CE, 2024). Compared to the total investments done in the EU wind industry, which were €15 billion, there is an actual investment gap of €74 billion a year (I4CE, 2024).

In 2023, the total wind capacity deployed in the EU was 253.96 GW. This was composed principally by in-shore wind capacity of 201 GW and 17.62 GW of offshore capacity.

Also in the wind sector Germany is the European leader in terms of total deployment capacity with 69 GW, followed by Spain with 31 GW, France with 22 GW, Sweden with 16 GW, Italy with 12.3, the Netherlands with 10.7 GW and Poland with 9.3 GW. The wind sector in the EU is dominated by onshore installations which represents 92% of the total capacity installed. Offshore wind installations, which are a very promising technology for greening the energy sector, are relevant only in Germany with 8.4 GW, the Netherlands with 4 GW, Denmark and Belgium with 2.65 GW and 2.26 GW respectively (Figure 3.15 and Table 3.2). However, the annual growth of offshore wind power passed from 2.98% in 2022 to 12.89% in 2023 thus marking the increase of that technology in the EU wind sector.

**Figure 3.15 Off-shore and in-shore wind capacity deployed in GW in 2023**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

**Table 3.2 Deployment of Wind electricity capacity in EU countries, China and the US in 2021 to 2023, GW**

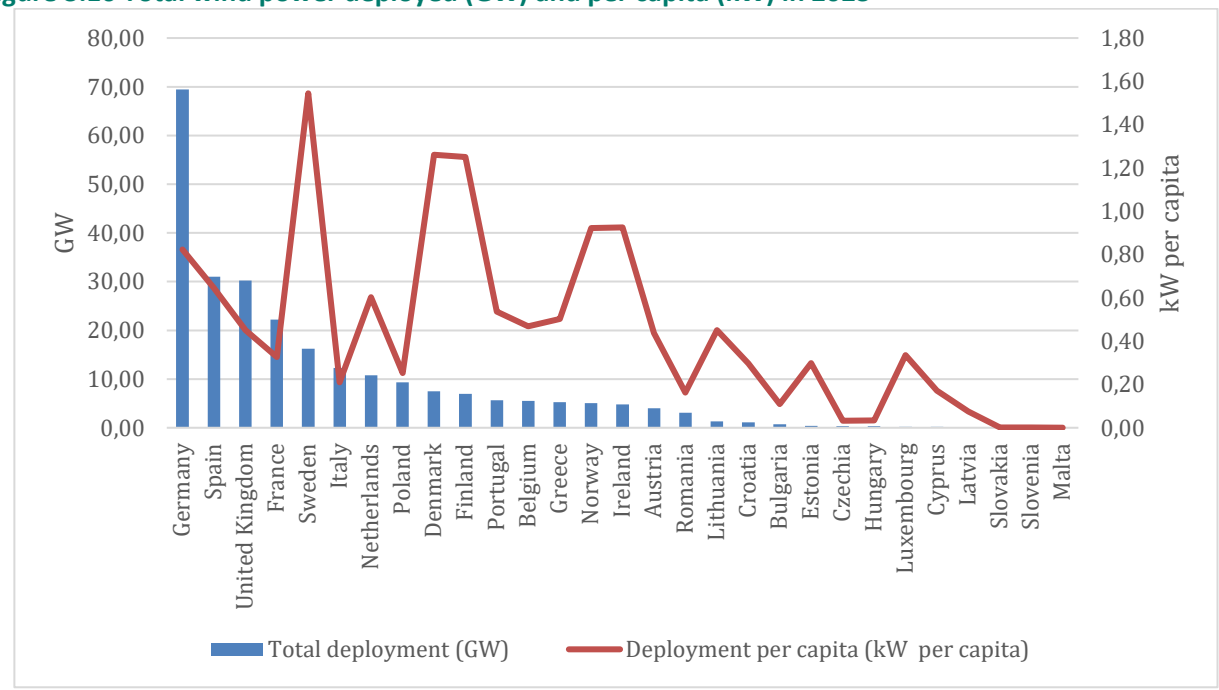
| | Electricity Installed Capacity (GW) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Onshore wind energy | | | Offshore wind energy | | | Total (Onshore + Offshore) wind energy | | |
| | 2021 | 2022 | 2023 | 2021 | 2022 | 2023 | 2021 | 2022 | 2023 |
| Austria | 3.41 | 3.58 | 3.98 | 0.00 | 0.00 | 0.00 | 3.41 | 3.58 | 3.98 |
| Belgium | 2.69 | 3.04 | 3.24 | 2.26 | 2.26 | 2.26 | 4.95 | 5.30 | 5.50 |
| Bulgaria | 0.70 | 0.70 | 0.70 | 0.00 | 0.00 | 0.00 | 0.70 | 0.70 | 0.70 |
| Croatia | 0.99 | 0.99 | 1.14 | 0.00 | 0.00 | 0.00 | 0.99 | 0.99 | 1.14 |
| Cyprus | 0.16 | 0.16 | 0.16 | 0.00 | 0.00 | 0.00 | 0.16 | 0.16 | 0.16 |
| Czechia | 0.34 | 0.34 | 0.34 | 0.00 | 0.00 | 0.00 | 0.34 | 0.34 | 0.34 |
| Denmark | 4.70 | 4.78 | 4.83 | 2.31 | 2.31 | 2.65 | 7.00 | 7.08 | 7.48 |
| Estonia | 0.32 | 0.32 | 0.41 | 0.00 | 0.00 | 0.00 | 0.32 | 0.32 | 0.41 |
| Finland | 3.18 | 5.60 | 6.88 | 0.07 | 0.07 | 0.07 | 3.26 | 5.68 | 6.96 |
| France | 18.55 | 20.81 | 22.19 | 0.00 | 0.00 | 0.00 | 18.55 | 20.81 | 22.20 |
| Germany | 55.90 | 58.01 | 61.05 | 7.81 | 8.15 | 8.41 | 63.71 | 66.16 | 69.46 |
| Greece | 4.65 | 4.70 | 5.22 | 0.00 | 0.00 | 0.00 | 4.65 | 4.70 | 5.22 |
| Hungary | 0.32 | 0.32 | 0.32 | 0.00 | 0.00 | 0.00 | 0.32 | 0.32 | 0.32 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Ireland | 4.31 | 4.51 | 4.78 | 0.03 | 0.03 | 0.03 | 4.34 | 4.54 | 4.81 |
| Italy | 11.25 | 11.82 | 12.31 | 0.00 | 0.00 | 0.00 | 11.25 | 11.82 | 12.31 |
| Latvia | 0.08 | 0.08 | 0.14 | 0.00 | 0.00 | 0.00 | 0.08 | 0.08 | 0.14 |
| Lithuania | 0.67 | 0.95 | 1.29 | 0.00 | 0.00 | 0.00 | 0.67 | 0.95 | 1.29 |
| Luxembourg | 0.14 | 0.17 | 0.22 | 0.00 | 0.00 | 0.00 | 0.14 | 0.17 | 0.22 |
| Malta | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Netherlands | 5.21 | 6.19 | 6.77 | 2.46 | 2.57 | 3.98 | 7.67 | 8.75 | 10.75 |
| Poland | 6.97 | 8.15 | 9.31 | 0.00 | 0.00 | 0.00 | 6.97 | 8.15 | 9.31 |
| Portugal | 5.40 | 5.51 | 5.59 | 0.02 | 0.02 | 0.02 | 5.43 | 5.54 | 5.62 |
| Romania | 3.01 | 3.02 | 3.09 | 0.00 | 0.00 | 0.00 | 3.01 | 3.02 | 3.09 |
| Slovakia | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Slovenia | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Spain | 27.90 | 30.11 | 31.02 | 0.01 | 0.01 | 0.01 | 27.91 | 30.11 | 31.03 |
| Sweden | 11.92 | 14.09 | 16.06 | 0.19 | 0.19 | 0.19 | 12.12 | 14.28 | 16.25 |
| Norway | 5.05 | 5.06 | 5.06 | 0.00 | 0.00 | 0.00 | 5.05 | 5.06 | 5.07 |
| United Kingdom | 14.49 | 14.83 | 15.47 | 11.26 | 13.93 | 14.75 | 25.75 | 28.76 | 30.22 |
| **China** | 302.58 | 335.50 | 404.60 | 26.39 | 30.46 | 37.29 | 328.97 | 365.96 | 441.89 |
| **United States** | 132.98 | 141.63 | 147.98 | 0.04 | 0.04 | 0.04 | 133.02 | 141.67 | 148.02 |
| **EU27** | 172.79 | 187.94 | 201.06 | 15.16 | 15.61 | 17.62 | 187.95 | 203.55 | 218.68 |
| **EU27+Norway+UK** | 192.33 | 207.84 | 221.60 | 26.41 | 29.54 | 32.37 | 218.74 | 237.38 | 253.96 |

Source: author's calculation based on Bruegel's “European clean tech tracker” data.

Per capita deployment provides a different picture among EU countries with a higher level of deployment in Northern countries such as Sweden (1.5 kW per capita), Denmark (1.26 kW per capita ) and Finland (1.25 kW per capita). Scandinavian leaders are followed by Ireland with 0.93 kW per capita, Norway with 0.92 kW per capita, Germany with 0.82 kW per capita (Figure 3.16).

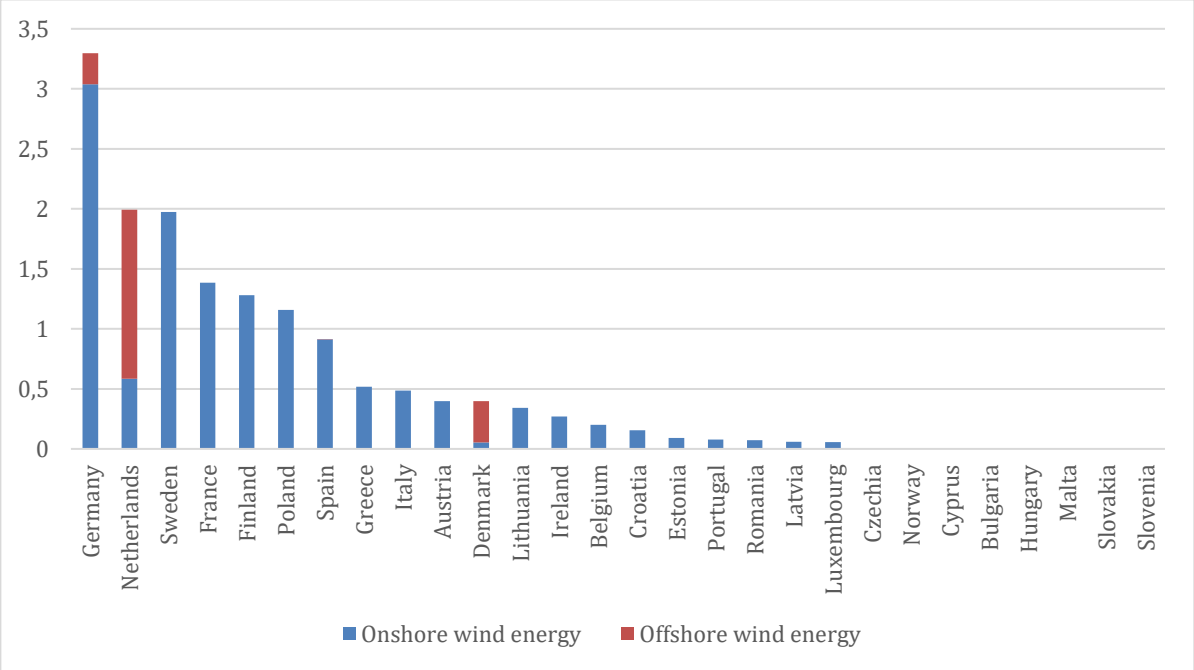
**Figure 3.16 Total wind power deployed (GW) and per capita (kW) in 2023**




Source: author's calculation based on Bruegel's “European clean tech tracker” data.

The annual net deployment in the EU27 in 2023 has been 15.13 GW, made of 13.12 GW of onshore and 2.01 GW offshore, which increased its contribution in the annual wind deployment compared to 2022. Germany had the highest level of annual wind deployment in 2023 with 3.3 GW of new wind installations principally from onshore technology. The Netherlands are the second country in 2023 for wind power implementation made principally by offshore wind technology, with 1.4 GW of offshore wind power installed against 0.58 GW of onshore wind power deployed in the same year (totally 2GW) (Figure 3.17).

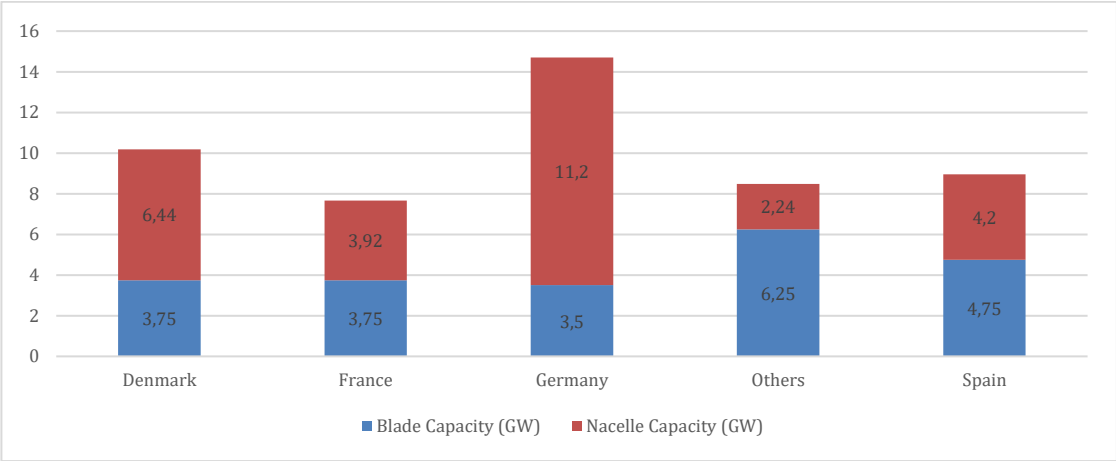
**Figure 3.17 In-shore and Off-shore net wind power capacity deployed among EU countries in 2023**




Source: author's calculation based on Bruegel's “European clean tech tracker” data.

The EU is leader in wind technology manufacturing with five of the most important companies of the sector: Vestas, Siemens Energy, Enercon, Nordex SE and GE Renewable Energy (Bruegel, 2024). At the end of 2022, the EU wind manufacturing annual capacity was 61.4 GW for turbines, 53.1 GW for blades and 58.8 GW for nacelle. The total manufacturing capacity of the EU wind sector is 173.34 GW, resulting in a surplus of wind manufacturing capacity of 154.71 GW. In per capita terms the surplus of wind power manufacturing capacity is 0.30 kW per capita. Manufacturing wind facilities are spread across all countries in the EU but they are especially concentrated in Denmark, France, Germany and Spain where the 63% of blades and 92% of nacelles are manufactured. Germany has the highest level of manufacturing wind capacity with 14.7 GW totally, made principally by nacelle technology (11.2 GW), followed by Denmark with 10 GW totally, made by 6.4 GW of nacelle and 3.7 GW of blades, then Spain with a total wind manufacturing capacity of 8.5 GW and France with 7.7 GW (Figure 3.18).

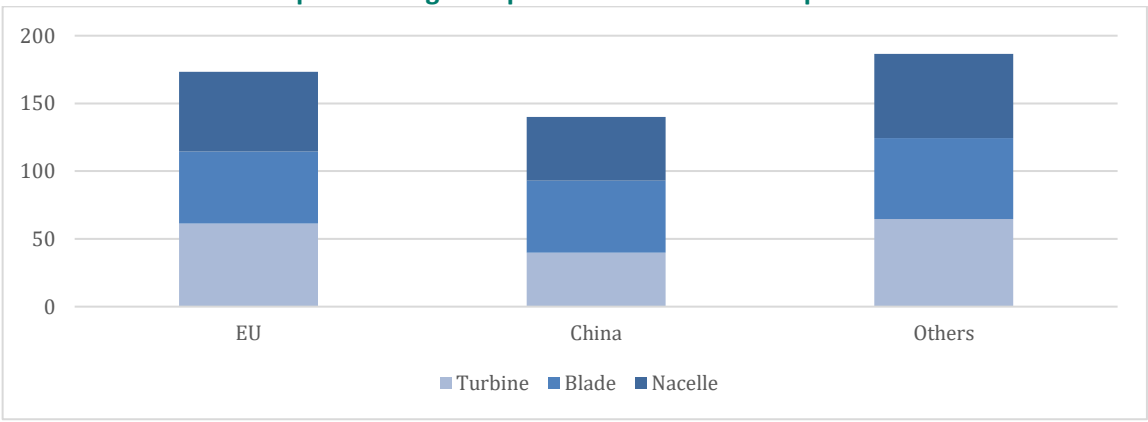
**Figure 3.18 Manufacturing wind capacity for blade and nacelle in GW in main country**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

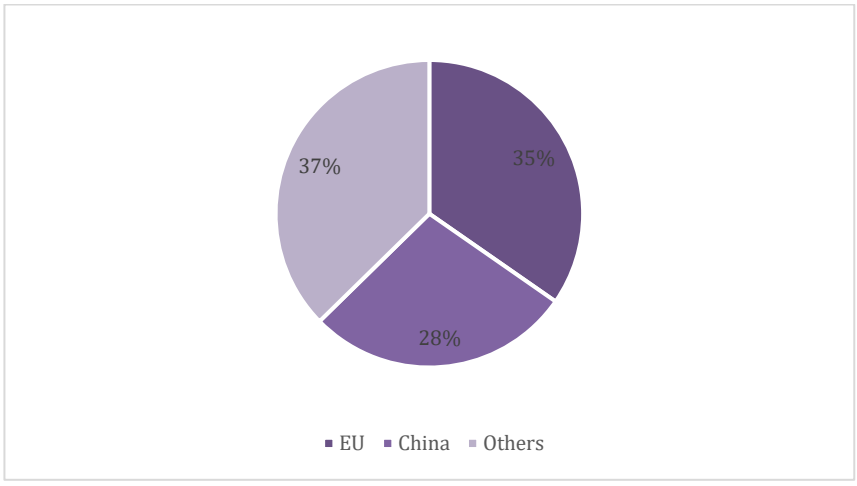
China emerged as a global competitor in the wind sector becoming the second producer in the wind manufacturing sector at global level with a total capacity of 140 GW, a global share of 28% compared to Europe a share of 35% (Figure 3.19 and 3.20).

**Figure 3.19 International comparison of global production of Wind components in GW**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

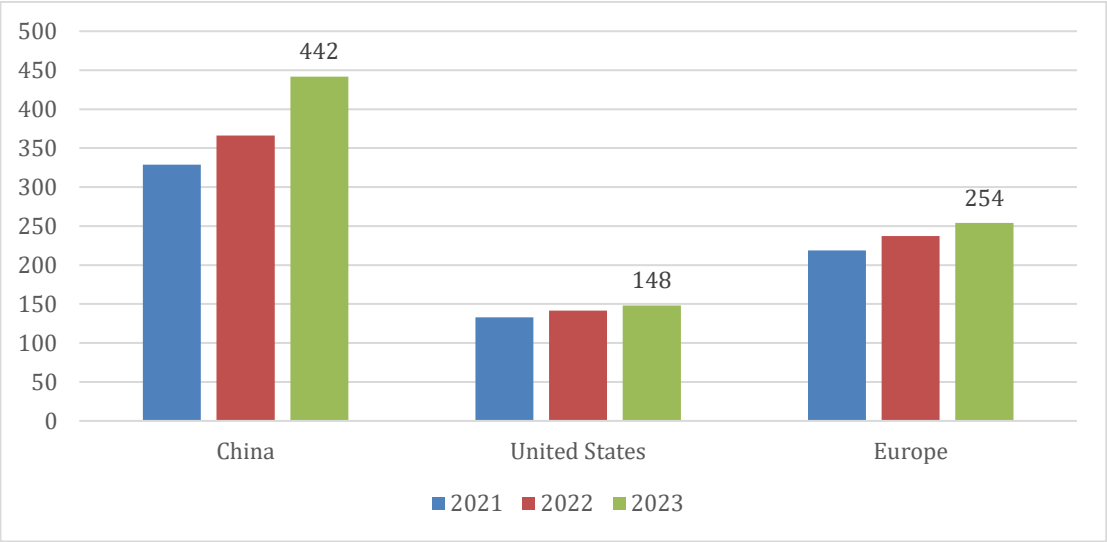
**Figure 3.20 Share of global wind components production**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

In terms of total wind capacity deployment China is the global leader with a total installed capacity of 442 GW in 2023, which is more than the total capacity installed of Europe and the US, amounting respectively to 254 GW and 148 GW in the same year (Figure 3.21).

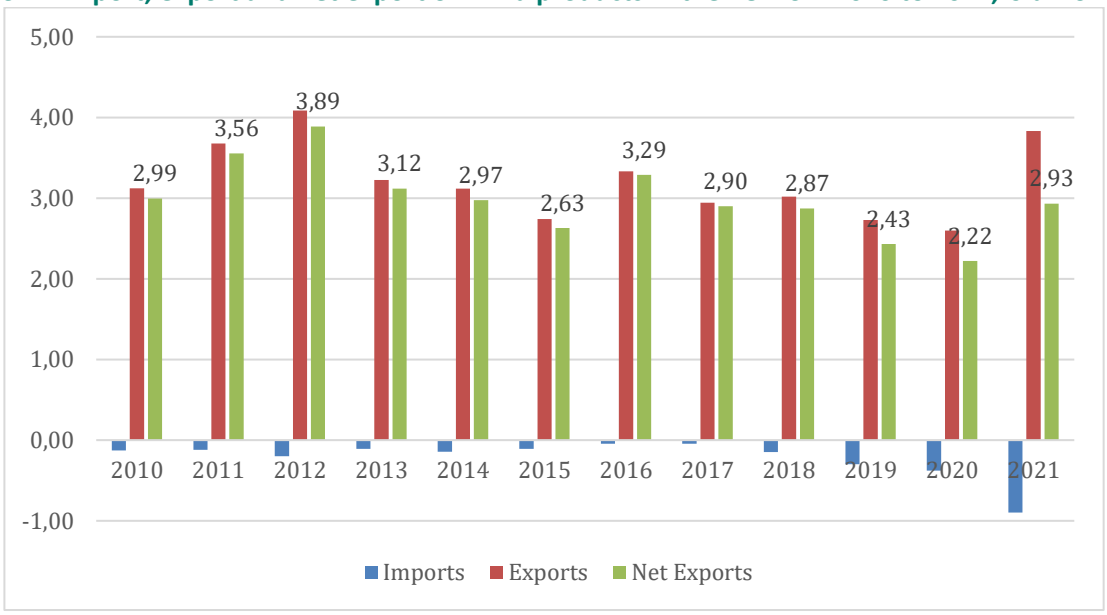
**Figure 3.21 Wind deployment (off-shore + on-shore) in Cian, US and Europe, GW**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

Thanks to its manufacturing capacity, Europe has always been a net exporter of wind technology in the international markets. The volume of exports remained stable in the last decade from €3.12 billion in 2010 to €3.83 billion in 2021 with an average next export of €2.98 billion per year in that time frame (Figure 3.22).

**Figure 3.22 Import, export and net export of Wind products in the EU from 2010 to 2021, € billion**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

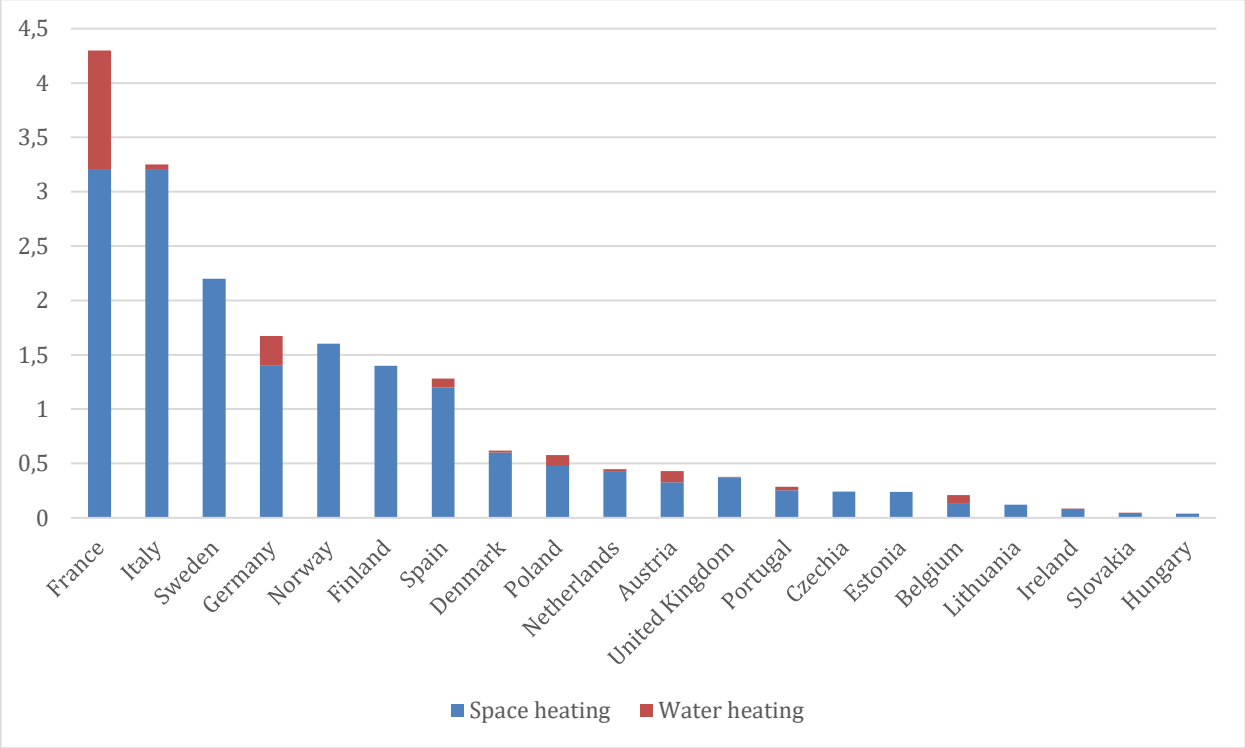
*Heat Pumps*

In Europe, heat pumps for a capacity of 174 GW are installed, and the deployment in 2022 has been 28.2 GW. Heat pumps can have a strategic role in the decarbonization of the energy sector since they are an efficient technology for heating and cooling systems both for buildings and for industries. This technology is

powered by electricity and therefore can contribute in greening the energy mix used for heating, which is still mainly based on highly emitting sources (gas, coal and oil).

In terms of deployment of heat pumps, there are 19.42 million units installed in Europe, of which 17.5 million are for space heating and 1.87 million for water heating. The leader in Europe for heating deployment is France with 4.3 million of total units installed, followed by Italy with 3.2 million of units, Sweden with 2.2 million of units installed, Germany with 1.7 million and Norway with 1.6 million units of heat pumps installed (Figure 3.23).

**Figure 3.23 Deployment Heat Pumps by type among EU countries in million units**




Source: author's calculation based on Bruegel's “European clean tech tracker” data.

In Europe, 172 heat pumps manufacturing facilities are operating. The major producer is Italy, with 27 facilities followed by Germany with 24, France with 17, Poland with 14 and Spain with 10 facilities (Figure 3.24).

**Figure 3.24 Geographical distribution of heat pumps manufacturing facilities**


Source: author's calculation based on Bruegel's "European clean tech tracker" data.

### *3.2.2 Transports*

The transport sector is the second largest source of GHG emissions in the EU, and its decarbonization is of key importance to the EU's green transition. However, it is the only major sector that experienced a increasing level of emissions from 1990, +16% up to 782 MtCO2-eq in 2021. At the current level of emissions, achieving the EU targets is extremely difficult: to meet the 2050 target the average yearly reduction in GHG emissions of the sector should increase tenfold (Institut Rousseau, 2024). EU strategies for decarbonizing the sector are broader, as the sector includes aviation, maritime transport, road freight, and civil road transport. This latter is a fundamental area of intervention since it makes up alone the 90% of the emission of the intra-European transport (Institut Rousseau, 2024). Decarbonizing private vehicle fleets is crucial to achieve the European Union's 2050 Net Zero carbon target since they account for the 76% of total European vehicles (248 million private cars on total 325 million of vehicles).

One of the main policies put in place by the European Commission has been the ban of internal combustion vehicle for new vehicles by the end of 2035. This policy is also being prepared also for commercial vehicles and trucks with a deadline set at 2037 (see section 2). A crucial aspect for the conversion of the private cars sector is achieving the price parity between low emission and conventional cars, because the accessibility to low emission cars for the vast majority of EU citizens is limited. The cost of batteries and the improvement in their efficiency are critical for the development of the low emissions car sector. Batteries manufacturing and the future development of their supply chains has to face the issue of critical raw materials for which the EU has a high import dependence.

The Institut Rousseau (2024) assessed the public investments needed for the EU mobility transition in being €18.2 billion per year. The I4CE have estimated the investment gap to sustain the actual deployment of the public private transport in being €5.5 billion of additional investments need to boost the mobility transition (I4CE, 2024).

*Batteries and EVs deployment in the EU*

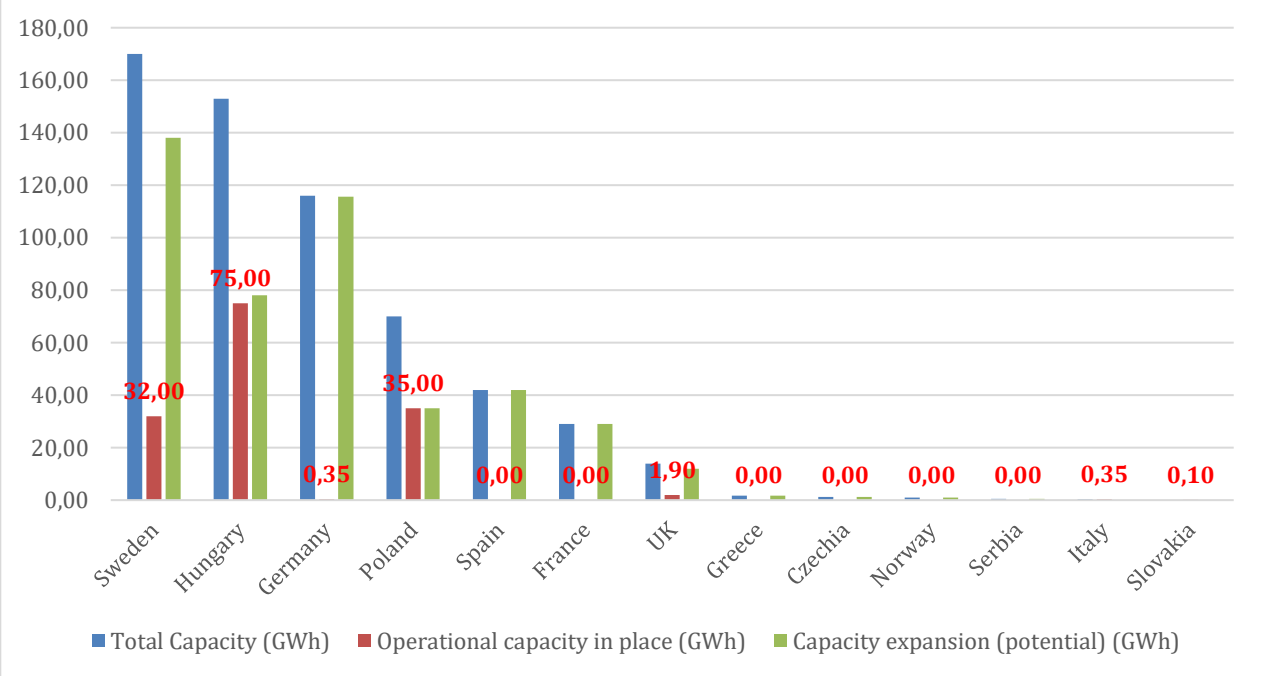
The European supply chain for Electric Vehicles (EV) relies on the expertise of EU automotive industry which has dominated the global market for years. Even though many components of EV are the same as for conventional ones, for many new components the manufacture is different and especially for batteries, which represent almost on third of EV's value (Bruegel, 2024).

Batteries manufacturing and the reliance on a functional and efficient (and accessible) supply chain is fundamental for the future development of electric mobility in the EU. At the same time, the risk of strong dependence from non-EU countries for the imports of critical materials used for batteries is high.

The EU's current (2023) deployment of batteries have been so far partially–satisfied by domestic manufacturing capacity: the EU cell manufacturing capacity is 144.7 GWh with a demand (from EV and energy storage systems) of 210 GWh. However, the demand for inputs, batteries components and raw materials (e.g., lithium, nickel, cobalt and other active materials) is covered mainly by imports.

Considering both the operational capacity already in place and the capacity expansion due to declared and undergoing investments in the sector, total EU capacity can achieve 598.65 GWh. The operational capacity already in place is 144.7 GWh mainly concentrated in Hungary (75 GWh), Poland (35 GWh) and Sweden (32GWh). Those three countries account for 98% of the total manufacturing capacity of Europe (Figure 3.25). The battery manufacturing capacity is growing with a potential capacity of 454 GWh already under construction or planned to be put in place soon (Figure 3.25). The major European players are: Germany with planned 155.65 GWh of new operational capacity, France 29 GWh and Spain 42 GWh. This operational capacity will be added to the capacity expansion planned by Sweden (138 GWh), Hungary (78GWh) and Poland (35 GWh), the latter being the leading European countries in this sector with accumulated capital, technology and human capital in this sector (Figure 3.25).

**Figure 3.25 Total operational capacity in 2023, planned capacity expansion and total capacity of batteries production in EU countries, GWh equivalent**

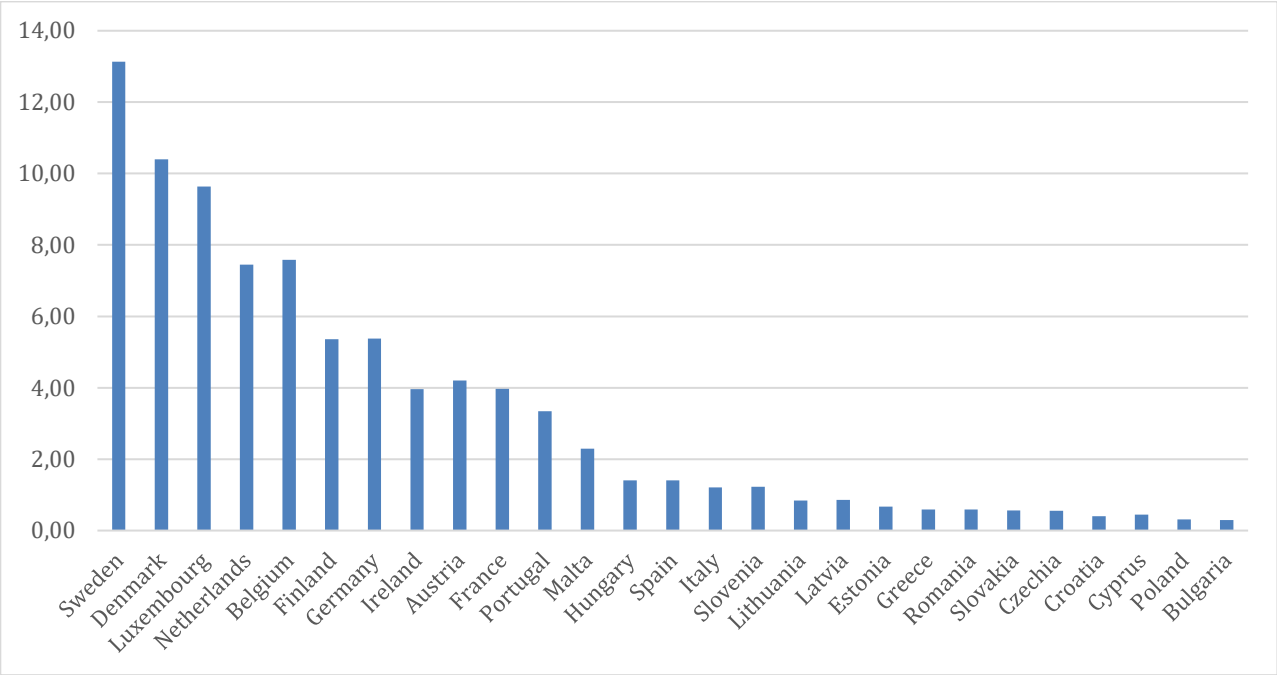



Note: Total capacity is calculated as the sum of the actual batteries production capacity and the planned capacity expansion.
Source: author's calculation based on Bruegel's "European clean tech tracker" data.

In Europe, the uptake of EV has increased steadily over the past decade. From 2010 to 2023, the total stock of EVs has increased at an average annual growth rate of 81%, a figure also explined by the exetremely low

initial level. The EV diffusion shows significant heterogeneity across EU Member States, highlighting that economic accessibility is a major barrier to diffusion (Bruegel 2024). High-income European countries show a much higher share of EV deployment as a percentage of the total vehicle fleet than low- and middle-income countries, with differences in some cases of tenfold. Sweden is the EU country with the highest share of EV in the total fleet, with 13.1 percent in 2024, followed by Denmark with 10.4 percent, Luxembourg with 9.6 percent, the Netherlands and Belgium with 7.58 percent and 7.45 percent respectively. Halfway up are Germany and Finland (both with 5.4 percent), Ireland and Austria (4.2 percent), and France (3.97 percent). Southern and Eastern EU countries show a considerably low share of deployment: Hungary and Spain both with 1.4 percent, Slovenia and Italy both with 1.2 percent. The other EU countries show shares EV in the total fleet of less than 1 percent (Poland, Greece, Slovakia and the Czechia, among others). It is worth noting the good level of Portugal and Malta compared to their neighbours, with EVs deployment shares of 3.6 percent and 2.4 percent, respectively (Figure 3.26).

**Figure 3.26 Stock of Electric Vehicles (EV) in EU countries as a percentage of total vehicles in 2023**

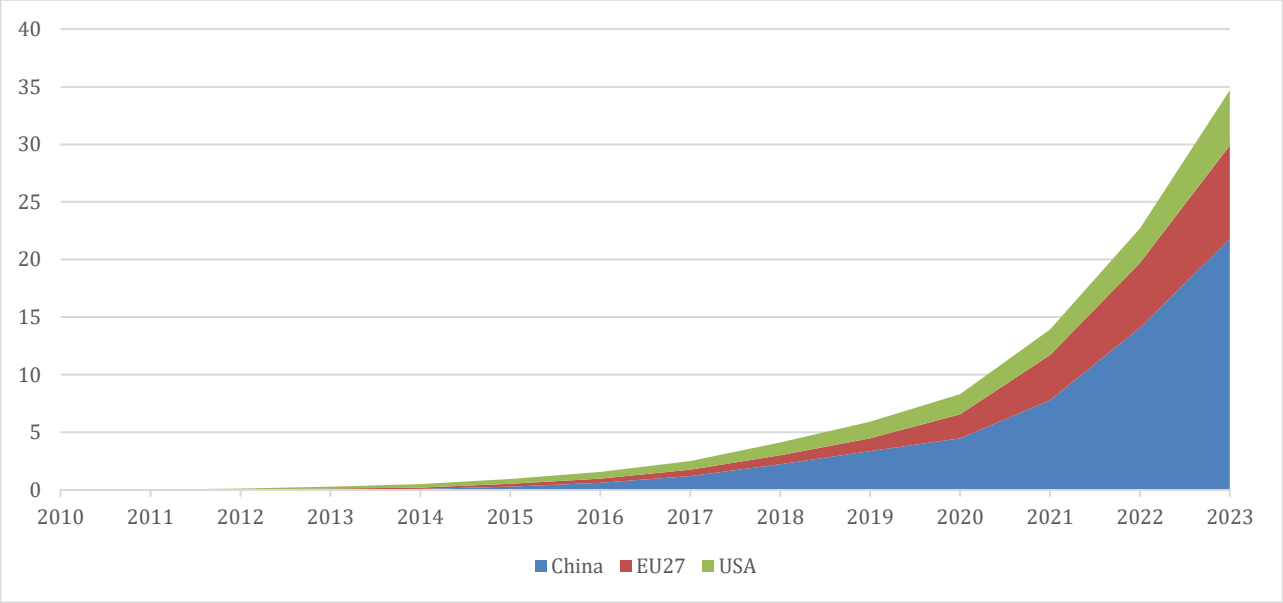



Source: author's calculation based on Bruegel's “European clean tech tracker” data.

*International comparison and trade imbalances for EVs and batteries*

In terms of EV deployment, Europe has a total stock of 8.1 million EVs and a 23.3 % share of global EV deployment, which is almost double the amount of EV registered in the United States, with a total stock of 4.8 million EV, accounting for a 13.8 % share of global deployment in 2023. The U.S. and the EU’s EV stocks are far behind the total EV deployment of China’s, which, with 21.8 million EV, is the world leader in EV deployment with a total EV share of 62.8 % of total global EV deployment (Figure 3.27).

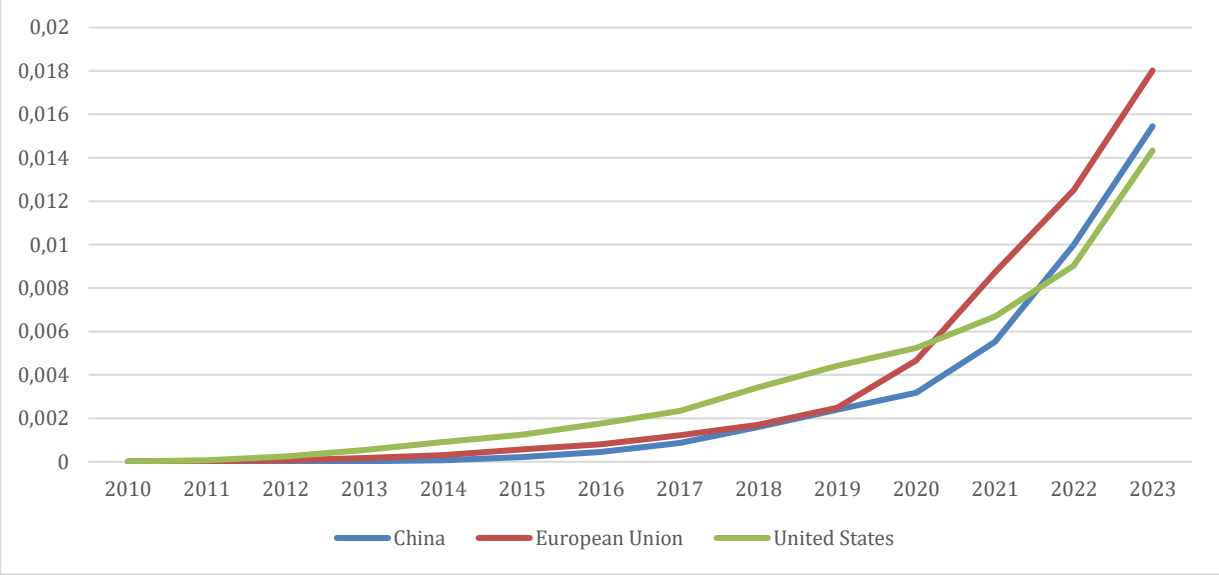
**Figure 3.27 EV stock in million of cars in China, US and the EU from 2010 to 2023**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

However, when looking at the total stock of EV per capita, this large divergence between China, the EU and the United States is not as pronounced: all these areas show a similar level of deployment per capita. In 2023, 0.018 EVs per capita were adopted in the EU, 0.015 in China, and 0.014 in the U.S., indicating that at the individual level the diffusion path between these large macro-areas is very similar (Figure 3.28).

**Figure 3.28 Deployment of EVs per capita in China, the EU and the US from 2010 to 2023**




Source: author's calculation based on Bruegel's "European clean tech tracker" data.

Despite 11 billion battery components exported abroad in 2021, the EU is a net importer in the battery market. From 2010 to 2021, battery imports were lower than total EU exports, resulting in negative net export. Instead, the imbalance between battery imports and exports in 2010 was €1.42 billion, growing to €2.43 billion in 2015 and up to €7.46 billion in 2021. This figure highlights the main fragility of European EV production, also depending on critical inputs for the battery and energy storage supply chain (Figure 3.29).

**Figure 3.29 Import, Export and Net export of batteries in the EU, 2010 – 2021, € billion**

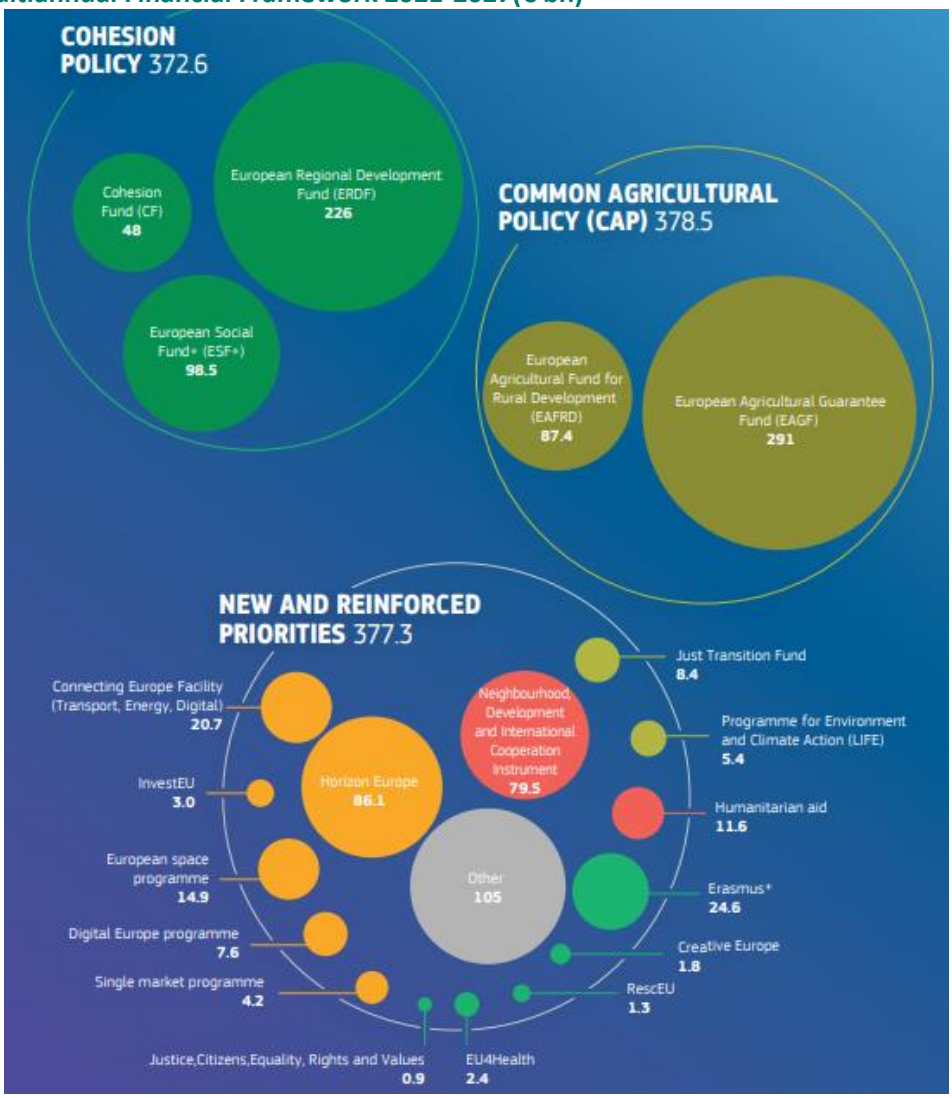

Source: author's calculation based on Bruegel's "European clean tech tracker" data.

# 4. Financial resource for the transition: EU funding, the private sector and the cost of capital

## 4.1 EU funding: MFF, NGEU and other instruments

European heads of state and government agreed in December 2020 on the largest ever EU budget of €2.018 trillion (in current prices, as of November 2020), consisting of the new seven-year Multiannual Financial Framework (MFF) of €1.211 trillion and the additional Next Generation EU programme (NGEU, 2021-2026) of €806.9 billion, which is aimed at supporting the recovery from the COVID-19 pandemic and the EU's long-term priorities across different policy areas. Figures 4.1 and 4.2 show the funding allocations of the MMF 2021-2027 and NGEU for their different programmes. Overall, the MFF 2021-2027 and NGEU cover seven main spending areas, namely: single market, innovation and digital: (€161 billion); cohesion, resilience and values (€1,203.2 billion); natural resources and environment (€419.9 billion); migration and border management (€25.7 billion); security and defence (€14.9 billion); neighbourhood and the world (€110.6 billion); European public administration (€82 billion; EC, 2021k).

**Figure 4.1 Multiannual Financial Framework 2021-2027(€ bn)**



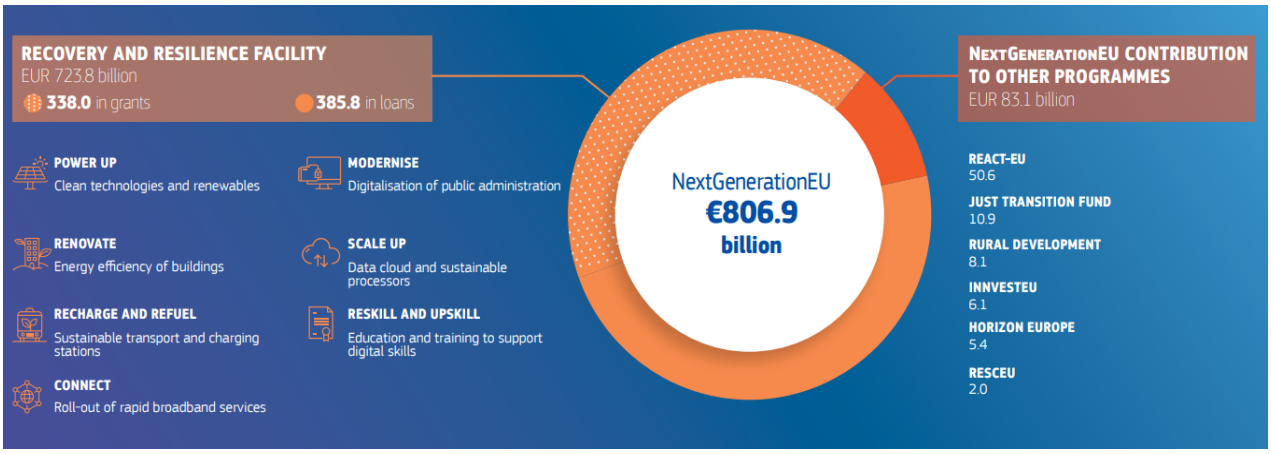

Note: funded under the MFF 2021-2027 only. Some policies (such as cohesion, and programmes such as the EAFRD, the Just Transition Fund, InvestEU, RescEU and Horizon Europe) receive top-up allocations under NGEU. The precise

additional allocations will be established annually. All amounts are in € billion in current prices, as of November 2020, when not otherwise specified.
Source: EC, 2021k

The whole NGEU recovery instrument and parts of the MFF must respect the 'Do no significant harm' principle (DNSH) enshrined in the EU Taxonomy Regulation (EU, 2020; Agora Energiewende, 2021).

Moreover, the EU has increased its ambition for climate-related financing to 30% of the overall EU budget including NGEU. Moreover, under the Recovery and Resilience Facility (RRF), which is the centrepiece of NGEU, at least 37% of financing will go towards investments and reforms tackling climate change and at least 20% towards furthering the digital transition. The RRF has a budget of €723.8 billion in current prices (€338 billion to be provided in form of grants and €385.8 billion to be used to fund loans from the EU to individual Member States on favourable conditions).[16] It is used to implement national recovery and resilience plans (RRPs) without requiring national co-financing. Many of the RRPs, adopted by the end of 2021, exceed these minimum requirements, showing the shared commitment to the twin climate and digital transitions across the EU.

### Figure 4.2 Next Generation EU (€ bn)




Note: all amounts are in € billion in current prices, as of November 2020, when not otherwise specified.
Source: EC, 2021k

*Recovery and Resilience Plans*

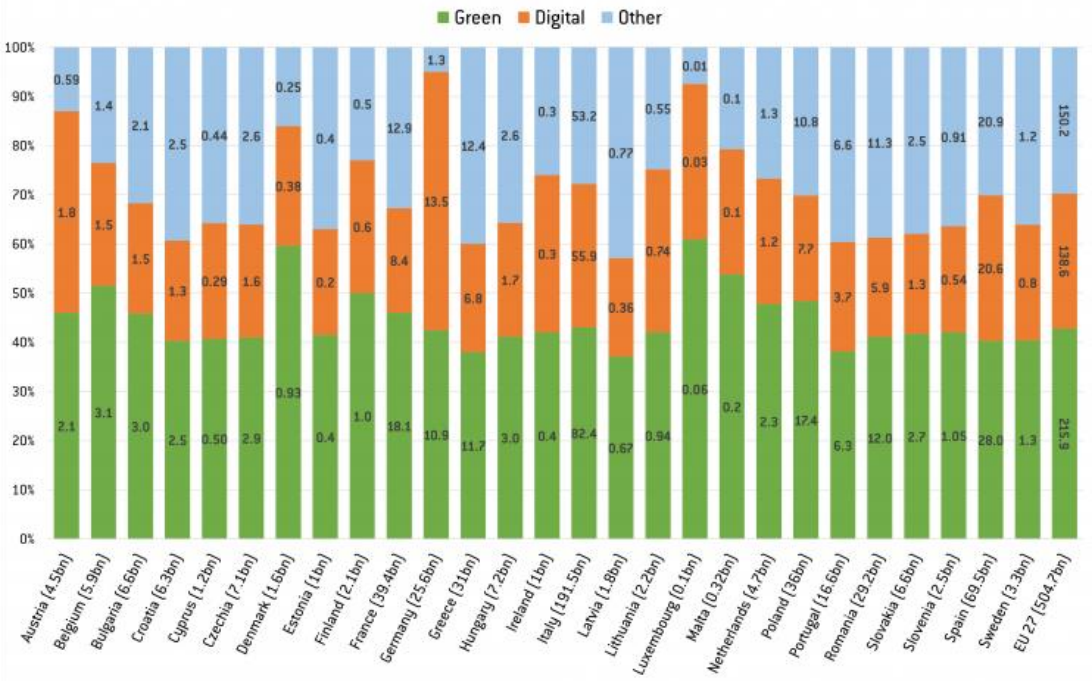
Overall, Member States have committed about 40% of financing to tackling climate change and about 26% to furthering the digital transition (EC, 2022m). Figure 4.3 compares the green and digital components of the RRPs. It emerges that countries that receive relatively smaller amounts from the RRF as a share of their GDP presented plans that concentrate on green and digital spending (Germany, Luxembourg and Denmark), while plans of the countries that receive larger amounts are more diverse with higher 'other' (non-green and non-digital) shares of spending (Darvas et al., 2023).

More detailed comparison between national resource allocation in RRPs is challenging, because they present data in very different structures. The number and definition of headline categories and the

[16] The EU has already reduced the total amount available from €723 billion to €648 billion after governments failed to apply for almost €100 billion in loans before an interim end-2023 deadline (Politico, €500B remains unspent from EU' Covid recovery fund, 8 April 2024, https://www.politico.eu/article/capitals-call-on-the-eu-to-speed-up-post-pandemic-cash-transfers/)

availability of summary information about sub-categories varies from country to country. Based on Darvas et al. (2023), Tables 4.1 and 4.2 compare national allocations in two different ways.

**Figure 4.3 Overall resource allocation in national recovery and resilience plans (% of total and € bn)**




Note: the numbers in brackets after the country names indicate the total € amount of the plan to be financed by the RRF, while the numbers over the bars show the € value of the components (in bn). For Italy, both RRF grants and loans are included. The Figure reports the headline green and digital numbers, as the level of detail in most national plans does not allow us to properly account for the overlaps between green and digital spending.
Source: Darvas et al., 2023 (updated to February 2023)

Table 4.1 shows the composition of RRPs according to the seven flagship areas identified by the EC (power up, i.e. clean technologies and renewables; renovate, i.e. energy efficiency of buildings; recharge and refuel, i.e. sustainable transport and charging stations; connect, i.e. roll-out of rapid broadband services; modernize, i.e. digitalisation of public administration; scale-up, i.e. data cloud capacities and sustainable processors; reskill and upskill, i.e. education and training to support digital skills).

At the EU level, the most important flagship area is 'recharge and refuel' (with 18% of the total spending), but uncategorized allocations amount to 22% of the total. At the national level, there is a high variability in the composition of RRPs, with some countries that have mainly channelled the available financial resources on a few priorities (e.g. in Denmark 43% of the national spending concerns 'other green' and in Poland 38% is invested in 'power up'), while a more balanced situation can be observed in others (e.g. France).

**Table 4.1 Composition of recovery plans according to the flagship areas identified by the EC (€ bn)**

| | *1 Power up* | *2 Renovate* | *3 Recharge and refuel* | *4 Connect* | *5 Modernise* | *6. Scale-up* | *7 Reskill upskill* | *8 Other green* | *9 Other digital* | *Not categorised* | *Country Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **AT** | 0.74 | 0.29 | 0.85 | 0.89 | 0.19 | 0.13 | 0.48 | 0.35 | 0.21 | 0.37 | 4.50 |
| **BE** | 0.61 | 1.07 | 0.88 | 0.09 | 0.58 | | 0.88 | 1.09 | 0.09 | 0.62 | 5.93 |
| **BG** | 1.46 | 0.93 | 0.48 | | 1.21 | | 0.95 | 0.37 | | 1.21 | 6.61 |
| **HR** | 0.52 | 0.76 | 0.41 | 0.11 | 0.45 | 0.06 | 0.15 | 1.54 | 0.25 | 2.16 | 6.40 |
| **CY** | 0.36 | | 0.09 | 0.05 | 0.13 | | 0.09 | | | 0.51 | 1.23 |
| **CZ** | 1.81 | 1.32 | 0.15 | 0.27 | 0.46 | 0.40 | 2.15 | | | 0.50 | 7.07 |
| **DK** | 0.30 | 0.25 | 0.22 | 0.01 | 0.07 | 0.01 | 0.00 | 0.67 | | 0.03 | 1.56 |
| **EE** | 0.14 | 0.05 | 0.20 | 0.02 | 0.10 | | 0.02 | 0.01 | 0.11 | 0.34 | 0.98 |
| **FI** | 0.38 | 0.27 | 0.15 | 0.05 | 0.19 | 0.03 | 0.24 | 0.24 | 0.04 | 0.52 | 2.10 |
| **FR** | 3.68 | 7.32 | 6.78 | 0.24 | 3.01 | 1.80 | 7.40 | 2.29 | 0.38 | 8.05 | 40.95 |
| **DE** | 3.32 | 2.52 | 5.93 | 2.20 | 7.89 | 0.75 | 1.47 | | 1.90 | 1.98 | 27.95 |
| **EL** | 1.83 | 2.82 | 1.05 | 0.58 | 2.54 | 0.06 | 2.41 | 0.78 | 0.36 | 5.75 | 18.19 |
| **HU** | 0.79 | 0.19 | 1.81 | | 0.05 | | 1.47 | 0.42 | 0.57 | 1.91 | 7.20 |
| **IE** | 0.05 | 0.10 | 0.16 | | 0.21 | | | 0.13 | 0.09 | 0.25 | 0.99 |
| **IT** | 15.07 | 19.42 | 35.44 | 12.73 | 12.43 | 1.00 | 21.17 | 18.20 | 0.50 | 55.54 | 191.50 |
| **LV** | 0.08 | 0.23 | 0.31 | 0.11 | 0.38 | 0.01 | 0.09 | | | 0.62 | 1.83 |
| **LT** | 0.26 | 0.22 | 0.35 | 0.07 | 0.31 | | 0.10 | 0.06 | 0.12 | 0.74 | 2.22 |
| **LU** | | 0.02 | 0.03 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | | | 0.09 |
| **MT** | 0.08 | | 0.11 | | 0.06 | | | | | 0.10 | 0.34 |
| **PL** | 13.49 | | 7.30 | 4.90 | 4.54 | 0.25 | 1.41 | | | 4.08 | 35.97 |
| **PT** | 1.23 | 1.30 | 0.97 | 0.28 | 0.90 | | 1.74 | 1.63 | 1.26 | 7.34 | 16.64 |
| **RO** | 4.53 | 2.41 | 8.84 | 0.00 | 1.15 | 0.79 | 3.87 | 1.85 | 1.08 | 4.88 | 29.39 |
| **SK** | 0.75 | 0.74 | 0.80 | 0.04 | 1.12 | | 1.62 | | | 1.48 | 6.55 |
| **SI** | 0.25 | 0.09 | 0.29 | 0.05 | 0.24 | | 0.28 | 0.44 | 0.08 | 0.76 | 2.48 |
| **ES** | 4.72 | 6.82 | 13.20 | 10.64 | 5.38 | | 7.32 | 4.03 | 11.24 | 6.17 | 69.53 |
| **SE** | | 0.40 | 0.15 | 0.20 | 0.02 | | 0.50 | 1.05 | 0.24 | 0.74 | 3.30 |
| **EU total** | 56.44 | 49.54 | 86.94 | 33.54 | 43.62 | 5.30 | 55.83 | 35.16 | 18.51 | 106.64 | 491.51 |

Source: Darvas et al., 2023 (updated to February 2023)

In Table 4.2 national spending has been classified into three main categories (green transition; digital transition; social, economic and institutional development), which have been further divided into several subcategories. Hybrid categories have been, then, created to account for overlaps. When adding up the three spending categories which include the green transition, again relevant differences emerge across the EU. Spending on green transition ranges in absolute terms from € 0.06 billion of Luxembourg to €91.58 billion of Italy and in relative terms (as a percentage of total national spending) from 34.4% of Greece to 92.3% of Denmark.

**Table 4.2 Composition of recovery plans according to Bruegel classification (€ bn)**

| | *Green transition* | *Green transition & Social, economic, and institutional development* | *Green transition & Digital transformation* | *Digital transformation* | *Digital transformation & Social, economic, and institutional development* | *Social, economic, and institutional development* | *Not categorised* | *Total* |
|---|---|---|---|---|---|---|---|---|
| **AT** | 2.20 | 0.04 | | 1.60 | 0.02 | 0.65 | | 4.50 |
| **BE** | 3.57 | | | 1.38 | 0.00 | 0.97 | 0.01 | 5.93 |
| **BG** | 2.66 | | 0.02 | 1.13 | 0.07 | 1.96 | 0.75 | 6.61 |
| **HR** | 2.70 | 0.20 | 0.38 | 0.59 | 0.16 | 2.32 | 0.05 | 6.40 |
| **CY** | 0.45 | | | 0.09 | | 0.70 | | 1.23 |
| **CZ** | 2.79 | | | 1.25 | | 2.45 | 0.58 | 7.07 |
| **DK** | 1.44 | | | 0.09 | | 0.03 | | 1.56 |
| **EE** | 0.39 | | | 0.25 | | 0.34 | | 0.98 |
| **FI** | 1.05 | 0.04 | | 0.26 | 0.12 | 0.61 | 0.01 | 2.10 |
| **FR** | 20.19 | 1.50 | | 6.02 | 0.16 | 13.09 | | 40.95 |
| **DE** | 11.26 | | 0.50 | 10.28 | 3.89 | 1.98 | 0.05 | 27.95 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **EL** | 5.71 | 0.42 | 0.12 | 3.29 | 0.60 | 7.55 | 0.51 | 18.19 |
| **HU** | 3.02 | 0.19 | | 0.60 | 0.57 | 2.83 | 0.00 | 7.20 |
| **IE** | 0.56 | | | 0.22 | 0.07 | 0.10 | 0.04 | 0.99 |
| **IT** | 82.53 | 5.75 | 3.30 | 33.61 | 7.71 | 55.66 | 2.94 | 191.50 |
| **LV** | 0.65 | | | 0.39 | | 0.78 | | 1.83 |
| **LT** | 0.93 | 0.06 | | 0.48 | 0.15 | 0.58 | 0.03 | 2.22 |
| **LU** | 0.04 | 0.02 | | 0.03 | 0.00 | 0.00 | | 0.09 |
| **MT** | 0.19 | | | 0.06 | | 0.10 | | 0.34 |
| **PL** | 23.26 | | | 4.90 | | 7.81 | | 35.97 |
| **PT** | 6.35 | | | 2.75 | | 7.55 | | 16.64 |
| **RO** | 15.27 | 1.00 | | 2.57 | 0.41 | 10.10 | 0.04 | 29.39 |
| **SK** | 2.30 | | | 0.71 | | 3.55 | 0.00 | 6.55 |
| **SI** | 1.29 | | 0.09 | 0.23 | 0.17 | 0.68 | 0.02 | 2.48 |
| **ES** | 28.48 | | 2.42 | 12.41 | 16.07 | 10.16 | 0.00 | 69.53 |
| **SE** | 1.60 | 0.29 | | 0.26 | 0.20 | 0.95 | | 3.30 |

Source: Darvas et al., 2023 (updated to February 2023)

It has to be highlighted that, in 2023, all RRPs have been revised to maximise the RRF's impact in a changing context. Indeed, increased energy prices, high inflation and supply chain disruptions caused by Russia's war against Ukraine, and, in some cases, natural disasters made it challenging for Member States to implement certain reforms and investments in their RRPs. The amendments to the RRF Regulation (EU, 2023l), made it possible, in particular, to add in the RRPs dedicated chapters including new reforms and investments to deliver on the REPowerEU objectives (23 REPowerEU chapters have been approved since March 2023). Moreover, commitments that were no longer achievable due to objective circumstances were adjusted and, in many cases, replaced by more suitable alternatives.

Through the revisions, the size of EU support to Member States has grown: close to €150 billion in financial support was made available to EU economies in 2023 as follows:

- €18.9 of additional grants (compared to the original RRF grants of €357 billion) under the Emission Trading System (€17.3 billion) and the Brexit Adjustment Reserve (€1.6 billion);
- Additional loans, amounting to €125.5 billion (overall, of the total available envelope of €385 billion, close to €291 billion has been committed by the end of 2023; EC, 2024e).

With regard to the status of implementation of the RRPs, the mid-term evaluation of the RRF was completed in 2024, covering the period from 2021 to 2023 (EC, 2024e). In the three years since the entry into force of the RRF Regulation (EU, 2021d), €225 billion have already been disbursed[17] and around 75% of the milestones and targets planned to be achieved by end 2023 either have already been assessed by the Commission as satisfactorily fulfilled or are reported as completed by Member States.

In total, the estimated climate expenditure amounts to around €275 billion. Through the REPowerEU chapters, an additional €60 billion will be dedicated to speeding up the green transition. Newly requested loans for REPowerEU chapters[18] make up €40 billion of that, while additional grants for REPowerEU measures from resources under the Emission Trading System and the Brexit Adjustment Reserve make up the remainder (EC, 2024e). About 55% expenditure in REPowerEU chapters towards climate objectives has been on renewable energy and networks, followed by energy efficiency (30%; EC website c).

According to the Commission, the RRF has effectively supported the EU economic recovery. Hence, public investment in the EU was maintained and even increased in the aftermath of the COVID-19 pandemic and the energy crisis, from 3.0% in 2019 to an expected 3.3% in 2023. Around half of the increase in public investment expected in the EU between 2019 and 2025 is estimated to result from investments financed by

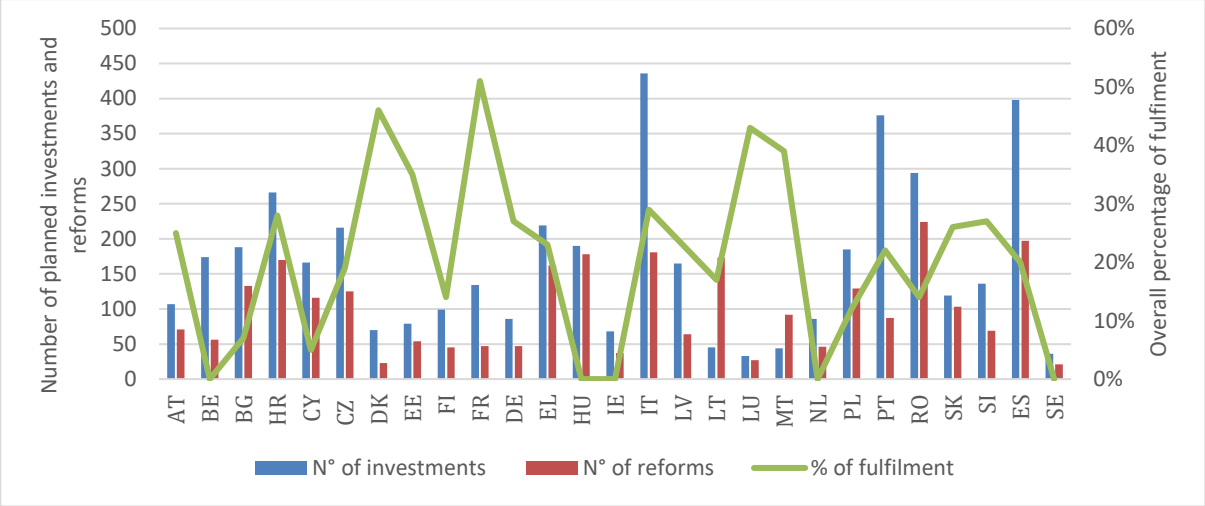
[17] Close to €67 billion have been disbursed in pre-financing, which helped alleviate the short-term impact of the crisis on Member States budgets and kickstart implementation. In addition, €157.2 billion have been disbursed upon the satisfactory fulfilment of milestones and targets.

[18] Each REPowerEU chapter should amount at least 37% of climate expenditure.

the EU budget, particularly by the RRF. Commission modelling suggests that NGEU has the potential to increase EU real GDP by up to 1.4% in 2026 above a no-NGEU scenario (EC, 2024e).

A different picture emerges from the EC Recovery and Resilience Scoreboard (EC website d). According to it, at the EU level, only 19% of the 4,400 investments and 2,700 reforms planned by the national plans (i.e. RRPs' milestones and targets) under the 'green transition' pillar have been fulfilled so far, with significant discrepancies between Member States (Figure 4.4). This data is significantly lower than the above-mentioned 75% reported by the mid-term evaluation of the RRF (EC, 2024e).[19]

**Figure 4.4 Number of investments and reforms planned by RRPs under the 'green transition' pillar and overall share of fulfilment**




Note: the Figure shows the overall number of milestones and targets, divided between reforms and investments. A milestone or target is fulfilled once a Member State has provided the evidence to the EC by submitting a payment request (maximum twice a year) that it has completed the milestone or target in a satisfactory manner and the EC has assessed it positively in an implementing decision.
Source: EC website d, as of 05.06.2024

*React-EU*

Recovery assistance for cohesion and the territories of Europe (React-EU) is a new funding source on top of the cohesion spending allocation for 2021–2027, to be used until end 2023 to finance investment projects that foster crisis-repair capacities and enable a green, digital and resilient recovery of the economy. It can also promote job creation and youth employment measures, healthcare systems and the provision of working capital and investment support for SMEs. The total budget is €50.62 billion (current prices) under NGEU, with a climate contribution target of 25%. No national co-funding is required for this funding.

*Multiannual Financial Framework 2021-2027*

The long-term budget provides the framework for the funding of almost 40 EU spending programmes over a seven-year period (2021-2027). As highlighted above, 30% of the total expenditure from the MFF and Next Generation EU is to target climate-related projects. The green transition will be mainly supported by the Cohesion Policy; the Common Agriculture Policy (CAP); the European Maritime, Fisheries and Aquaculture Fund (EMFAF); the Just Transition Fund; Horizon Europe; LIFE programme; and the Connecting Europe Facility (EC, 2021j). However, when considering the funding opportunities explicitly identified by the EGDSF

[19] The European Court of Auditors published in September 2024 a report on assessing the performance of RRF - see https://www.eca.europa.eu/en/publications/sr-2024-13#:~:text=The%20Recovery%20and%20Resilience%20Facility%20(RRF)%2C%20amounting%20to%20%E2%82%AC,it%20is%20progressing%20with%20delays

to meet its objectives, a wider range of programmes is to be taken into account (see Table 4.3), which are shortly presented below (based on EC website e and Agora Energiewende, 2021).

- ✓ *Cohesion Fund* (CF): it provides support to EU Member States with a gross national income per capita below 90% (EU-27 average) to strengthen the economic, social and territorial cohesion of the EU. The fund finances investments, through dedicated national or regional programmes, in 15 Member States,[20] mainly in the field of environment and trans-European networks in the area of transport infrastructure. The CF has a budget of €48 billion (in current prices), fed by the MMF, 37% of which are expected to contribute to climate objectives.
- ✓ *European Regional Development Fund* (ERDF): it aims at strengthening economic, social and territorial cohesion in the EU, by correcting imbalances between its regions. In the 2021-2027 period, it will enable investments in a smarter (through innovation, digitalisation and support to small and medium-sized businesses), greener (i.e. low carbon and resilient), more connected (by enhancing mobility) and more social Europe that is closer to its citizens (e.g. by promoting effective and inclusive employment, education, skills, social inclusion, as well as locally-led development and sustainable urban development). The Fund has a budget of €226 billion (in current prices), fed by the MFF, 30% of which are reserved for a 'greener Europe', i.e. projects that contribute to the larger objective of climate neutrality. In addition 8% of funds are specifically reserved for sustainable urban development, where many green transition investments occur, e.g. in heating microgrids or mobility.
- ✓ *European Social Fund Plus* (ESF+): it is the EU's main fund for investing in people. With a budget of €99.3 billion (in current prices) for 2021-2027, fed by the EU budget, Member States can use the money to create and protect job opportunities, promote social inclusion, fight poverty, and give workers the skills needed for the digital and green transition. There is no specific amount in the ESF+ earmarked for activities related to decarbonization, but upskilling in sectors related to the environment, climate, circular economy and bio-economy is encouraged.
- ✓ *LIFE - The financial instrument for the environment*: it is the only EU funding programme entirely dedicated to environmental, climate and energy objectives. It is divided into four sub-programmes, namely 'Nature and biodiversity', Circular economy and quality of life', 'Climate change mitigation and adaptation' and 'Clean energy transition'. It has a total financial envelope of €5.43 billion (in current prices) for the period 2021-2027, fed by the EU budget, with €1.94 billion reserved for the field of climate action (divided into €947 million for the sub-programme 'Climate Change Mitigation and Adaptation', and €997 million for the sub-programme 'Clean Energy Transition'). It may be combined with other sources of EU funding (e.g. Horizon Europe and InvestEU).
- ✓ *Common Agriculture Policy* (CAP): the total allocation for the CAP amounts to €386.6 billion (current prices), fed by the MFF and NGEU and divided between two funds (often referred to as the 'two pillars' of the CAP): the European Agricultural Guarantee Fund (EAGF – first pillar) has an allocation of €291.1 billion, while for the European Agricultural Fund for Rural Development (EAFRD – second pillar) the total allocation amounts to €95.5 billion. The EAGF primarily finances income support for farmers (through different payment schemes, including a payment for sustainable farming methods –'green direct payments'-) and market measures. All payments are subject to compliance with EU rules on food safety, environmental protection, and animal welfare. The EAFRD finances the CAP's contribution to the EU's rural development objectives, namely improving the competitiveness of agriculture; encouraging sustainable management of natural resources and climate action; achieving a balanced territorial development of rural economies and communities. These objectives are realised through national and

[20] Bulgaria, Czechia, Estonia, Greece, Croatia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Portugal, Romania, Slovenia, Slovakia.

regional rural development programmes, which are co-financed by the national budgets of EU countries. Overall, 40% of total CAP expenditure will be dedicated to climate action.

- ✓ *European Maritime, Fisheries and Aquaculture Fund* (EMFAF): the EMFAF has a total budget for 2021-2027 of €6.11 billion (in current prices), fed by the MFF. The fund supports the EU common fisheries policy (CFP), the EU maritime policy and the EU agenda for international ocean governance, by developing innovative projects that ensure that aquatic and maritime resources are used sustainably. The climate contribution target is 30%.
- ✓ *InvestEU*: it aims at triggering a wave of over €372 billion in (public and private) investment in the period 2021-2027, 30% of which will contribute to fighting climate change. It has total budget of €10.28 billion, of which €6.07 billion under NGEU (current prices), which allows the EU budget to provide a guarantee of €26.2 billion. It is structured around four policy windows, namely sustainable infrastructure; research, innovation (targeting higher risk innovations) and digitisation; SMEs; and social investment and skills. The majority of the InvestEU budget (75%) will be made available from the European Investment Bank and the remainder from national promotional banks.
- ✓ *Connecting Europe Facility* (CEF): it is the EU's main infrastructure programme and supports the development of high performing, sustainable and efficiently interconnected trans-European networks in the fields of transport, energy and digital services. Over a budget of €20.73 billion (current prices), fed by the MFF, 60% should be devoted to climate-related projects.
- ✓ *Horizon Europe*: it is the EU's key funding programme for research and innovation. The fund has a total budget of €95.51 billion, of which €5.4 billion under NGEU. It has a climate target of 35% and a dedicated cluster on 'Climate, Energy and Mobility' (another relevant cluster is 'Food, Bioeconomy, Natural Resources, Agriculture & Environment'). Under Pillar III of Horizon Europe on 'Innovative Europe', the European Innovation Council, with a budget of €10.1 billion, will support innovations with breakthrough and disruptive nature and scale up potential that are too risky for private investors (70% of the budget earmarked for SMEs).
- ✓ *Erasmus Plus* (Erasmus+): it is the EU's programme to promote education, training, youth and sport in Europe. It has an estimated budget of €26.2 billion, fed by the MFF. It places a strong focus on social inclusion, the green and digital transitions, and promoting young people's participation in democratic life. It supports priorities and activities set out in the European Education Area, Digital Education Action Plan and the European Skills Agenda.
- ✓ *Modernisation Fund*: it is a dedicated funding programme to support ten lower-income EU Member States[21] in their transition to climate neutrality by helping to modernise their energy systems and improve energy efficiency. The fund also supports the just transition in carbon-dependent regions (redeployment, re-skilling and upskilling of workers, education, job-seeking initiatives and start-ups). It is funded from revenues from the auctioning of 2% of the total allowances for 2021-30 under the EU ETS and additional allowances transferred by beneficiary Member States (five opted to do so, namely Croatia, Czechia, Lithuania, Romania and Slovakia). The total revenues of the Modernisation Fund may amount to €48 billion from 2021 to 2030 (at €75/t$CO_2$), depending on the carbon price (around €28 billion coming from allowances that beneficiary Member States have transferred to the fund and around €20 billion comings from the auctioning of 2% of the total EU ETS allowances from 2021 to 2030).
- ✓ *Innovation Fund*: it is a large funding programme for the demonstration of innovative low-carbon technologies. The fund is financed by the EU ETS and will provide about € 38 billion, depending on the carbon price (at €75/t$CO_2$), for the commercial demonstration of innovative low-carbon technologies, aiming to bring to the market industrial solutions to decarbonise Europe and support its transition to climate neutrality. This is done through calls for large and small-scale projects focusing on: innovative low-carbon technologies and processes in energy-intensive industries, including products substituting

[21] Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia.

carbon-intensive ones; carbon capture and utilisation; construction and operation of carbon capture and storage; innovative renewable energy generation; energy storage. According to REPowerEU (EC, 2022a), the EC will double the funding available for the 2022 Large-Scale Call[22] of the Innovation Fund next autumn to around €3 billion.

It has also to be underlined that in 2024 the *Strategic Technologies for Europe Platform* (STEP) was set up by the EU (EU, 2024) to support European Industry and boost investment in critical technologies in Europe, with particular regard to digital technologies and deep-tech innovation; clean and resource efficient technologies and biotechnologies. However, contrary to the EC initial proposal,[23] no new financial resources have been provided to achieve these objectives and STEP will raise and steer funding across 11 existing EU programmes (EU website).

[22] 'Large-scale' are projects with a capital expenditure above €7.5 million.

[23] According to the EC initial proposal, an additional total amount of €10 billion was to be allocated to support existing and well-proven EU investment schemes aimed at strengthening STEP investments (EC, 2023r).

## Table 4.3 EU funds explicitly identified by EGD strategies/action plans to support the achievement of the related goals

| EU funding programmes → / ← EU strategies | Cohesion F. | ERDF | ESF+ | Just Transition F | REACT-EU | LIFE | CAP (EAFRD + EAGF) | EMFAF | InvestEU | CEF | Horizon Europe | JTF | Erasmus+ | RRF | Innovation F. (2) | Modernisation F. (3) | Social Climate F. (4) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2021-2027** (unless otherwise specified) **Budget** (1) → | 48 | 226 | 98.5 | 8.4 + 10.9 | 50.6 | 5.4 | 378.5 + 8.1 EAFRD | 6.11 | 3 + 6.1 | 20.7 | 86.1 + 5.4 | 19.2 | 26.2 | 338 (grants) 385.8 (loans) | 38 2020-2030 | 48 2021-2030 | 86.7 2027-2032 |
| 2020 CEAP | (x) | (x) | x | x | | x | | | x | | x | x | | | | | |
| Hydrogen Strategy | (x) | x | (x) | x | x | | | | x | | x | x | | | x | | |
| Renovation Wave | (x) | x | x | x | | x | x | | x | | x | x | | x | | x | |
| Biodiversity Strategy | (x) | (x) | (x) | (x) | | x | x | x | x | | x | | | | | | |
| Farm to Fork | | x | | | | | x | x | x | | x | | | | | | |
| CRMs Action Plan | | x | | | | | | | | | x | x | | | | | |
| Methane Emissions Strategy | | | | | | | x | | | | x | | | | | | |
| Chemicals Strategy | | | | x | x | x | | | x | | x | x | | x | | | |
| Offshore Renewable Energy | (x) | (x) | (x) | x | | | | | x | x | x | x | | x | x | | |
| Sustainable Mobility | (x) | x | (x) | (x) | | | | | x | | | | | x | x | | |
| Adaptation Strategy | (x) | (x) | (x) | (x) | | x | x | | x | | x | | x | x | | | |
| Organic Production AP | | | | | | | x | x | | | x | | | | | | |
| Blue Economy | (x) | x | x | (x) | | | | x | x | | x | | x | x | x | | |
| Zero Pollution Action Plan | (x) | (x) | (x) | (x) | | | x | | | | x | | x | x | | | |
| Fit for 55 | | | x | | | | | | x | | x | | x | x | x | x | x |
| Forest Strategy | (x) | (x) | x | (x) | | x | x | | | | x | | | | x | | |
| Soil Strategy | (x) | (x) | (x) | (x) | | x | x | | | | x | | | x | | | |
| Sust. Carbon Cycles | (x) | (x) | (x) | (x) | | x | | | | x | x | x | | | x | | |
| Sust. & Circular textiles | | x | | | | x | | | | | x | | | x | | | |
| Solar Strategy | (x) | x | x | x | x | | | | x | x | x | x | x | x | | x | x |
| Save Energy | x | x | (x) | x | | x | x | | x | | x | x | | x | | x | x |
| RepowerEU | (x) | (x) | (x) | (x) | | | | x | x | | | | x | x | | | x |
| Energy transition - Fisheries | | x | x | | | | | x | x | | x | | x | | | | |
| Sust. Fisheries Action Plan | | x | x | | | x | x | x | | x | x | | x | x | | | |
| Sust. use of natural resources | | | | | | x | x | | | | x | | | | | | |
| Offshore renewable energy | | x | | | | | | | x | | x | | x | x | x | | |
| Wind Power Action Plan | x | x | | x | | | | | x | x | x | | x | x | x | | |
| Industrial $CO_2$ Man. Strategy | | | | | | | | | x | x | x | | | x | x | | |
| Europe's 2040 target | (x) | (x) | (x) | x | | | | | x | | x | | | x | x | | x |

Note: yellow cells: programmes financed by the EU MFF 2021-2027; red cells: programmes financed by Next Generation EU; orange cells: programmes financed by the MMF 2021-2027, whose budget has been integrated by Next Generation EU; blue cells: programmes financed through the EU ETS. When 'Cohesion Policy Funds' are mentioned, the Cohesion Fund, ERDF, European Social Fund+ and Just Transition Fund are marked (using brackets when there is not explicit mention of the programme). (1) € billion (in current prices, as of November 2020 with regard to programmes financed by the MFF 2021-2027 and Next Generation EU). (2) At €75/ $tCO_2$. (3) Funded from revenues from the auctioning of 2% of the total allowances for 2021-2030 under the EU ETS. At a price of allowances at €75/$tCO_2$, total revenues of the Modernisation Fund could amount to about €48 billion. (4) €65 billion from the EU budget (including revenues from the emission trading for buildings and road transport as foreseen in the amendment to Own Resources Decision presented by the EC), plus 25% co-financing by Member States (amounting to an estimated total of €86.7 billion, based on the provisional agreement between the EP and the Council of December 2022); currently under adoption.
Source: own elaboration (updated to April 2024).

Moreover, in order to ensure that the transition towards a climate-neutral economy happens in a fair way, leaving no one behind, in the context of the EGD, the EC has created the *Just Transition Fund* (JTF) and it is setting up a *Social Climate Fund* (SCF). The former (EU, 2021e) addresses the social and economic effects of the transition, focusing on the regions that are heavily reliant on fossil fuels, along with their industries and workers. It is the first pillar of the Just Transition Mechanism. It has a budget of €19.2 billion in current prices, fed by the MFF and NGEU, which is expected to mobilise around €25.4 billion in investments. In order to support the economic diversification and reconversion of the territories concerned, the fund will promote: the up- and reskilling of workers; investments in SMEs; the creation of new firms, research and innovation; environmental rehabilitation; clean energy; job-search assistance; and the transformation of existing carbon-intensive installations. The fund excludes from its scope fossil fuels and nuclear power, while it includes a green rewarding system (up to 18% of JTF allocation under MFF) and conditional access to 50% of national funding allocations for Member States based on the adoption of national objectives for climate neutrality by 2050 (Agora Energiewende, 2021). Member States can get access to the JTF by preparing territorial just transition plans that cover the period up to 2030, identifying the territories that should get support.

Under the Fit for 55 legislative package, a new, separate emissions trading system (ETS 2) covering fuel combustion in buildings and road transport will be launched in 2027 to achieve 42% emission reductions compared to 2005 by 2030 (EU, 2023b). To address any social impacts that arise from this new system, the EC has introduced the *Social Climate Fund* (SCF; EU, 2023c). The Fund will finance structural measures and investments in energy efficiency and renovation of buildings, clean heating and cooling and integration of renewable energy, as well as in zero- and low-emission mobility solutions. Moreover, Member States will have the option of spending part of the resources on temporary direct income support. These measures/investments will have to be scheduled by national Social Climate Plans to be submitted to the EC by June 2025. Payments will be disbursed to the Member States only if the related milestones and targets are achieved. The Fund will be financed by the auctioning of the allowances from the ETS 2, as well as through 50 million allowances from the existing EU ETS. Together with a mandatory 25% contribution of the Member States to their Social Climate Plans, the SCF should mobilise at least €86.7 billion over the 2026-2032 period (EC, website e).

According to some scholars (Akgüç et al., 2022), the social dimension of the EGD remains significantly fragmented and underdeveloped. The JTF will reach only a small fraction of the people affected by decarbonisation, while the proposed SCF has a very specific target (i.e. to fend off the detrimental distributional effects of ETS 2), but even for that purpose it may not be enough. In addition, Council Recommendation on ensuring a fair transition (Council of the European Union, 2022) is a 'toolbox' for Member States to help them manage the employment and social effects of the green transition, based on existing tools. Its implementation will be monitored via the European Semester, but the instrument is not legally binding.

## 4.2 How much investment from the private sector?

A key question is how much of the total investment will need to be financed by the public sector, that is EU funds as well as national governments, and how much by the private sector. The EU stepped up funds available for the green transition with the Green Deal Investment Plan, also referred to as Sustainable Europe Investment Plan, by committing to mobilise at least €1 trillion in sustainable investments up to 2030 via the EU budget and associated instruments. A vital component is the InvestEU programme (see Section 4.1), which aims to generate at least €372 billion in additional investment by providing EU budget guarantee of €26.2 billion and thus supporting investments by public and private partners.



However, the additional investment needs cannot be raised by the public sector alone: the private sector must cover a substantial share. This is the model behind the sustainable finance agenda where private funds complementing public money are crucial for the transition process, especially by funding long-term investments in sustainable economic activities and projects. Interestingly is that studies estimating the split are concluding rather big variation within the EU with projection ranging between a ratio of 1:5 (Darvas and Wolf, 2021), up to 1:2 (Baccianti, 2022) between the public and private role in financing additional investment needs. What seems to be rather clear is that the split will vary in Europe because, for example, the European Investment Bank (EIB) projected that about 60% of additional investments will be funded by public sources in Central and Eastern Europe and the share will only be 37% in Western and Northern Europe (EIB, 2021).

The report 'Les Incidences Économiques De L'Action Pour Le Climat' published in May 2023 projects that the decarbonisation of the French economy will require additional investment of close to €70 billion annually or over two percentage points by 2030. The public spending is expected to exceed €30 billion and about half of this extra spending will be government investment (Pisani-Ferry and Mahfouz, 2023).

The actual investment space being occupied by the private sector is therefore a crucial issue of the transition and it will deserve a more specific attention in policy making, because optimistic expectations on an easy and quick alignment of the private sector to the needed pathways of investment allocations should be avoided.

The more interesting challenge to be considered is whether the private sector is willing to invest in the green transition. A ballpark figure is that about 55 percent of investment needs can be met by private capital (McKinsey and IFF, 2023). Even more worthwhile is to mention the findings published by Finance Watch (2024) referring to estimates made by McKinsey 'that only 40% of climate mitigation projects have a risk/return profile suitable for private investment, and our assumption of 20% for adaptation projects, there will be a significant shortfall'. This means that 'the root cause of the problem is the fact that many green projects (for instance, building walls to protect countries against rising sea levels) are insufficiently profitable for the private sector to want to invest' (Euractiv, 2024). Therefore, it is decisive to study the question of what can actually be financed by private capital because the key question not sufficiently raised in the policy debate is whether the yield of the investment will be sufficient to make the investment economically viable for private investors.

It is valuable to mention that the EC summaries in the context of investment needs to strengthen EU's net-zero technology manufacturing capacity that 'as a proxy based on estimates that cover a much broader range of interventions linked to energy and climate, one could apply a ratio of 17-20% of required public investment' (EC, 2023q).

Finally, it is worthwhile to look at whom funded the energy transition during the last years. According to the 2024 edition of the IEA's World Investment Report (IEA, 2024a), the commercial sector has by far the biggest role in advanced economies because it provided the largest share of finance of global energy investment between 2015 and 2023. During this period, the share of investment by households has doubled, with their investments in clean energy reaching about 18% of the total, triggered by spending from higher-income households on rooftop solar, energy efficiency improvements, heat pumps and electric vehicles (EVs) at the global level. The highest share of household investment is found in advanced economies in 2023, with 29% in Japan and Korea and 27% in Europe, followed by 11% in North America. The analysis of the IEA also reveals that the total energy investments is projected to increase by 74% (adjusted for price changes) between 2019 and 2024 in the EU and the share of investments in fossil fuel energy dropped from 11% to 8%. The biggest increase is projected for renewable power, power grids and storage, energy efficiency where the investment roughly doubled between 2019 and 2024. When distinguishing between technology, the data reveal that households are very strong in investing in end-use technology (buildings and transport) as well in wind and solar PV. The public sector is very active funding investments in the power sector focusing on the transmission, distribution and fossil power as

compared to the corporate sectors which is backing investments in fuel supply especially in clean fuels (Tam et al., 2024).[24]

The Annex 2 of the report of the European Platform on Sustainable Finance highlights that investment in environmental protection from private sources, amounted to €69 billion in 2022, including wastewater treatment plants, waste transport vehicles, natural reserves creation or less polluting equipment – excluding renewable energy. 65% of those investments (around €44 billion) were corporate investments. The manufacturing sector accounted for 38% of those investments, though the share environmental protection investments in corporations' total investments of corporations was low, namely 2.0% in 2022, with no significant change as compared to 2018-2020.

## 4.3 The cost of capital: a critical factor for scaling up clean-tech investments

'While long recognised as an important factor in mobilising investment in developing countries, the cost of capital has been relatively neglected in clean energy projections and associated policy discussions in developed countries, at least until recently' (OECD, 2024). This quotation sets the scene accurately. Looking back, it is surprising that low attention was given to the cost of capital (which is sometimes termed as the 'financing costs') discussion because investment in clean energy entails higher upfront spending and lower operating costs compared to investment into conventional energy infrastructure[25]. Although this fact is well-known, it was regularly disregarded in the policy agenda but is nowadays a hot topic which can credited to the deterioration of the macroeconomic and financial conditions in Europe as triggered by COVID-19 pandemic, the energy crisis and Russia's invasion of Ukraine.

The cost of capital (CoC) is a key element affecting the cost of renewable power generation and is determined by a base rate (also known as a risk-free rate) and a risk premium. Long-term government bonds denominated in local currencies and maturing in around 10 years are regularly serving as the benchmark indicator for the base rate as they are seen as risk-free, although no asset is completely risk-free. The monetary tightening of the last years increased the yield[26] on ten-year government bonds by 3.2 percentage points (from 0.31 to 3.51)[27] at the EU-27 level between 2020 and 2023, but with large variations between EU Member States, as for example the change amounted to increase by 2.6 percentage points for Sweden and by 4.3 for Poland respectively 5.3 for Hungary. These increases also increased the spread between EU Member States so that the lowest yields were 2.31 in Germany, Sweden (2.51) and Denmark (2.64) and the highest yields in Hungary, Poland (5.8), Romania (6.71) and Hungary (7.51) in 2023. This trend affects investment decision as high long-term interest rates discourage investment[28].

The latter factor, i.e. the risk premium, 'is influenced by a wide variety of risk factors linked to macroeconomic, country, sector, technology, and project conditions' (OECD, 2024). Thus, the risk

[24] It can be noted that the projected total investment in clean energy in the EU amounts to €412 billion (2023 prices) in 2024, which is lower than the projected average annual energy system investment needs of € 661 billion for the period 2031-2050 presented in Table 4.1 above. See the IEA website World Energy Investment 2024 Overview and key findings at https://www.iea.org/reports/world-energy-investment-2024/overview-and-key-findings

[25] See for a detailed discussion on the cost of capital at https://www.iea.org/articles/the-cost-of-capital-in-clean-energy-transitions and https://www.iea.org/reports/reducing-the-cost-of-capital

[26] The bond's yield is the return an investor expects to receive each year and hence reflects the annual cost of borrowing which has to be paid by the issuer of the bond.

[27] See the trend in annual bond yields published by Eurostat as the 'EMU convergence criterion series – annual data': https://ec.europa.eu/eurostat/databrowser/view/irt_lt_mcby_a__custom_12061003/default/table; The Maastricht Treaty EMU convergence criterion series relates to interest rates for long-term government bonds denominated in national currencies.

[28] See also Heusaff et al. (2024).

premium discloses the uncertainty surrounding the investment and is reflected in the extra return investors require for borrowing the funds so that the investment can be executed.

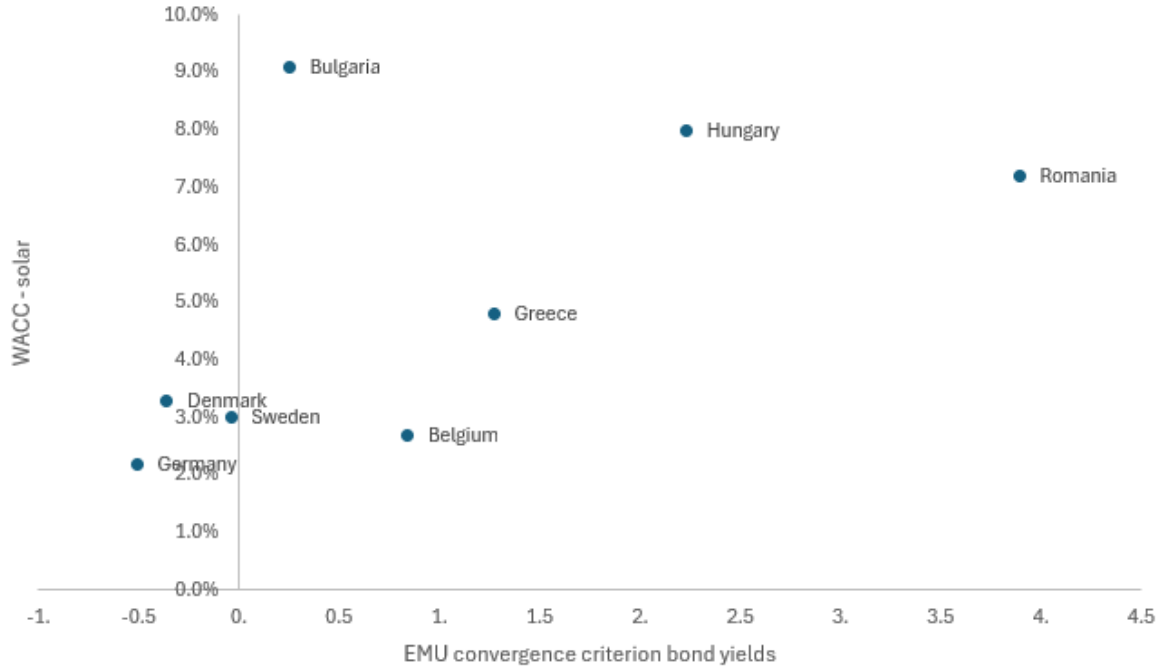
The overall electricity costs are affected by changes in the CoC because 'increasing the WACC (weighted average cost of capital) from 2% to 10% raises the LCOE of a representative solar PV or onshore wind project by 80%' (OECD, 2024)[29]. Other reports conclude that renewable energy technologies will be affected heavier in terms of an increase in electricity costs than traditional technologies when CoC are surging as the former are more capital-intensive than the latter (Steffan and Waidelich, 2022).

Currently, the wind industry, in particular offshore wind, is facing challenges by the new macroeconomic environment, such as supply chain disruptions and higher costs. They are evident as large offshore wind projects were cancelled or postponed in the United States and the United Kingdom (IEA, 2024b). One of the reasons for this development was that investment costs increased by 20% compared to only a few years ago resulting that the planned investment would be no more economically viable and therefore delays – at least for the moment - the transition to a decarbonised energy supply.

Political and economic reality indicates that the cost of capital is one of the largest barriers to investment in clean energy infrastructure. This fact is well-known, and it is therefore quite surprising that it is not considered in analytical exercises as '[M]any models assume that the costs of capital are uniform across countries and technologies and over time' (Polzin et al., 2021). However, there are exceptions in academic and advanced research, like for example Polzin et al. (2021), Roth et al. (2021) and Steffen and Waidelich (2022), and recently IRENA (2023) published country-level differences in the cost of capital (WACC) for different energy technologies. Although the WACC presented by Polzin et al. (2021) for all EU Member States are out-of-date as they show the situation as of 2015, they illustrate that North-Western European countries had the lowest WACC as compared to Southern and Eastern European countries and that WACC for gas plants were by far the lowest compared to renewable power technologies. Large differences were reported between the WACCs renewable power technologies with solar having the lowest WACC of all renewable energy technologies in all countries. The countries with the lowest cost of capital are generally the ones with the lowest yields on ten-year government bonds in 2015. These results were also valid in more recent cost of capital published by IRENA (2023) for the period 2019 to 2021, indicating that investment into capital-intensive renewable infrastructure is concentrated in low-risk countries and in the ones with the lowest borrowing costs expressed as lowest yields for investors (Figures 4.5 and 4.6). It is furthermore sensible to highlight the conclusions drawn by Polzin et al. (2021) in terms of linking cost of capital with the geographical and physical conditions for renewable power technology that '[F]or wind power, this may coincide well with the physical availability of wind resources, but for solar PV, this clearly is not the case, as some southern EU countries with favourable PV potentials tend to face high country risks and consequently high WACCs (e.g. Greece)'.

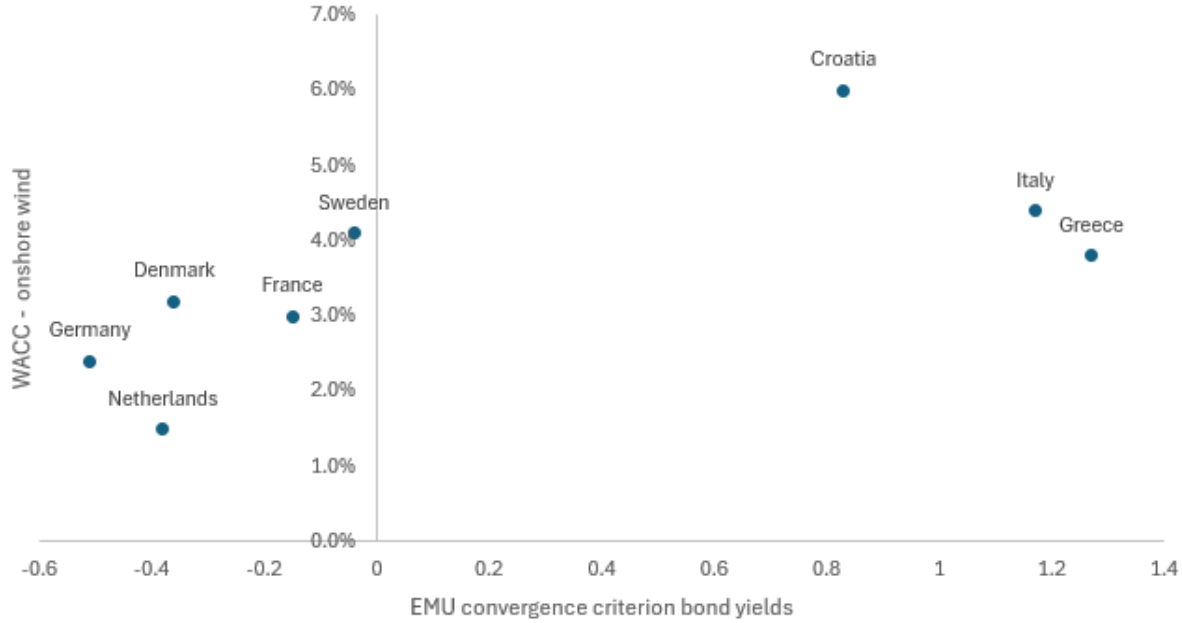
[29] We adapt IRENA's approach of using 'cost of capital' (CoC) and 'weighted average cost of capital' (WACC) as well as 'total cost of electricity' and 'levelised cost of electricity'(LCOE) interchangeably (IRENA, 2023).

**Figure 4.5 Cost of capital of solar and bond yields for EU Member States, 2019-2021**




Source: IRENA, 2023 and Eurostat EMU convergence criterion bond yields – annual data (2020)

**Figure 4.6 Cost of capital of onshore wind and bond yields for EU Member States, 2019-2021**




Source: IRENA, 2023 and Eurostat EMU convergence criterion bond yields – annual data

The differences in costs of capital for renewable energy investments makes the building of wind and solar power plants in some European countries more expensive than in others, although the weather conditions may be more suitable (see Figures 4.5 and 4.6). This means in reality that this fragmentation can lead to an allocation of capital that will hamper to follow a cost-effective energy transition pathway. The challenge of how these country-level differences in the cost of capital for renewable energy investments was addressed by suggesting the EU Renewable Energy Cost Reduction Facility as a policy tool so that EU Member States with high costs of capital would be able to build up renewable energy infrastructure at costs comparable with the costs investors are facing in countries with low cost of capital, such as Germany

or France (Agora Energiewende, 2018). The result would be the '[E]qualising the costs of capital for investments in renewables throughout the EU could generate significant savings to consumers and taxpayers' (Temperton, 2016) and in addition it could be expected that the transformation of the electricity sector would accelerate.

As mentioned above, the energy technology pathway for reaching carbon neutrality by 2050 require additional investment (high CAPEX) for the transformation of the capital stock of the energy system, but 'also reduces the operating costs of the global energy system by more than half over the next decade compared with a trajectory based on today's policy settings' (IEA, 2024c). This reduction in operating costs (OPEX) affects wholesale electricity prices because of zero marginal costs of renewable energy technologies decrease these prices.

Modelling exercises undertaken by IMF scholars found out that for each 1 percentage points increase in the share of renewable energy, wholesale electricity prices in Europe will reduce on average by 0.6 percent (Cevik and Ninomiya, 2022).They conclude, based on the empirical findings, that '[F]or example, increasing the share of renewables in electricity production in Europe from an average level of 14 percent during the period 2014–2021 to 30 percent would lower wholesale electricity prices by 8.8 percent—and by almost 20 percent if the share of solar and wind reaches 50 percent' (Cevik and Ninomiya, 2022)[30]. These findings are not universal valid as a higher share of renewable energy may lead to greater volatility in electricity production implying higher wholesale electricity prices. We can again refer to the IMF scholars for policy solutions of how these challenges can be addressed: 'Therefore, to maximize the price dampening effect of green power resources, policymakers need to pursue reforms for modernization and closer integration of electricity grids throughout Europe and increase investment to reduce congestion on transmission lines and introduce volatility-dampening technology solutions like storage' (Cevik and Ninomiya, 2022).

These outcomes of the transition process must be linked to the political discussion because high energy prices are attributed as one of the reasons for the loss of competitiveness of the European industries globally. The transformation of the electricity systems by increasing the share of renewable production may further lead to the reduction of electricity prices and go along with an improving competitiveness.

## 4.4 The cost of capital for companies in renewables and transports

The cost of capital for a company represents the cost incurred to secure financing. It is the minimum return a company must generate on its investments to cover the cost of its financial resources, whether from debt (loans, bonds) or equity (shares, retained earnings). This cost serves as a profitability threshold: if the company fails to generate a return at least equal to the cost of capital, it indicates that the company is destroying value. The Weighted Average Cost of Capital (WACC) is a measure of the overall cost of capital and is a fundamental driver in private-sector investment decisions (Polzin et al., 2021). In this Section, the focus will be on the WACC Cost of Debt, expressed as a percentage[31]. This specific measure captures the after-tax cost of borrowing, making it a crucial component for understanding how companies finance large-scale investments. By focusing on the cost of debt, we can better assess the financial pressures companies face, particularly in capital-intensive sectors like automotive and renewable energy. Differences in the cost of capital between companies can arise from various factors, reflecting the unique

[30] A report published by Business Europe (2024) concludes to a comparable result of the dampening effect of renewable energy on electricity prices: 'when renewables are developed in the least-costly locations and the roadblocks to their development are lifted, including on interconnections, this could lower wholesale power prices by almost 40%'.

[31] WACC Cost of Debt is calculated as it follows: $WACC = [(\frac{SD}{TD} \times CS \times AF) + (\frac{LD}{TD} \times CL \times AF)] \times (1 - T)$ . Where: SD: Short-term debt, TD: Total debt, CS: Cost of short-term debt, LD: Long-term debt, CL: Cost of long-term debt, AF: Debt adjustment factor, T: Tax rate.

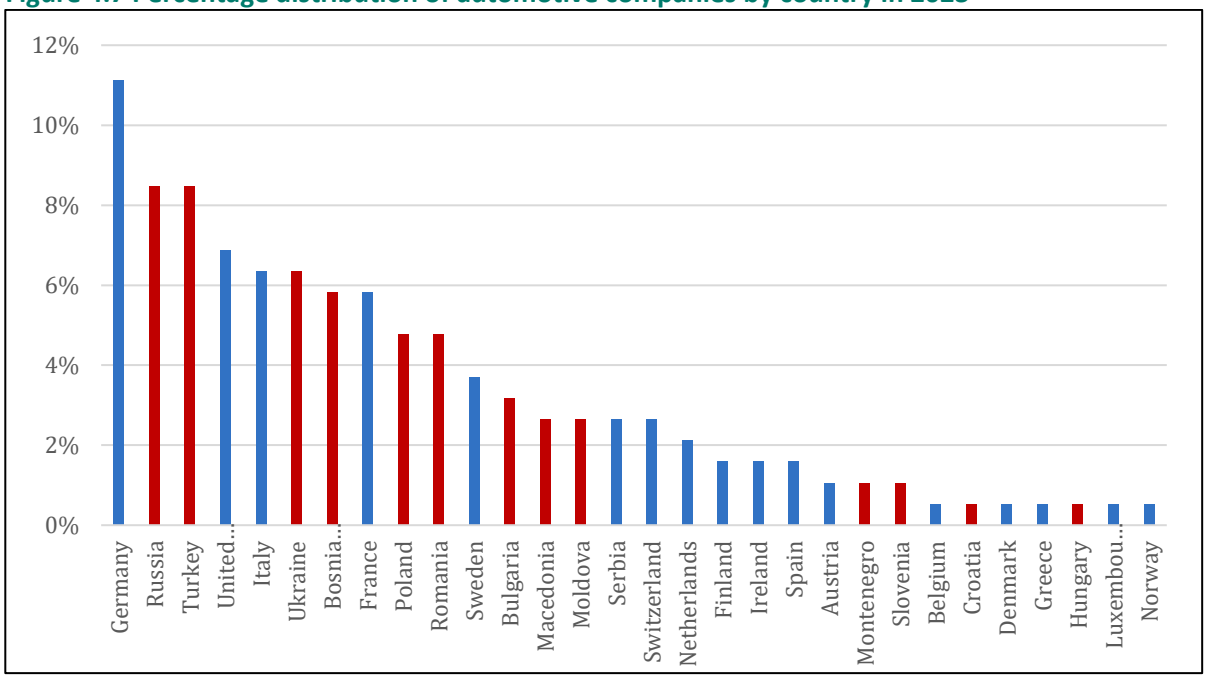
characteristics of each business, its industry, and external economic conditions (Franc-Dabrowska et al., 2021).

Among the sectors in which Europe has invested heavily to advance along the green transition are the automotive and renewable energy industries. Achieving the green transition requires companies to make significant investments in infrastructure, clean technologies, and sustainable innovation. It is crucial to understand the varying costs of capital for companies, as these can significantly influence and potentially slow down the pace of the green transition. [32]

### *4.4.1 The cost of capital in the automotive sector*

Figure 4.7 shows the percentage distribution of the number of companies in each country working in the automotive sector in 2023. Germany leads significantly the distribution, i.e. out of a total of 189 companies operating in the market, 21 (11.1%) are German companies. Russia and Turkey follow, with 8.5% each of the total. Other significant contributors include UK, Italy, Ukraine, and Bosnia Herzegovina, all with over 5%. Some Eastern European countries like Macedonia, Serbia, and Romania also contribute significantly but trail behind their Western counterparts. The red and blue colour coding highlights a geographical divide, showing that Eastern European countries (in red) dominate the higher ranges of the chart alongside Germany, while Western European countries (in blue) occupy a wider area, both in the middle and lower ends of the distribution.

**Figure 4.7 Percentage distribution of automotive companies by country in 2023[33]**



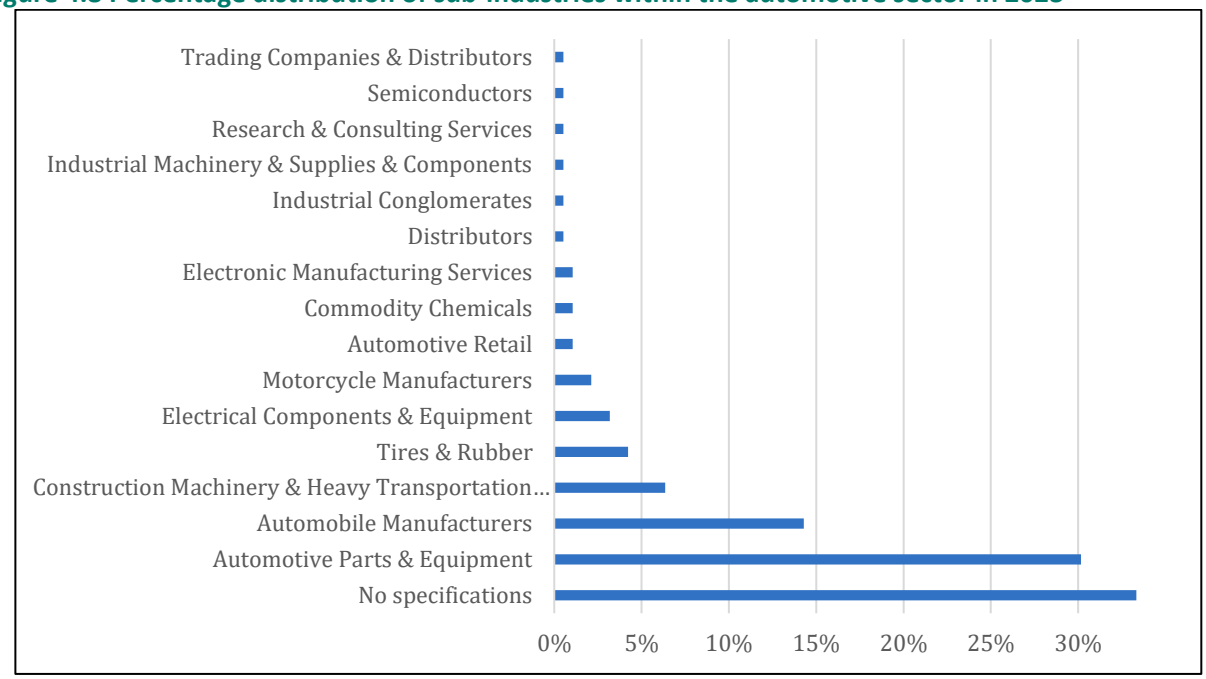

Source: Author's work on Bloomberg data

[32] The analyses presented in this Section are based on data obtained through the access by the author to the Bloomberg Terminal from Università Cattolica del S. Cuore, Milan. These data are used here for non-commercial research purposes and any care has been adopted on anonymizing data by presenting only elaboration of the data that present only aggregate indicators, also excluding those countries that have just one company in the sector considered within the Bloomberg dataset.

[33] Eastern European countries in red, Western European countries in blue.

In Figure 4.8, the automotive sector companies are divided by sub-industry. Excluding those categorized as “no specific indication” in the Bloomberg’s dataset, approximately one-third of the companies (57) operate in automotive components. Sub-industries like Tires & Rubber, Electrical Components & Equipment, and Motorcycle Manufacturers each represent around 3-5% of the total distribution. Other categories such as Automotive Retail, Commodity Chemicals, and Electronic Manufacturing Services have smaller percentages, under 3%. At the bottom of the chart, sub-industries like Semiconductors, Research & Consulting Services, and Trading Companies & Distributors make up very small portions of the automotive sector, less than 1%. The chart highlights that most companies belong to parts and equipment manufacturing, while traditional manufacturing also holds a significant share. Smaller sub-industries like semiconductors and consulting services contribute numerically in a minimal part to the overall sector.

**Figure 4.8 Percentage distribution of sub-industries within the automotive sector in 2023**




Source: Author's calculation on Bloomberg data

The map in the Figure 4.9 presents the average WACC in 2023 for companies in the automotive sector across European countries. WACC values vary between 1.06% and 5.55%. To improve the clarity of the data visualization, Russia and Ukraine were excluded from the graphical representation, as their average WACC values range between 30.62% (Russia) and 24.20% (Ukraine) would have distorted the scale. The data reveals clear geographic trends in the WACC for automotive companies across Europe in 2023 where a distinct East-West divide is visible. Eastern European countries like Croatia (5.55%), Bulgaria (4.18%), and Poland (4.23%) generally face higher WACC values, indicating more expensive access to capital. These higher costs likely reflect greater economic risks and financial instability compared to their Western countries.

In contrast, Western European countries, such as Norway (1.06%), Switzerland (1.26%), and Spain (1.55%), benefit from much lower WACC values, which signal easier access to cheaper financing due to more stable economic conditions and mature financial markets. Countries like Germany (2.45%) and France (3.60%) also maintain relatively low costs of capital, positioning Western Europe as the region with more favourable financial conditions.

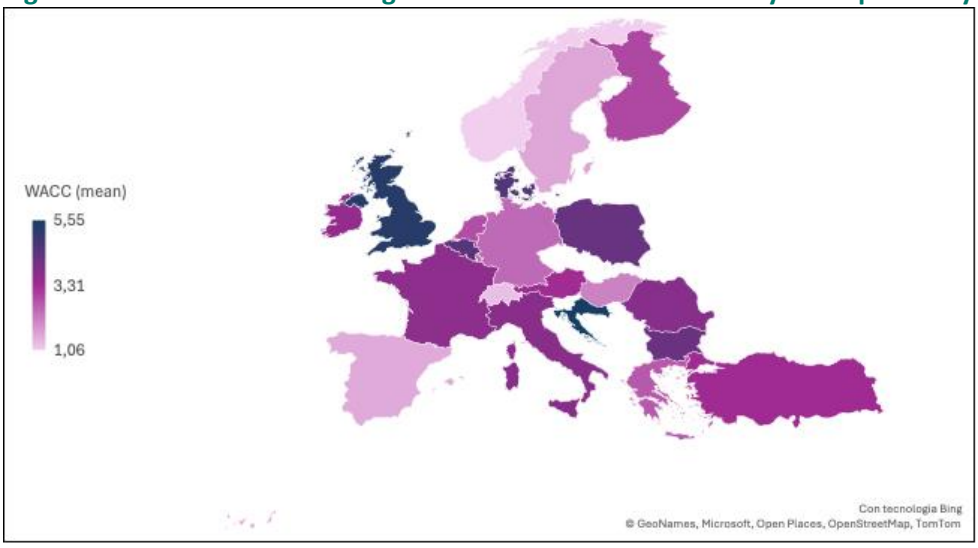
Additionally, while Northern countries generally enjoy more favourable financing conditions, Southern European countries display a wider range of outcomes. The Scandinavian countries Sweden (1.60%), Norway (1.06%) and Finland (2.91%) along with Germany (2.45%) and the Netherlands (2.82%) enjoy

relatively low to moderate WACC values, suggesting favourable access to capital, though they are still more favourable than those seen in Eastern Europe. However, in Southern Europe, countries like Italy (3.68%) and Greece (2.67%) face higher WACC levels, indicating more challenging financial conditions, while Spain (1.55%) enjoys lower costs, closer to the favourable conditions seen in the North.

A notable exception is the United Kingdom, which has one of the highest WACC values in Western Europe (5.27%). This spike is likely influenced by the economic uncertainties and increased risk perception following Brexit, which has disrupted trade relations, regulatory frameworks, and investor confidence.

In summary, the data highlights that companies in Western and Northern Europe generally have lower WACC, reflecting more favourable financing conditions, while Eastern European countries face higher costs, pointing to more challenging financial environments. Southern Europe, while benefiting from lower costs in some areas like Spain, still struggles with higher WACC in countries like Italy and Greece, which reflects regional economic disparities.

**Figure 4.9 Distribution of average WACC of automotive industry's companies by country in 2023**




Source: Author's calculation on Bloomberg data

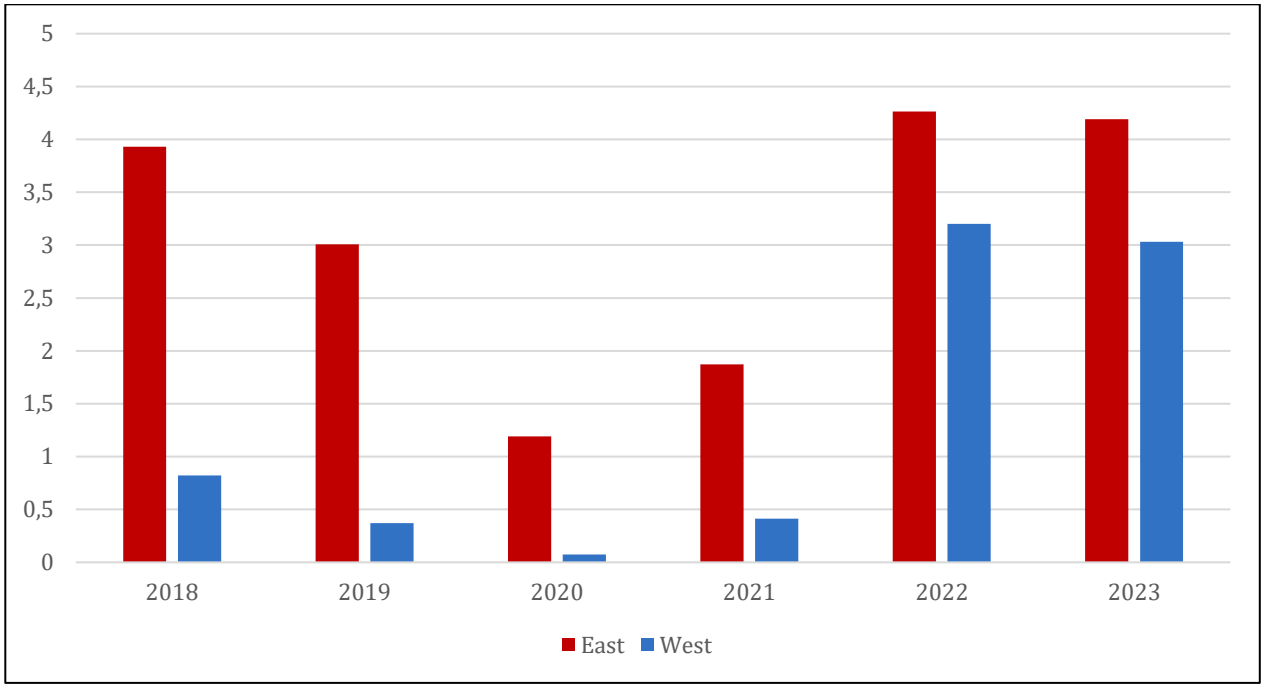
Figure 4.10 illustrates a noticeable disparity in the WACC between Eastern and Western European companies from 2018 to 2023. Throughout this period, Eastern European companies consistently experienced higher WACC than their Western counterparts. In 2018, Eastern Europe had a WACC of approximately 3.9%, while Western Europe started at a lower rate of around 0.8%. Both regions saw fluctuations over the years, with the WACC for Eastern Europe dropping to around 1.2% in 2020 before increasing again, peaking at about 4.2% in 2022. Western Europe maintained relatively lower WACC levels, with a slight rise in 2020 and peaking at 3.2% in 2022.

It's important to note that Russia and Ukraine were excluded from this analysis to maintain consistency with previous sections and because their WACC values were significantly higher than other countries in the region. The sharp rise in WACC observed during 2022 and 2023 can largely be attributed to the war in Ukraine, which caused substantial economic uncertainty in Eastern Europe, leading to increased risks and higher costs of capital. However, the exclusion of Russia and Ukraine ensures that the analysis focuses on

the broader trend across Eastern Europe without being skewed by the extreme financial volatility observed in these two countries.

In addition to geopolitical factors, inflation has also played a significant role in rising WACC levels. The European Central Bank's response to inflation, including raising interest rates, has increased borrowing costs across Europe, affecting both Eastern and Western Europe. Nonetheless, Eastern Europe, excluding Russia and Ukraine, still experienced more pronounced volatility compared to the West.

**Figure 4.10 Average level of the WACC of Eastern vs. Western European companies of the automotive sector from 2018 to 2023**



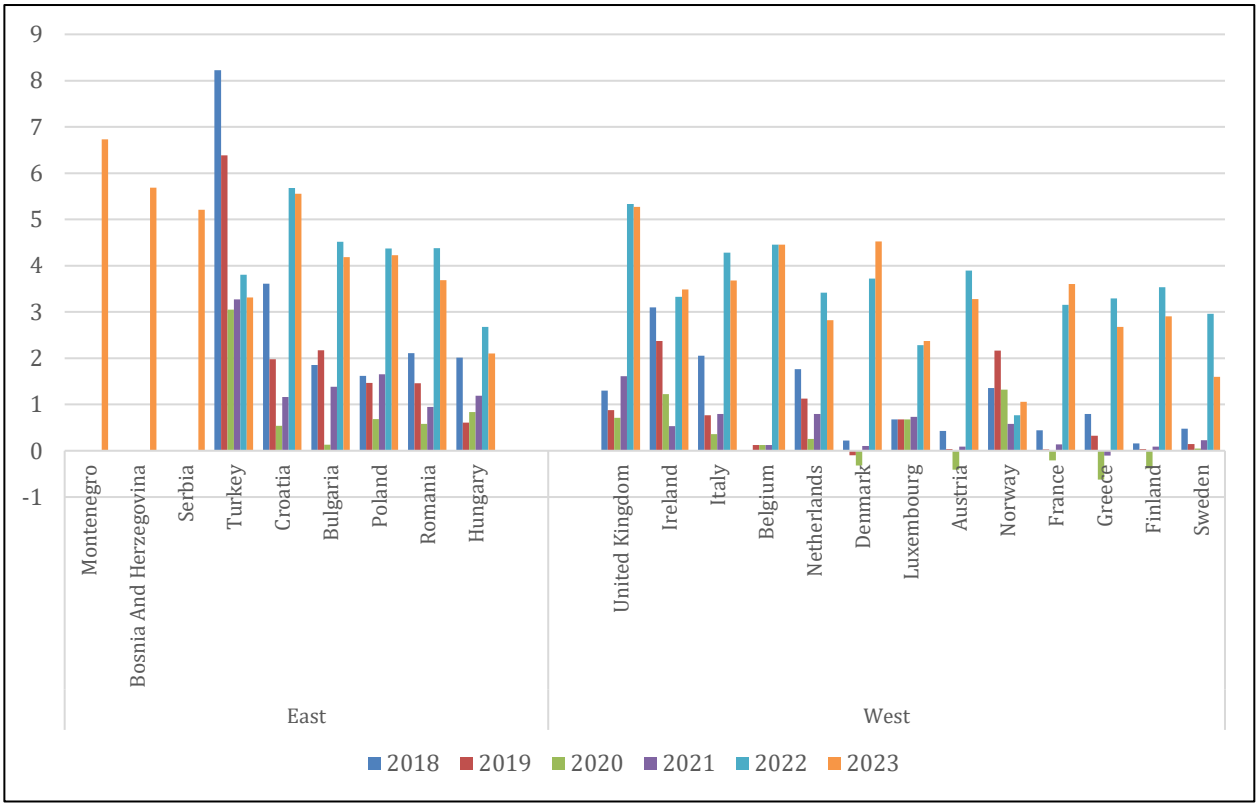

Source: Author's calculation on Bloomberg data

Figure 4.11 illustrates the distribution of the WACC for companies across single European countries grouped by their geographical distribution from 2018 to 2023, highlighting the important differences between Eastern and Western EU countries. The graph in Figure 4.11 highlights clear differences between these two geographical groups. Over the years, companies in Eastern European countries, such as Bosnia and Herzegovina, Serbia, and Croatia, consistently show higher WACC levels compared to companies in Western countries. Peaks in countries like Bosnia and Herzegovina and Montenegro reach up to 5%, particularly in recent years. In contrast, Hungary and Romania display relatively lower but still elevated WACC levels within Eastern Europe. Western European countries, on the other hand, maintain lower and more stable WACC levels. Companies in countries like France, Finland, and Sweden consistently show WACC values below 1% for the first four years, reflecting more favourable financing conditions. Notably, in 2023, Sweden maintained a relatively low WACC of 1.6%, which can be attributed to its strong economic fundamentals, energy independence, and effective inflation management. Sweden's reliance on renewable energy sources, such as hydro and nuclear power, shields it from the volatility seen in energy markets, helping keep financing costs low. In contrast, Denmark experienced a sharp increase in WACC, reaching 4.5% in 2023. This is likely due to Denmark’s higher exposure to global financial markets and the impact of ECB interest rate hikes. Furthermore, Denmark’s dependence on energy imports made it more vulnerable to the energy crisis, contributing to the higher WACC compared to countries like Bulgaria, Romania, and Hungary, which were less impacted by energy market volatility. Nevertheless, Denmark's WACC remains below the highest levels observed in Eastern Europe. Additionally, companies in Belgium and Denmark experienced significant increases in WACC in 2022 and 2023, but their values remain lower than those in Eastern Europe. A general rise in WACC values in 2022 and 2023 is visible across many

countries, particularly in Eastern Europe, reflecting increased economic uncertainty and risk perceptions. Interestingly, Greece exhibited relatively low WACC levels in 2021 and 2022, despite its history of financial instability. This can be explained by improved economic conditions following years of reforms and support from the European Central Bank (ECB), which likely helped reduce borrowing costs. However, Greece's WACC began to rise in 2023 as economic uncertainty and tightening global financial conditions increased borrowing costs across Europe.

Overall, the data reveals a persistent divide between Eastern and Western Europe, with companies in Eastern countries consistently facing higher costs of capital, while Western Europe enjoys more stable and advantageous financing conditions throughout the period. Additionally, it is evident that all countries, regardless of region, experienced an increase in WACC levels from 2021 onward, reflecting global financial tightening and higher risk perceptions. Notably, the largest average difference between the periods 2018-2020 and 2021-2023 was observed in the United Kingdom (increased by 3.1%), Belgium (increased by 2.9%), Denmark (increased by 2.8%), and Poland (increased by 2.1%).

**Figure 4.11 Distribution of the average WACC level of the country's companies by year. From 2018 to 2023**



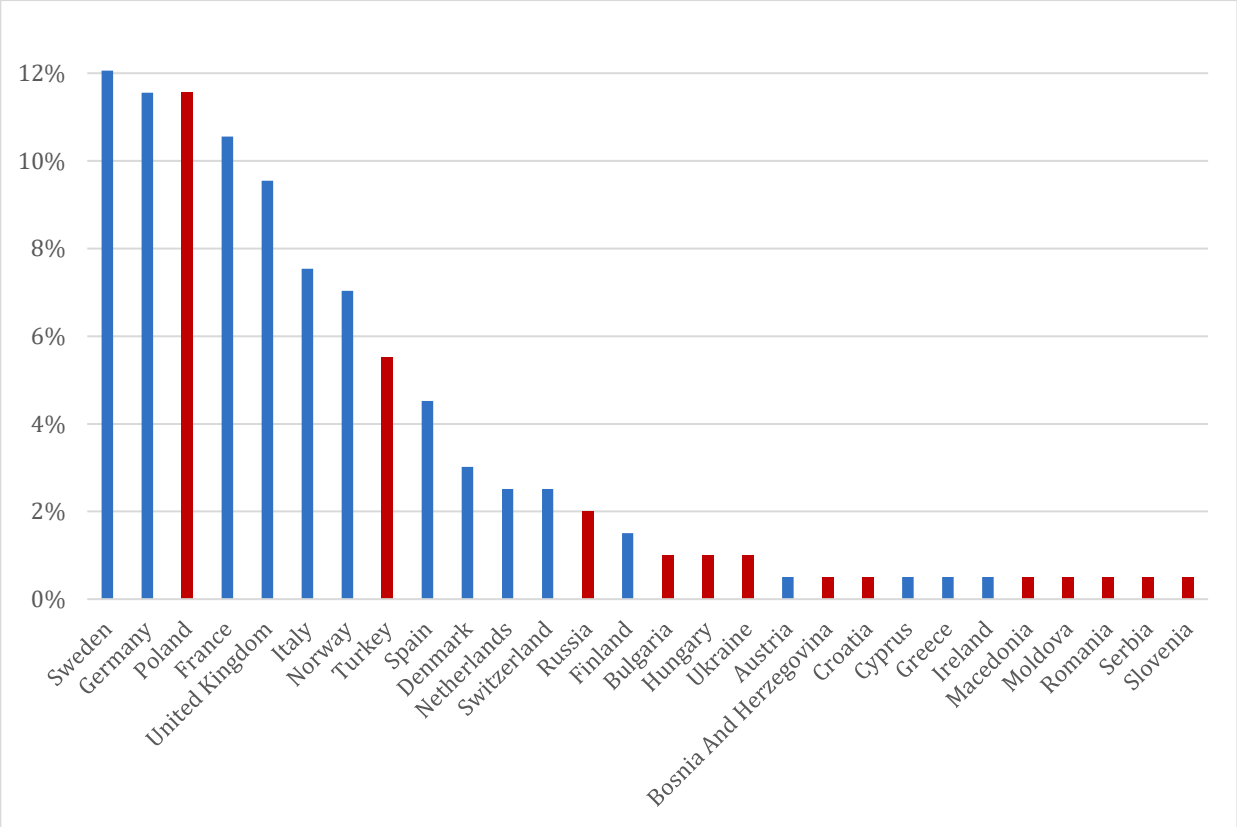

Source: Author's calculation on Bloomberg data

## *4.4.2 The cost of capital in the renewable energy sector*

In the European renewable energy market, 199 listed companies operated in 2023. The graph in Figure 4.12 illustrates the percentage distribution of these companies across European countries. More than half are concentrated in five countries: Sweden (12.1%), Germany (11.6%), Poland (11.6%), France (10.6%), and the United Kingdom (9.5%). Italy and Norway follow, each accounting for about 7% of the total number of companies. Western European countries dominate in terms of the presence of renewable energy companies, while Eastern European countries are generally less represented, except for Poland, which

holds a significant share in the sector. Overall, the graph highlights a clear difference in the distribution of renewable energy companies between the two regions, with Western Europe leading the sector's development.

**Figure 4.12 Percentage distribution of renewable energy companies by country in 2023[34]**

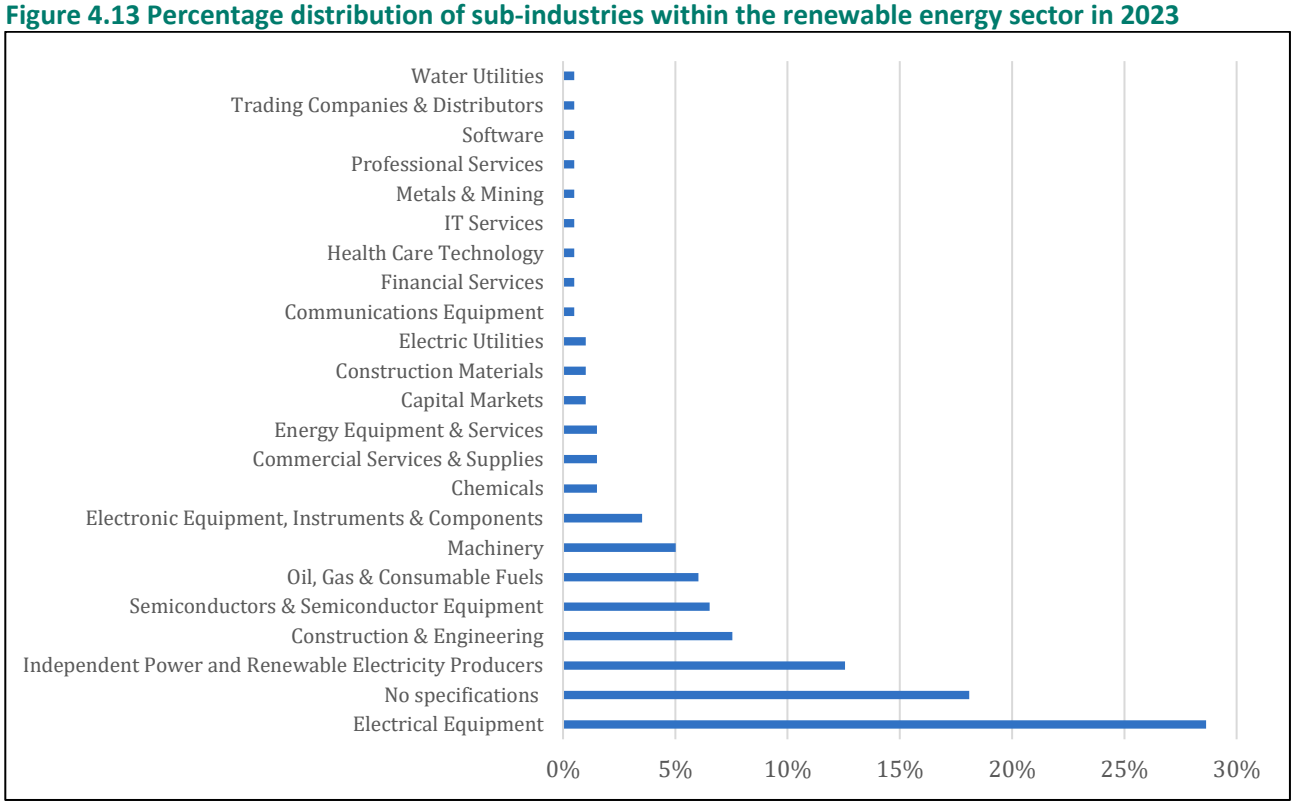



Source: Author's calculation on Bloomberg data

The renewable energy sector is highly complex and contains numerous sub-industries. The graph in Figure 4.13 shows the percentage distribution of these sub-industries. The most prominent industries are electrical equipment (28.6%) and energy production (12.6%). Other sub-industries include Construction & Engineering (7.5%), which is critical to infrastructure development, and Semiconductors & Semiconductor Equipment (6.5%), essential for energy production and management. The Oil, Gas & Consumable Fuels category (6%) refers to non-fossil fuels such as bioethanol and hydrogen, which are playing an increasingly important role in the energy transition. Although this category occupies a relatively small percentage of the chart, it represents a key technology for the future of the industry.

[34] Eastern European countries in red, Western European countries in blue.

**Figure 4.13 Percentage distribution of sub-industries within the renewable energy sector in 2023**



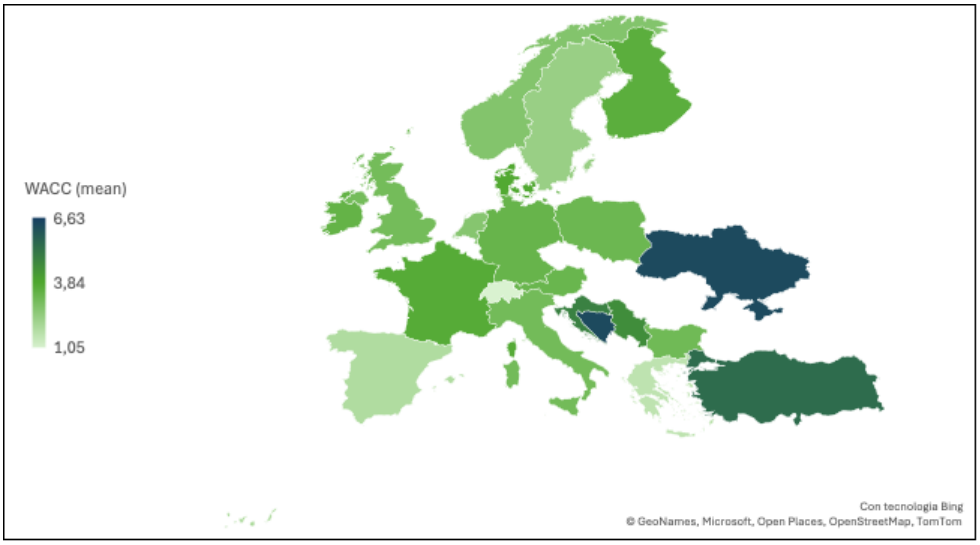

Source: Author's calculation on Bloomberg data

Figure 4.14 illustrates the distribution of the average WACC for companies in the renewable energy industry across European countries in 2023. Countries in Eastern Europe, particularly Turkey (5.4%) and Ukraine (6.3%), show some of the highest WACC levels, exceeding 6.63%. This suggests that companies in these regions face higher capital costs, likely due to a combination of factors, including geopolitical risks and economic instability. For instance, the ongoing war in Ukraine has led to increased uncertainty in the region, heightening perceived risks for investors and consequently driving up the cost of capital. Additionally, many Eastern European economies are more vulnerable to external shocks and economic fluctuations, further contributing to the higher WACC levels.

On the other hand, Western and Northern European countries exhibit significantly lower WACC levels. Countries such as the Netherlands (2.7%) and Sweden (2.35%) exhibit relatively low WACC values, reflecting more favourable financing conditions for renewable energy projects in these regions. Southern European countries like Spain (1.9%) and Greece (1.6%) also show low WACC values, indicating favourable conditions for investment. Countries like Italy (3.10%), Germany (3.35%), Ireland (3.41%), and France (3.68%), shows moderate WACC values, suggesting stable but slightly higher capital costs compared to their Northern counterparts.

It is important to note that Russia is not included in the map for reasons of clarity. With an average WACC of 53%, Russia's inclusion would have distorted the scale, making it difficult to visualize the nuances of WACC distribution across other European countries. Another important factor contributing to the higher WACC in Eastern Europe is regulatory uncertainty. Some countries in the region have less stable regulatory frameworks, especially regarding renewable energy policies and environmental regulations. This unpredictability can deter investors, who demand higher returns to compensate for the perceived regulatory risks. This, combined with the region's weaker financial markets and lower sovereign credit ratings, amplifies the challenges faced by companies in securing affordable capital.

**Figure 4.14 Distribution of average WACC of renewable energy industry's companies by country in 2023**

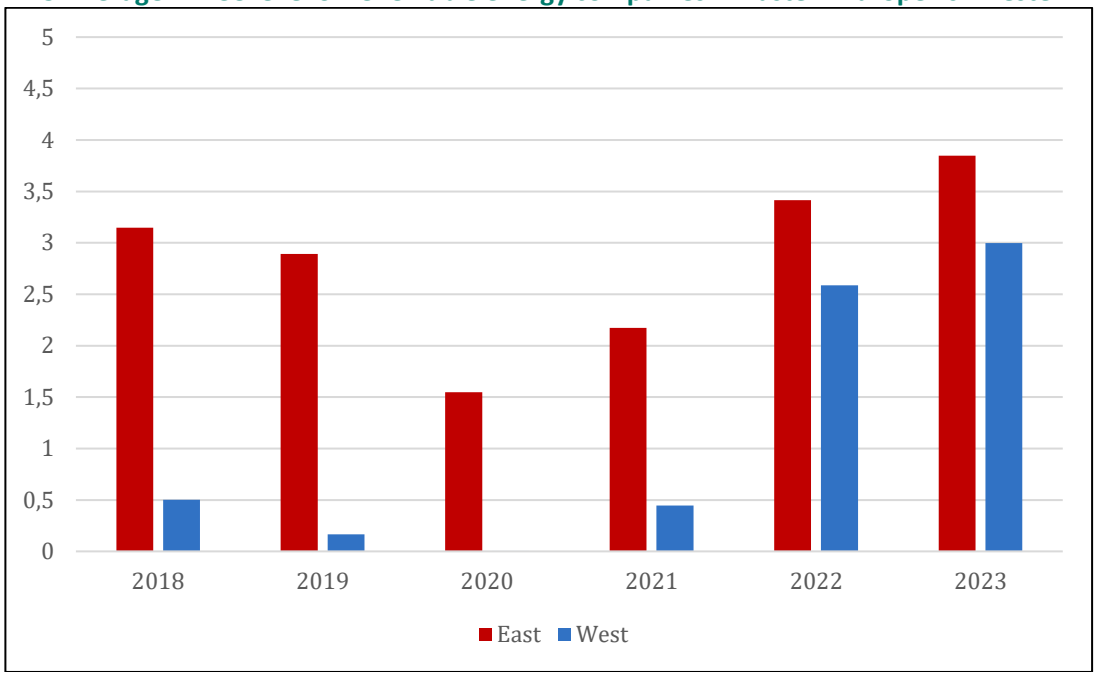



Source: Author's calculation on Bloomberg data

Figure 4.15 illustrates the average WACC levels of renewable energy companies in Eastern and Western Europe from 2018 to 2023. The data reveal a significant and persistent disparity between the two regions. Eastern Europe consistently exhibits higher WACC values, starting at approximately 3.15% in 2018 and slightly declining until 2020, when it reached around 1.55%. However, there is a marked increase in 2022, with the WACC rising to 3.42%, reflecting heightened geopolitical risks and economic instability. By 2023, Eastern Europe's WACC continues to rise, reaching 3.85%. In contrast, Western Europe maintains much lower and more stable WACC levels throughout the same period. After starting at 0.50% in 2018, the WACC in Western Europe declines sharply, nearly reaching 0% in 2020. It then gradually increases, peaking at 3.00% in 2023. It is important to note that Russia and Ukraine were excluded from this analysis to maintain consistency with previous sections and because their extremely high WACC values would have skewed the results for Eastern Europe.

This figure highlights the significant disparity in financing costs for renewable energy companies between the two macro-regions, with Eastern Europe consistently facing higher costs due to increased regional instability in recent years. The sharp increase in WACC for Eastern Europe in 2022 and 2023 can be attributed to the ongoing geopolitical tensions and the war in Ukraine, which have contributed to economic uncertainty and raised the cost of capital in the region.

**Figure 4.15 Average WACC level of renewable energy companies in Eastern Europe vs. Western Europe**



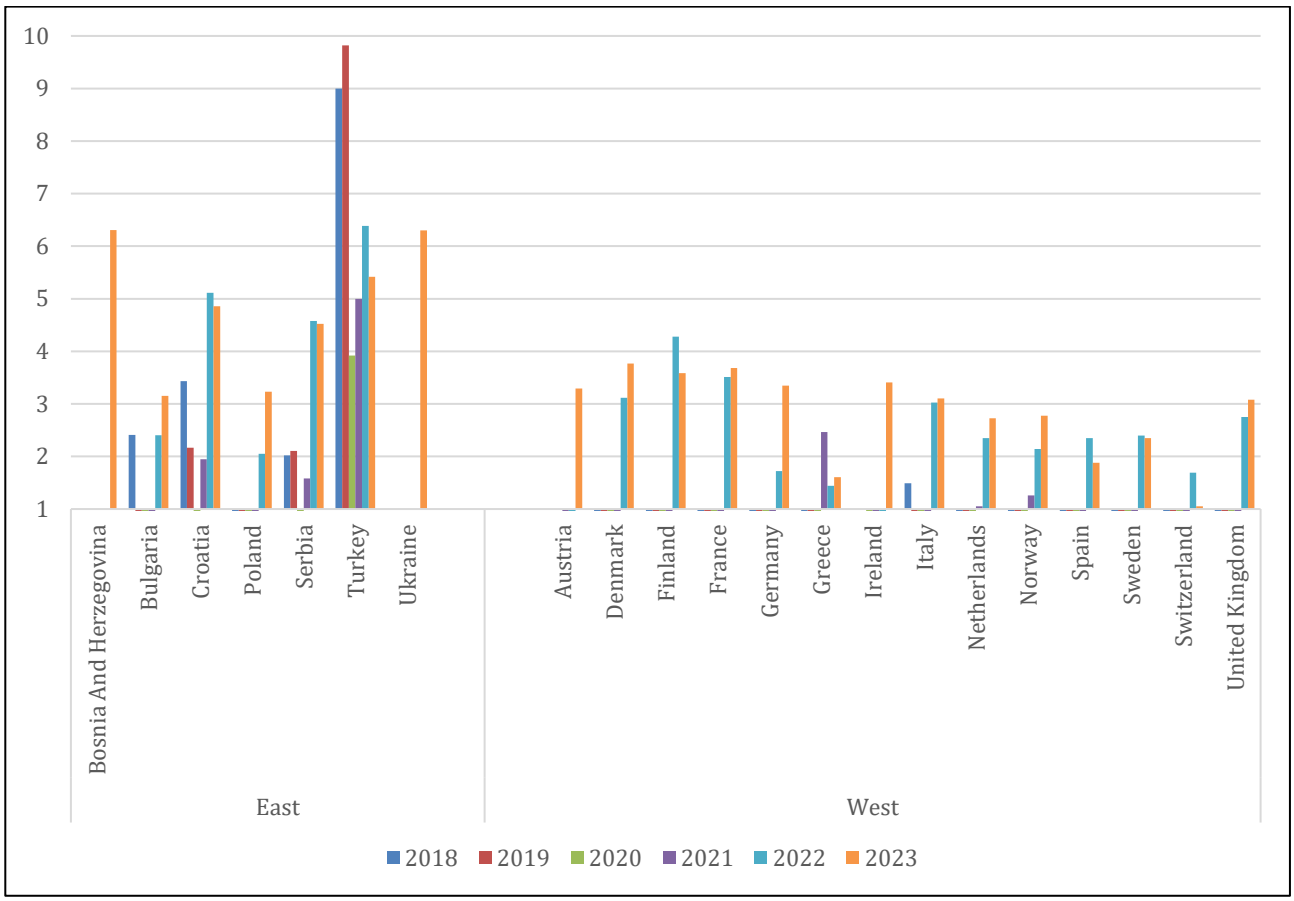

Source: Author's calculation on Bloomberg data

The graph in Figure 4.16 clearly illustrates the distinction between Eastern and Western European countries in terms of the average level of WACC. Eastern countries, such as Turkey and Serbia, exhibit higher values and greater volatility over time. Turkey, for example, peaks at 9.82% in 2019 before gradually declining to 5.42% in 2023, while Serbia reaches 4.58% in 2022 and remains relatively high at 4.53% in 2023. Western countries, such as France, Germany, and the United Kingdom, maintain more stable and generally lower WACC values. For instance, France moves from negative values in 2020 to 3.68% in 2023, and Germany increases from negative territory in 2020 to 3.35% in 2023. Similarly, the United Kingdom's WACC rises from 0.43% in 2021 to 3.08% in 2023.

Greece presents a unique case. After experiencing WACC levels close to zero from 2018 to 2020 due to support from the European Union and international institutions, the country saw a sharp rise in 2021, peaking at 2.47%. This increase reflects its recovery from the debt crisis but also highlights the higher perceived risk during that period. In 2022, the WACC dropped slightly to 1.44%, likely due to ongoing structural reforms and EU recovery funds that improved investor confidence. However, by 2023, the WACC increased again to 1.60%, reflecting global financial uncertainties and rising interest rates, which have made borrowing more expensive even for recovering economies like Greece.

Overall, all countries, both in Eastern and Western Europe, show an upward trend in the average WACC of renewable energy companies. Several factors can explain this increase. One possible explanation is the rising perceived risk associated with investment in the renewable sector. Although the sector is expanding, it remains subject to regulatory uncertainties, commodity price fluctuations, and high initial capital costs. Companies in the sector face challenges such as integrating new technologies, reliance on government incentives, and evolving energy policies. These factors tend to increase both equity and debt capital costs, reflecting the higher associated risks. Additionally, the global rise in interest rates in recent years has made debt financing more expensive, directly impacting the WACC of firms. This effect is particularly pronounced in emerging economies, where access to capital can be more costly and volatile.

**Figure 4.16 Distribution of the average WACC level of the country's companies by year. From 2018 to 2023.**




Source: Author's calculation on Bloomberg data

### *4.4.3 Comparison between the automotive and the renewables sector*

The analysis of the renewable energy sector and the automotive sector highlights significant differences in financing conditions across Europe. These differences have broader implications for the ability of companies in different countries/regions to invest and grow, creating potential economic imbalances between Eastern and Western Europe.

In the renewable energy sector, the WACC varies significantly, with Eastern European countries such as Turkey, Serbia, and Croatia experiencing more volatility and higher costs of capital. In contrast, Western Europe, particularly countries like Switzerland, Spain, and Germany, enjoys more stable and lower WACC levels, reflecting more favourable access to financing. These differences can directly impact the ability of companies to make long-term investments in renewable energy infrastructure. Countries with higher capital costs may struggle to attract the same level of investment as those with lower WACC, leading to slower growth in renewable energy capacity and innovation in Eastern Europe.

In the automotive sector, financing conditions tend to be more uniform across regions, but the WACC gap between East and West still exists. This can hinder the development of the automotive industry in Eastern Europe, which may lag behind Western Europe in terms of innovation and production capacity. The relatively higher cost of capital in the East limits the ability of companies to invest in cutting-edge technologies like electric vehicles or autonomous driving, which are crucial to the future of the automotive industry.

The disparity in access to capital across Europe, especially for the renewable energy sector, could exacerbate the economic divide between East and West. Western European countries, with their lower

WACC and more mature financial markets, are better positioned to take advantage of the green transition, making substantial investments in clean energy technologies. On the other hand, Eastern Europe, where capital costs are higher and more volatile, may struggle to keep pace, reinforcing the existing economic gap. This creates a dynamic where Eastern Europe is continually "chasing" the West in terms of investment, technology adoption, and sectoral growth.

In conclusion, capital access disparities have a profound effect on investment potential, with Western Europe leading in both sectors due to its more favuorable financial conditions. If left unaddressed, this could further entrench economic imbalances between the regions, particularly in the renewable energy sector, where investment is critical for meeting global climate goals. Eastern Europe may face continued challenges in catching up with the West, as higher financing costs limit their ability to compete and innovate at the same level.

# 5 The macro policy space for the transition investments

## 5.1 The EGD and 'Open Strategic Autonomy'[35]

Strategic Autonomy (SA) was officially mentioned for the first time, at the EU level, by the European Council conclusions on common security and defence policy of December 2013 (European Council, 2013). Since 2020, the scope of EU SA has been widened to virtually all policy areas, while the expression has often been qualified by the adjective 'open' or replaced by its multiple correlated 'derivations', such as 'strategic sovereignty', 'resilience', 'capacity to act', etc. (European Parliament, 2022). Although SA is currently defined in different and evolving ways (Miró, 2023), it may be broadly interpreted as the EU's ability to decide and act, free of foreign interference, in accordance with its rules, principles, and values (EC, 2021m; European Parliament, 2022; European Union Institute for Security Studies, 2021; Mauro, 2021). These undoubtedly include environmental protection, which has progressively moved in EU treaties from being a sectoral policy to one of the core, transversal principles of the EU legal order (Sikora, 2022) and, according to the EGD, a fundamental driver of economic growth (EC, 2019).

The green transition planned by the EGD has been affected by several external shocks (the COVID-19 pandemic, Russia's invasion of Ukraine, and the subsequent energy crisis), which on the one side, have confirmed the need to accelerate the green transition while highlighting, on the other, the related supply chain risks for critical and strategic materials, products, and technologies. In this context, also characterised by the increasing tendency of major powers to self-reliance and protectionism (Chinese Government website; European Parliament, 2022; Indian Government website; Kleimann et al, 2023), the debate about EU strategic autonomy (SA) has received renewed attention. SA has, hence, increasingly become a recurring element of the EGDSF. The late integration of SA into an already complex strategy, affecting all environmental policy areas and all economic sectors, is challenging in different respects. This situation is compounded by the multiple visions that EU policymakers and Member States have about what SA is and how to achieve it (ECFR, 2019; Miró, 2023). National divergences also reflect the uneven distribution of the costs associated with SA implementation across the EU-27 (which are, in general, higher for smaller countries because of their greater openness to and reliance on trade with non-EU countries).

In order to investigate the role of SA within the green transition (and the EGDSF), two specific issues should be addressed:

- First, given that SA is not an end in itself (European Union Institute for Security Studies, 2021; Gehrke, 2022), which are the specific purposes that, via SA, the EU strives to achieve in the green transition?
- Second, how is SA being operationalised? What kind of policy measures have been planned by the EGDSF and are being adopted to reach the desired autonomy?

In order to answer the above questions, an in-depth qualitative analysis of the EGDSF has been carried out. Based on this analysis, firstly, three specific SA objectives were detected within the EGDSF, namely:

1) Enhancing the resilience of supply chains that are key to the green transition, especially by making them less dependent on imports from third countries and less exposed to the related geopolitical risks. This objective pertains to the idea of SA as a spectrum that represents different degrees of autonomy and dependency (European Union Institute for Security Studies, 2021).
2) Promoting environmental protection and resilience beyond EU borders. Climate change and environmental degradation pose challenges (e.g. conflicts, food insecurity, changes in the availability of critical assets, population displacement, and forced migration) likely to influence almost any

[35] The present section is based on the research work presented in Paleari (2024).

initiative on SA (Akgüç 2021). Moreover, the lack of environmental commitment/results by third countries could undermine the EU's efforts in the face of global environmental problems, with potentially severe economic and social consequences both within and outside the EU. Since all EGDSF documents plan environmental actions with potential positive effects beyond EU borders, we have chosen to focus, from an SA perspective, only on those EGD measures that are specifically aimed at reducing environmental degradation and increasing resilience to environmental risks in third countries.

3) Ensuring a level playing field (firstly on the EU internal market) for EU businesses and products that must comply with environmental requirements. This objective reflects the European model of economic growth, which is based on 'sustainable competitiveness' (EC, 2023w) and the fact that the EGD is, at the same time, a growth and environmental strategy (EC, 2019). 'Green' EU business/products are needed to accelerate the EGD transition, but if they are not competitive, EU dependence on third countries will increase.

Secondly, for each specific SA objective, a categorisation of the related implementation measures scheduled by the EGDSF has been prepared. Implementation measures were classified into three groups according to the SA objective they mainly serve. Relevant legislative proposals of the European Commission were also considered (see Table 5.1).

**Table 5.1: SA objectives and classification of measures planned by the EGDSF to achieve them**

| |
|---|
| *1 Enhancing the resilience of supply chains that are key in the green transition, especially by reducing dependence on imports from third countries and the exposure to the related geopolitical risks* |
| • Measures to reduce the dependence on imports from third countries.<br>  ○ Measures to increase the domestic sourcing, processing, and production of key resources/products;<br>  ○ Specific environmental measures (e.g. to increase energy efficiency).<br>• Measures to diversify imports from third countries.<br>• Measures to manage critical/emergency situations. |
| *2 Promoting environmental protection and resilience beyond EU borders* |
| • Measures promoting sustainability and environmental protection in third countries.<br>• Specific measures to reduce the EU environmental footprint beyond EU borders |
| *3 Ensuring a level playing field in the EU market for EU businesses and products that must comply with environmental requirements* |
| • Measures setting environmental requirements applying to imported products and/or to the related production processes.<br>• Measures setting environmental requirements applying to non-EU companies and investors operating in the EU.<br>• Measures to improve the implementation/enforcement of the above environmental requirements. |

Source: Paleari, 2024

As a last step of the research process, it was discussed whether the specific SA objectives and the related implementation measures stated within the EGDSF support the EGD's environmental ambitions by highlighting the most relevant synergies and trade-offs.

Overall, the three core SA objectives embedded into the EGDSF have been set in support of EGD goals. The green transition indeed cannot take place if the EU is not able to improve the resilience of the related key supply chains, preserve the competitiveness of the EU business and products that must comply with environmental requirements, and promote environmental protection on a global scale.

Frictions, however, may arise depending on the implementing measures planned to meet SA objectives. Some implementing measures (e.g. energy efficiency and circular economy measures) are certainly beneficial from both SA and EGD perspectives. In other cases, instead, trade-offs tend to emerge. Identifying and managing these trade-offs is crucial for the success of the EGD. In particular, current

measures that promote self-sufficiency and the extension of environmental requirements to foreign businesses/products accessing the EU market raise some environmental, economic, and social concerns.

With regard to self-sufficiency, its improvement is a cumbersome process that requires 'political will, long-standing executive action and more than a mere contribution from the EU budget' (European Parliament, 2022, p. 8). This does not fit well with the EU commitment to be climate-neutral by 2050 and the urgency to efficiently transform Europe's energy system (Tagliapietra, 2023). Furthermore, the costs of resilience are not acknowledged by the proposed CRMs Act and the NZIA (EC, 2023g and 2023h), and there is no new EU-level funding strategy accompanying the EGD Industrial Plan. The way this objective is being operationalised also raises environmental and social concerns. In order to meet the targets, they established the CRMA and the NZIA (EC, 2023g and 2023h) introduce faster permitting procedures, even if permitting alone is unlikely to substantially speed up strategic project development. In light of the above and considering that international supply chains are often more efficient and diversified and, hence, more capable of rapid adaptation to new shocks than local ones, the EU should carefully evaluate on a case-by-case basis whether and for which products self-reliance is a valuable approach (Vega, 2021).

Another sensitive issue is the ongoing extension of the EU environmental requirements applying to imported products (see e.g. the legislative initiatives on eco-design (EC, 2022c) and setting new sustainability and safety requirements for batteries, packaging, construction products, vehicles, and toys (EC, 2022e, 2022n, 2023f, 2023j; EU, 2023i), the related production processes (see e.g. the CBAM (EU, 2023d) and the Regulation on the placing of products associated with deforestation or forest degradation on the EU market (EU, 2023j), and certain foreign companies accessing the EU market (see e.g. the proposal for a Corporate Sustainability Due Diligence Directive (CSDDD; EC, 2022o). These measures may generate environmental benefits beyond EU borders (so-called 'Brussels effect'; Bradford, 2012; Kettunen et al., 2020; Raimondi et al., 2022). However, the direct cost that they impose on the EU's trading partners may discourage the latter from exporting to the EU, which, in turn, plays against the EU's efforts to diversify its sources of imports (Guinea et al., 2023). Some of the proposed initiatives (like the CBAM; EU, 2023d) are often perceived as a distortion to international trade or as unequal since they mostly impact the least developed countries that are especially vulnerable to climate change (Guinea et al., 2023; Magacho et al., 2022). The new requirements could lead to undesirable countermeasures and directly affect the EU's openness to trade and investment (Molthof et al., 2022). In using these tools, the EU should, therefore, remember that its strength remains its market openness and that tackling climate change and other environmental challenges can only be carried out via global engagement and cooperation (EC, 2021m; Meyers, 2022).

## 5.2 The macro investment space: 'fiscal competition' and the Capital Markets Union

The investment needs and EU funding allocation to the EGD-led transition have macroeconomic relevance, and the feasibility of the process must be seen vis à vis the macroeconomic dynamics of the Union and its Member States (Cerniglia and Saraceno 2023).

Public budgets of the EU countries have been heavily impacted, after the 2007-2008 global financial crisis (GFC), by the economic effects from the Covid-19 pandemic, the energy crisis and Russia's invasion of Ukraine. Then, in this phase, the European macroeconomic policy environment is now again pervaded by concern of fiscal sustainability and the need of fiscal consolidation.

The Stability and Growth Pact (SGP) was suspended in 2020-2023 and the EC presented a proposal to reform the EU fiscal rules in April 2023 (EC, 2023r) and the reform proposal were adopted in April 2024.[36] The new SGP criteria do not allow to envisage radical changes with respect to the fiscal discipline of the old SGP. During the discussion of reforming the SGP several proposals were made to introduce a golden rule by excluding green public investment from the calculation of the 3% budget deficit rule and thus safeguarding the required investment expenditures for the green transition (see for further discussion and literature: Bénassy-Quéré, 2023, and Blesse et al., 2023) but it did not prevail within the reform.

The peril from this process is real that the political will to allocate resources to the EGD transition investment will fall short. The new fiscal reality must also incorporate the projections that Europe will face less economic growth entailing weaker government revenues and thus the financial scope of governments will decrease.

However, European government are facing competition in allocating scarce public budgets and solely focusing on higher public investment for the environment-energy-climate transition will miss the overall challenge of a sustainability transition in the evolving global macroeconomic and geopolitical framework. This process stimulates the concern that a 'fiscal competition' across different public policies already emerged before the Covid crisis will emerge again (EEA 2020).

Some of these fiscal and financial challenges can be: digital transition, increase in military expenditures, investment in social infrastructure (as already laid out in EC, 2018), high inflation followed by increases in the key interest rates by the European Central Bank leading to higher costs of public debt management (OECD, 2023 and Claeys et al., 2023), the projected steady increase in the costs of an ageing population (EC, 2021l,[37] and keeping the competitiveness of the European economies intact (EC, 2023sand 2023t).

For example, the EC additional annual investment for the digitalisation is projected to be in the range of €125 billion per annum until 2030 (EC, 2022k). The digital transition will contribute to the green objectives in various sectors of the economy (e.g. smart buildings, smart and sustainable mobility systems, digital 'product passports', precision farming), with synergies especially in many areas of a smart circular economy. The digital sector is expected to foster the uptake of technologies with lower environmental footprint and higher energy and material efficiency, for instance by promoting technological excellence through energy efficient semiconductors (EC, 2022k) (Table 5.2)

**Table 5.2 Social infrastructure – Additional annual investment needs until 2030 (€ bn)**

| ***Sector*** | ***€ bn*** |
|---|---|
| Education and long-life learning | 15 |
| Health* | 70 |
| Long-term care | 50 |
| Affordable housing | 57 |
| ***Total*** | ***192*** |

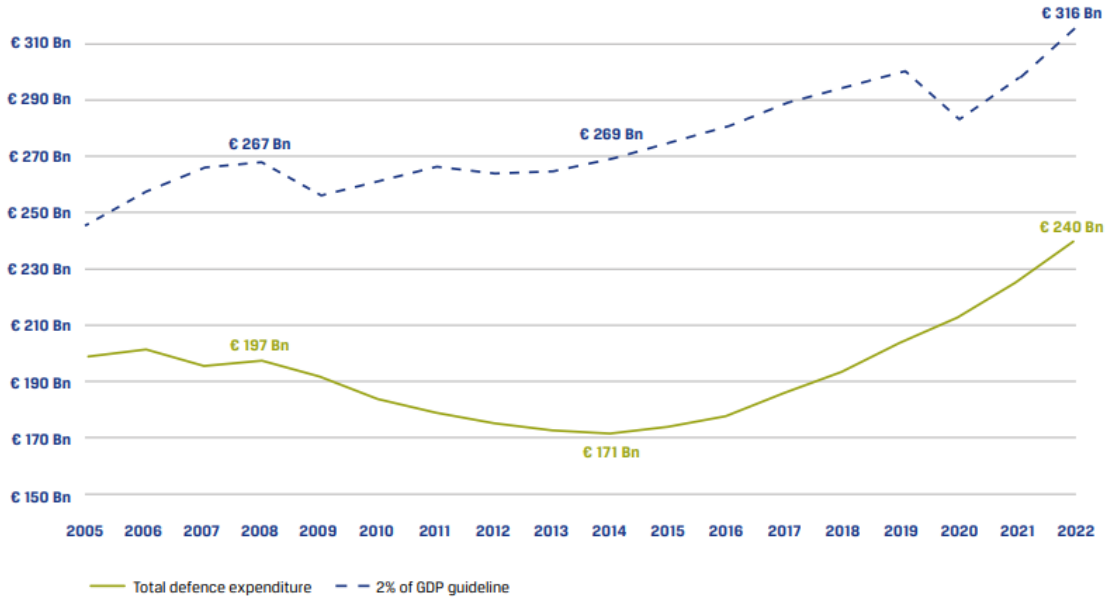
* The original estimate of €20bn before the crisis has been inceased to €70bn due to the crisis.
Source: EC, 2021j

In the area of defence, according to EDA, the European Defence Agency (EDA 2023), in 2022, before the Ukaine war, defence expenditure of the 26 EDA countries was growing since eight years, achieving a total amounts of €240billion, or 1.5% of GDP of the EDA countries. With respect to the historically lowest level

[36] See for more information on the proposal the policy brief of the European Trade Union Institute (Theodoropoulou, 2023), the note by Bruegel (Darvas, 2023) and for a summary of the main features of the new European Union fiscal framework (Darvas et al., 2024).

reached in 2014, defence expenditure increased by about €69 billion, or 40% in real terms. However, to comply with the guideline of spending 2% of GDP on defence EDA countries would still need to spend additional €76 billion (Figure 5.1). Then, defence expenditure resisted the economic impact of the COVID-19 and the Ukraine war created strong impulses to reach at least the 2% of GDP or to go beyond in the new strategic framework. An increase in defence spending will put fiscal pressure on the public budget of EU Member States which are members of NATO and are currently below the political commitment of 2% of GDP (Zettelmeyer et al., 2023 and NATO, 2022). According to EDA 'spending is set to grow by up to €70 billion by 2025, as Russia's invasion of Ukraine forces a paradigm shift in Europe's foreign and defence policy' (EDA, 2022).

**Figure 5.1 Total defence expenditure and 2% of GDP guideline in EDA countries (constant 2022 prices)**




Source: EDA, 2023

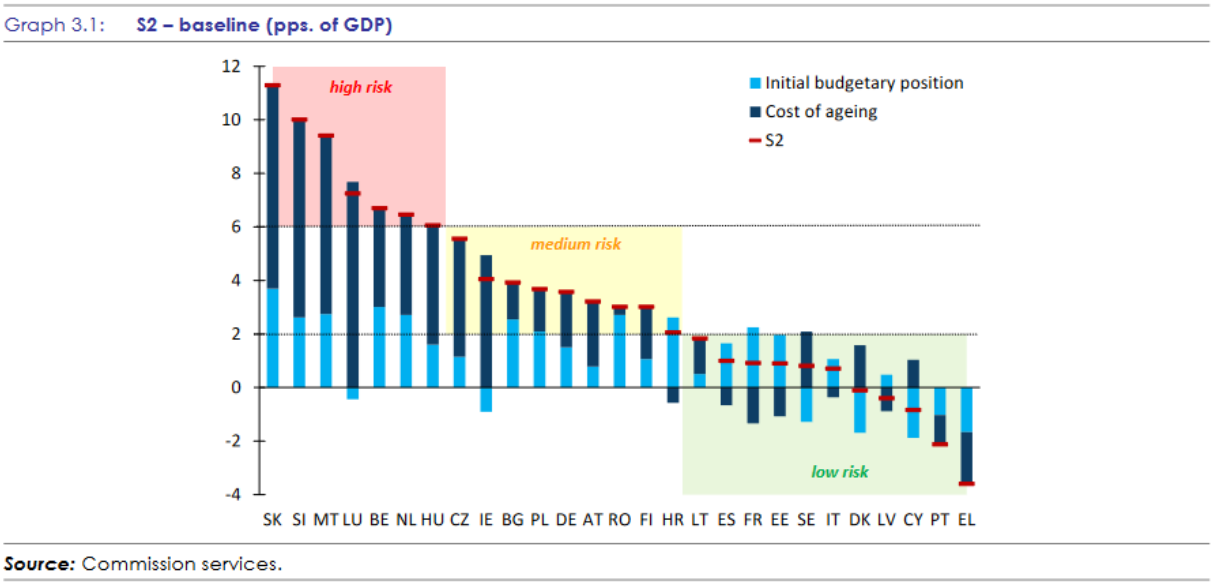
One of the most pressing challenges is the demographic transition: ageing societies and demographic change in terms of a shrinking population is expected to lead to an increased demand for public expenditure (pensions, health, assistance), although EU Member States are differently affected from the demographic transition (EEA, 2020). The latest projections published by the European Commission estimates that EU's total costs of ageing will increase by 1.4 (2.5) pps of GDP between 2019 and 2030 (2050) from 24% of GDP to 25.4% and to 26.5% in 2050 respectively (EC, 2021l). This development is expected to strain on productivity and economic growth in the EU (Blesse et al., 2023) and is a critical factor when assessing the fiscal sustainability of EU Member States[38].

According to the Debt Sustainability Monitor of 2022 (EC 2023u), ageing is a powerful factor of future fiscal imbalances. In the medium term, in the EU as a whole, the debt-to-GDP ratio is projected to decline slightly until the late 2020s, but it will rise again due to the increasing cost of ageing and the impact of interest payments and debt growth. Long term fiscal sustainability risks are high in seven Member States (Belgium, Luxembourg, Hungary, Malta, the Netherlands, Slovenia and Slovakia) and medium in twelve Member

[38] See for example the report of the Irish Department of Finance highlighting the fiscal risks and challenges evolving with an aging society when assessing of how to make the Irish fiscal system future-proof at a time of multiple crises (Department of Finance, 2023).

States, and they are largely driven by increasing ageing costs. The long-term sustainability indicator (S2) suggests that, in the EU as a whole, an average fiscal adjustment of 2.7 percentage points of GDP would be required to stabilise debt in the long term. To the initial budgetary situation that require an adjustment of 1.4 percentage points of GDP, another 1.3 percentage points should be added as a consequence of the budgetary costs induced by ageing (Figure 5.2).[39]

**Figure 5.2: Contribution of ageing to the fiscal sustainability gap**




Source: EC 2023u

The challenge is thereby to achieve the balance between maintaining healthy fiscal systems and funding large and strategic investments towards a digital and green, climate friendly society and economy in an increasingly adverse framework in which old issues, like ageing, and new issues, like the increase of military spending, create increasing competition for public resources. In particular, macroeconomic and monetary policies should be able 'to avoid a systematic trade-off between delivering on European investment priorities and the maintenance of healthy fiscal balances' (Blesse et al., 2023). The reform of the SGP highlights that the trade-off is real because of fiscal consolidation pushes. In this framework of resource constraints, the choice may be in favour of social spending and the allocation to urgent issues, like military spending, that receive immediate priority.

It can be noted that part of the higher public deficits and debt-to-GDP ratios achieved in the last few years in the EU countries arise from the transfers granted to households for subsidizing them in front of the increasing energy costs induced by the Ukraine war and its inflationary consequences. Even in this case, the social concerns *de facto* prevailed over the sustainability transition concerns in public budgets allocations: the increase in energy prices could have been a driver of behavioural changes and investments into environmentally friendly technologies, with strong responses of energy saving and efficiency, which is the same outcome expected from market-based instruments like carbon taxation. This has not been the case in most EU countries. In this perspective, approaches like reducing environmentally harmful subsidies, in particular energy tax exemptions or reductions, as a source of public funds for the sustainability transition risk to be unsuccessful as far as the removal of explicit and implicit subsidies entail costs for consumers and households, that is the social side of the sustainability transition.

[39] See Darvas, Welslau and Zettelmeyer (2024) for an update discussion regarding the ageing population and debt sustainability.

The possible insufficiency of public funding for the huge EGD-related investment needs, stimulates questions about the possible role of the financial system in complementing or substituting public finance.

Through a process started in 2018 with the Action Plan on Sustainable Finance, the EU is trying to deeply involve the financial sector as a key actor of the transition both in itself and as an agent that transfers the transition to the real economy through selection criteria (e.g. the Taxonomy [40]) for eligibility or preferentiality in borrowing and lending. However, the financial system is increasingly clarifying, inside itself and towards policy makers, that it can be an enabler and not a driving actor of the transition that can act as a substitute of specific policies.

In particular, the position of the international financial community (see IIF 2023) is that 'Recent debate amongst private sector, official sector, and civil society actors has revealed a diverse range of views on the role of the financial sector in supporting the net zero transition, with some stakeholders seeing the financial sector as a primary driver of change. There is limited common understanding of the capacities and limitations of the role of financial institutions in this context, nor is there agreement on the level of direct and indirect influence they can have on real economy decarbonization outcomes. While the financial sector has a critical role to play, its ability to support the transition will depend significantly on whether the conditions are in place to enable the real economy to transition, thereby creating opportunities for finance and investment to support such activities. Over-reliance on the financial sector and its regulators to deliver the net zero transition risks diverting attention from the fundamental policies needed to catalyse actions across the entire economy.'

As a consequence, the financial sector can enable the work to be done, on the one hand, by policies and, on the other hand, by enterprises in moving towards the key objectives, like the Net Zero transition. More in particular, in order to keep financial sustainability, the financial sector can intervene when the real-economy actors are credited profitability on their transition investments, which can depend on policy provisions, from regulation to fiscal instruments (e.g. carbon pricing), co-financing from public funds, changing consumers' attitudes, and other profitability factors. The consequence of confirming the key features of the financial business even within the wave of sustainable finance is that, if profitable, also investments in 'brown economy' can be part of the financial sector portfolio: 'The ability of financial institutions' activities to support the net zero transition will therefore depend in large part on whether the necessary enabling environment for real economy transition is in place. For transition activities to be economically viable, clear commercial incentives are needed for action to be taken across the real economy, alongside regulations and legislation that can directly influence corporate behavior in sectors with high impacts on the environment. Fiscal policy (e.g., tax credits, consumer subsidies) may be used to provide incentives for consumers and firms across the value chain. By leveraging market mechanisms, carbon pricing provides the most efficient and cost-effective way of shifting the underlying economics of transition investments, while also generating tax revenues that can be used to fund other aspects of the transition. Equally, as long as high-emitting, highly polluting activities which are unaligned with net zero transition goals continue to be profitable, they will continue to attract capital from investors that are seeking returns.' (IIF, 2023)

Therefore, taxonomies coupled with ESG criteria and other compliance tools can be additional selection tools in the hands of the financial sector, and as such can be very relevant, but cannot be the basic incentive for enterprises to invest. Furthermore, 'transition planning' is the preferred approach for financial actors in dealing with the Net Zero, and it must be distinguished from climate-related material and regulatory risks, which should be treated instead as the other risks of lending, provided that they deserve a specific attention for the reliability of climate risk measures.

[40] See for further information with regard to the EU taxonomy for sustainable activities: https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en

This expected intermediation role of the financial sector, clearly raises the issue of the propensity of the private sector to invest into the EGD transition (see Section 4.2).

When looking at the macro-financial conditions of the transition, it is relevant to look at the current political debate regarding the Capital Markets Union (CMU), which was in particular put forward by the former Italian prime minister Enrico Letta in his recently published report on the EU single market (Letta, 2024). The CMU framework was established 10 years ago with the objective of the creation of a single market for capital across the EU and thus promoting financial integration. The planned outcome was to make it easier for businesses in one EU Member State to source funding from another Member state, and thereby boosting investment and creating jobs in the EU. However, it must be said that the performance of the CMU is disappointing (Véron, 2024) and the policy initiative more or less failed in the sense that the initiative didn't make it easier for companies to obtain debt and equity capital.

The CMU project was re-labelled as the 'Savings and Investments Union' by Letta (2024) and is now marketed as a key tool in providing the required funds for the transition to a climate neutral and digital Europe, as '[C]ompleting the Capital Markets Union could attract an extra EUR 470 billion of investment per year' (von der Leyen, 2024).

Though there may be uncertainties whether national governments will have sufficient fiscal space for investment under the new EU fiscal governance[41], which was adopted in April 2024. The new fiscal rules may relieve some pressures for national governments of how strategic investments will be funded. The investment needs for the green transition are substantial but investment needs are also identified in other sectors, such as the digital transition, social infrastructure like health or education, investment for public capital stock and especially for defence, (see above and EEA, 2023). When these broader investment needs are considered, it is stated in an ECB blog (2024) that '[F]or some countries, the fiscal space made available by the new fiscal rules may still not be sufficient' (Bouabdallah et al., 2024). EIB's annual investment report (2024) concludes that 'the reinstalment of fiscal rules is likely to result in fiscal consolidation, which tends to affect public investment disproportionately'. This may be not the case immediately, as the Recovery and Resilience Facility (RRF) of the NextGenerationEU may protect public investment until the RRF expires at the end of 2026. Afterwards there is a risk that national governments will be forced to introduce fiscal consolidation either by reducing spending or by increasing existing or implementing new taxes. The trend is to follow the former policy because 'cutting public investment, which is usually the first victim of fiscal consolidation' (EIB, 2024).

## 5.3 A stronger industrial policy towards a Clean Industrial Deal

An important element of the required structural transition towards a competitive, digital, and climate-friendly Europe is the industrial sector and what role industrial policy can and will play for the transition process – also with regard to the new geopolitical and geo-economic environment (see Section 5.1).

This is the core of the second phase of the European Green Deal, as European Commission President Ursula von der Leyen put the launch of a Clean Industrial Deal at the top of the EU agenda for 2024-2029 (von der Leyen, 2024). To achieve the major task of making decarbonisation compatible with industrialisation, the EU will need to foster major shifts in its industrial structures, including transitions from fossil fuels to renewable energy and from combustion engine cars to electric cars. Shifting economies from brown to green will be an historic socio-economic transformation. Not by coincidence, the climate action challenge is often referred to as an industrial revolution against a deadline. In this context of broad, paradigmatic,

[41] See https://economy-finance.ec.europa.eu/economic-and-fiscal-governance/new-economic-governance-framework_en

change for the European industry, a strong green industrial policy becomes fundamental to Europe's climate change ambitions.

There are limits to what the market and the state can individually deliver. For a successful green industrial policy, mechanisms will be needed that make them work together efficiently. The design of public-private partnerships (PPPs) will make or break industrial policy efforts. The major transformative change demanded by climate change will also require the involvement of civil society more than in other areas of industrial policy. Green technologies, often still emerging, are complex and uncertain. Future uncertainty about climate and technology scenarios underlines the importance of self-discovery on the market, and industry-research collaboration.

To date, Europe has been characterised by a multitude of green industrial policy initiatives, undertaken at regional, national and EU levels (Table 4.1).

**Table 5.3: Europe's main green industrial policy tools**

| | *Innovation* | *Deployment* | *Framework conditions* |
|---|---|---|---|
| ***EU level*** | • Horizon Europe<br>• European Research Council<br>• European Innovation Council<br>• European Institute of Innovation and Technology | • European Alliances<br>• IPCEIs<br>• EU Innovation Fund<br>• European Investment Bank<br>• EU Cohesion Funds<br>• Next Generation EU<br>• Single market rules | • Trade and investment policy<br>• Competition policy<br>• Environmental standards<br>• Climate policy<br>• Energy policy<br>• Development policy |
| ***National level*** | • R&D programs | • State aid<br>• Investment programs<br>• Incentive programs<br>• Public procurement rules<br>• Clean energy standards | • Energy policy<br>• Environmental standards<br>• Environmental taxation |
| ***Regional level*** | • Regional PPPs | • "Smart" specialization strategies<br>• Regional investment budgets<br>• Implementation of EU Cohesion policies | • Regional regulations |

Source: Tagliapietra et al. 2023b.

These initiatives are generally not coordinated. This is a major issue, because significantly different green industrial policies in different EU countries fragment the EU single market and could disrupt the level playing field. A fragmented EU single market for green technologies prevents innovative European cleantech companies from scaling up in the way that their United States and Chinese competitors do on their domestic markets. It is thus important for Europe to develop a solid regulatory framework accompanied by competition policy enforcement, ensuring access to a truly single, competitive EU market with common environmental standards (Tagliapietra and Veugelers, 2020).

This issue, already very important in the past, has become a top political priority after the introduction of the Inflation Reduction Act (IRA) by the US Administration. This move has sparked profound industrial competitiveness concerns across Europe and pushed the need for a new and strong EU green industrial policy. At a time in which the European industry was already under severe pressure due to high energy prices, the fear is that the IRA could push European clean-tech manufacturers to shift their investment decisions and move to the United States – in search for an attractive mix of IRA subsidies and low energy prices. This fear is reinforced by the early evidence emerging in the US for post-IRA investments in both clean tech manufacturing and deployment. According to Rhodium Group and MIT-CEEPR (2024), there was USD 493 billion in new investment in clean technologies and technologies by business and consumers since the IRA was enacted in 2022 until the first half of 2024. This corresponds to a 71% increase from the two-year period preceding the legislation. Federal investment is estimated to be in the range of USD $78 billion — including tax credits, grants, and loan guarantees — during the same period indicating that private investment in these technologies was 5-6 times larger than public investment.

Even though such concerns are not new to Europe (see, for instance, the race for semiconductors with Japan in the 1980-1990s, and the competition with China in several sectors including solar panels in the early 2000s) this time around, things look even more complicated. The US puts forward a green industrial

policy package that is both sizable (i.e., USD 369 billion of subsidies) and very simple and effective (i.e., mainly tax credits for 10 years). This mix makes the package particularly attractive for companies and places the US on course to leapfrog Europe in the clean tech space.

This is particularly problematic for Europe. First, Europe is lagging behind Asia and the US on the global race for digital technologies. This increases pressure to be a leading force in the green tech space. Otherwise, it will fail to reap the industrial benefits of both the ongoing revolutions, digital and green. Second, the European economic fabric is highly reliant on carbon-intensive industries, such as the automotive industry, that will be completely reshaped in the coming years. Turning brown jobs into green jobs thus represents a key necessity for Europe to maintain and strengthen its socio-economic model in the future. Overall, this ultimately is the reason why the EU has adopted the European Green Deal as its "growth strategy".

The European Commission published in March 2023 the legislative proposal for an EU response to the IRA: the Net Zero Industry Act (NZIA; EC, 2023g). The proposal is an industrial policy to promote cleantech manufacturing organised in four steps. First, it lists net-zero technologies considered to be "strategic". These include solar photovoltaic and solar thermal, onshore wind and offshore renewables, batteries and storage, heat pumps and geothermal energy, electrolysers and fuel cells, sustainable biogas and biomethane, carbon capture and storage (CCS) and grid technologies. Second, it would set an overall benchmark target for EU domestic manufacturing in these technologies to meet at least 40 percent of the EU's annual deployment needs by 2030. The NZIA also proposes a target for an annual injection capacity in CO2 storage of 50 million tonnes (Mt) CO2 by 2030, to spur the development of CCS. Third, it outlines a governance system based on the identification of Net-Zero Strategic Projects (NZSPs) by member states, with a minimal check by the European Commission. NZSPs must contribute to CO2 reductions, competitiveness and security of supply, and should involve technologies close to commercialisation. This approach represents a break with what has been done so far: support focused on earlier stages of technology development, including research, early-stage development and prototyping. Fourth, the NZIA outlines a set of policy instruments, mostly at national level, to support the selected NZIA projects: i) Acceleration of permitting and related administrative procedures, within time limits pre-set by the EU, including by identifying a one-stop-shop national authority in charge of these projects; ii) Coordination of private funding. The Commission estimates that meeting the headline 40 percent target by 2030 will require €92 billion in investment, with the bulk (around 80 percent) coming from the private sector, to be facilitated by a "*Net-Zero Europe Platform fostering contacts and making use of existing industry alliances*"; and iii) Limited public subsidies, mainly at national level (see below).

Support for NZSPs is to be prioritised in national and EU budgets. However, the NZIA proposal does not allocate new EU-level funding, and neither is such funding being allocated in parallel; iv) Public procurement procedures and auctions, which are to include "sustainability and resilience" criteria, which can be given a weight of up to 15-30 percent. At the same time, bids that propose the use of equipment for which a non-EU country of origin provides at least 65 percent of EU supply are to be disadvantaged; v) The NZIA proposal also mentions other areas, including regulatory sandboxes and the skills agenda, where the NZIA proposes coordinating initiatives, such as Net Zero Industry Academies, through the Net-Zero Europe Platform.

Since EU countries are assigned the role of main provider of public funds for NZSPs, it is important to read the NZIA in parallel with the Temporary Crisis and Transition Framework (TCTF) for state aid measures, modified by the European Commission in early March 2023 in response to the IRA (EC, 2023v)[42]. The TCTF outlines conditions under which the Commission will approve 'aid accelerated investments in sectors strategic for the transition towards a net-zero economy', defined as batteries, solar panels, wind turbines,

[42] The TCTF expired at the end of June 2024 for most sectors and will expire for sectors, like agriculture and fishery at the end of 2024.

heat pumps, electrolysers and carbon capture usage and storage, as well as the production and recycling of priority components and critical raw materials. Specifically, EU countries are allowed to:

1. Provide more support to cleantech production located in disadvantaged regions, capped at a certain percentage of the investment costs and nominal amounts, depending on the location of the investment and the size of the beneficiary;
2. Grant higher percentages of the investment costs if the aid is provided via tax advantages, loans or guarantees. This implies that state aid is not limited to funding capital expenditures but that operating expenditures (OPEX) can also be covered, up to the identified funding gap. This approach is novel for Europe as it has been only rarely adopted previously, most notably in the case of cohesion regions;
3. Provide matching aid, that is, the amount of support the beneficiary could receive for an equivalent investment in the alternative location, or the amount needed to incentivise the company to locate the investment in the EU. This part is perhaps the clearest revision of the state-aid guidelines as a reaction to the IRA. This matching-aid option requires individual notification and must respect several safeguards: (i) investments must be in assisted areas, as defined in the applicable regional aid map; or (ii) cross-border investments involving projects located in at least three countries, with a significant part of the overall investment taking place in at least two assisted areas, one of which is an 'a' area (outermost regions or regions where the GDP per capita is below or equal to 75 percent of the EU average). Furthermore, the beneficiary should use state-of-the-art production technology from an environmental emissions perspective. Finally, the aid cannot trigger relocation of investment between EU members.

The NZIA represents a useful first step in the process of creating a truly European green industrial policy, on which the Clean Industrial Deal could build further on. The EU new course of policy action will primarily need to focus on promoting the right framework conditions for private green investments across the continent, starting with the removal of barriers such as lack of access to finance, high energy costs, policy fragmentation and scarcity of critical skills. Addressing these barriers may be more useful, even from the narrow perspective of promoting cleantech, than giving preferential treatment to cleantech projects. Reducing these obstacles would require much more comprehensive reforms than proposed in the NZIA. These include a more integrated European electricity market that would help to lower energy costs structurally, an EU-wide strategy to develop and improve (green) tech skills, and the creation of a banking and capital markets union to overcome Europe's highly bank-dominated and fragmented financial system and mobilise private capital for cleantech (Kleimann et al, 2023). Furthermore, those reforms would promote not only cleantech investment but would foster growth and competitiveness in the EU more broadly. At the same time, more targeted industrial policy interventions will have to be promoted to support specific clean technologies more specifically.

The Clean Industrial Deal announced by the new European Commission requires a broader green industrial policy agenda to leverage the EU single market in a credible manner, to build a solid new governance framework and a new EU-level funding approach[43]. To deliver on this key item, it will be important to first set its core principles right (Tagliapietra et al., 2023b).

To start, green industrial policy is unique. Instead of solely focusing on the competitiveness of industries and companies, as it typical of traditional industrial policy, green industrial policy indeed tackles the larger societal challenges arising from climate change. This sets it apart from climate change policy, which usually has more narrow objectives aimed at reducing carbon emissions. Similar to standard industrial policy, the selection of tools and projects for green industrial policy should be based on where private and public returns of clean markets diverge the most. A green industrial policy should be developed in coordination with the policy instruments used by climate policy and industrial policy instruments more generally. For

[43] On the need to revise climate, social and innovation policies in an interconnected way see also Diaz Lopez, Mazzanti and Zoboli (2023).

example, carbon pricing is an important instrument in the green industrial policy toolbox, comprising, among others, subsidies, taxes, targets, regulations, and standards. Green technologies, often still emerging, are complex and uncertain. Future uncertainty about climate and technology scenarios underlines the importance of learning and information sharing, and thus experimentation, risk taking, self-discovery on the market, and industry-research-policy collaborations to share risks, costs and information. Clean technologies are not only characterized by high risk and uncertainty, but also by high externalities - if only because of the variety of climate policies worldwide. This calls for a more directed approach in supporting investments in clean technologies. In addition, an investment push directed to clean technologies is necessary to counter the locking-in of fossil fuel-based technologies and their path-dependencies. The difficulty in profiting from green technologies and in developing new low-carbon technologies lies in the hidden support to fossil fuel products through in different forms –from the absence of a sensible carbon price to explicit fossil fuel subsidies. These mechanisms can skew the market, not only in terms of production and technology adoption, but also in terms of innovation (Aghion et. al 2011, 2016, 2019).

The case for subsidizing green technologies, in this sense, is broader and stronger than the general case. Environment-directed innovation policy technology (innovation) cannot be neutral. It needs to select for 'clean' to address the higher knowledge externalities and lock-in problems. This still leaves the issue of whether and how to choose among "clean" technologies and which winners to pick (e.g., focusing on individual clean technologies such as batteries or hydrogen). When choosing among clean technologies, the principle of divergence between expected social and private returns and highest scope for reducing clean market failures should guide the decision-making process. Choosing within clean technologies should also take into account the "externalities" of any choice on other non-selected clean technologies, calling for a good mix between vertical and horizontal instruments, limiting in time support and the importance of ensuring competition as a level playing field (Aghion et al, 2011).

The climate crisis requires urgent mitigation efforts, and green industrial policy is no exception. More than other areas of industrial policy, the lack of risk-taking can be particularly problematic in the long run. A green innovation policy portfolio with risks entails accepting failures. This brings experimentation as a key principle for green industrial policy, together with close monitoring of effectiveness of experiments and adaptability. Finally, by addressing larger societal concerns, green industrial policy requires the involvement of a variety of stakeholders covering a larger set of private sector areas. Public-private partnerships ought to be central in green innovation policy, much more than in climate policy and standard industrial policy. The extent of the transformation brought about by climate change calls the involvement and support of civil society more than in other areas of industrial policy.

It must be clear that difficult trade-offs exist in this space, the most important being the one between decarbonisation, competitiveness and security. Textbook examples being Chinese solar panels and electric cars: while they are certainly good for Europe's decarbonisation, they certainly also are problematic for its competitiveness and security.

To manage this difficult trade-off, Europe needs to avoid black-and-white solutions. For instance, as suggested by the Draghi report (2024), the EU needs to firmly rejects the temptation to emulate the US approach of systematically shutting out Chinese clean technologies, as that would only make the European green transition more difficult and expensive. Instead, it should deploy smart and technology-specific green industrial policies, really tailored on the specificities of each individual industrial sector. For instance, in industries like solar panels, where Europe has no strong comparative advantage, the Draghi report suggests Europe to keep its doors open and basically free ride on the expensive subsidies provided by the countries of origin for their manufacturing, while diversifying suppliers to the possible extent so to increase security.

On the contrary, in industries like wind turbines where Europe does have a strong comparative advantage, based on solid know-how and established manufacturing capacity, the report suggests Europe to ramp-up support, for instance also introducing explicit minimum quotas for local products and components in public procurement. The report also stresses the need to make a stronger use of trade policy instruments

- starting with tariffs - where necessary to ensure the level playing field, and it stresses the need to deploy all possible tools to support and protect those infant industries where Europe has an innovative edge and future growth potential.

In terms of concrete policy action, to develop a strong Clean Industrial Deal the EU firstly needs to leverage its greatest asset: the single market. Only a well-functioning, globally linked EU market will be able to achieve a similar scale to the domestic markets of the United States and China. Fragmented national measures will not lead to private investments in cleantech ecosystems at the scale that Europe needs to become a globally competitive, resilient, cleantech powerhouse. To achieve this, the EU needs to foster and deepen its single market for goods, services, components, energy, capital, people and ideas. Without such 'horizontal' policies, targeted 'vertical' policies (including NZIA instruments such as permitting, public procurement and skills) will not deliver results at the needed scale. Take the example of skills. This is a major bottleneck for the development of cleantech manufacturing in Europe, more than permitting. While the EU has limited competence in this field, providing the right incentives to member states could catalyse national action.

At the same time, single market reforms require a new push, including on banking union and capital markets union. The cost of accessing finance is an important factor in firms' clean-tech investments. The EU financial system is highly bank-dominated and fragmented along national lines, which makes it ill-suited to enabling the massive investments needed for the green transition through the provision of private capital. Major policy initiatives have been undertaken to that effect, particularly since 2012 (Banking Union) and 2014 (Capital Markets Union), but they remain unfinished and have largely stalled in recent years. They must be revived as part of a comprehensive EU response to the IRA.

To be a forceful lever for private cleantech manufacturing investment, the single market must be open and competitive. EU trade policy should not fall into a reciprocal protectionist trap: it needs to remain open to allow the EU to import intermediate goods and natural resources that it cannot competitively produce itself, and to help keep export markets open. Most of these horizontal framework conditions have been essential for EU competitiveness in the past and are now more important than ever.

Skills are also very important here. The speed of manufacturing and roll-out of clean technologies is correlated closely with the simultaneous development of a qualified workforce to implement clean projects. Ensuring a sufficient capacity of skilled workers is of prime importance for Europe, both to avoid shortages and to ensure a high level of productivity for its clean-tech industry. This also is a crucial item when it comes to the just transition, as part of the workforce currently employed in carbon-intensive sectors can be re-skilled and re-employed in green-energy projects (IEA, 2022).

Recognising these factors, the EU has put forward a European Skills Agenda (EC, 2020j)) to help individuals and businesses develop more and better skills in these sectors. It has earmarked sizeable funds to support worker training: the €61.5 billion European Social Fund Plus (ESF+), and also the Just Transition Fund (JTF) and the Recovery & Resilience Facility (RFF).

The European Commission has stressed that the EU and its members can do more. For instance, as Europe seeks to develop pan-European clean-tech supply chains, it would be efficient to have integrated continuous monitoring at EU level of the status of supply and demand in green skills and jobs. The EU single market for clean skills could be promoted by developing a Europe-wide strategy for clean-tech higher qualifications, and by easing intra-EU mobility of talent, linked also to Erasmus+ funding. Sector-level efforts should also be made through links to European industrial alliances. The establishment in February 2023 of a large-scale skills partnership for onshore renewable energy under the Pact for Skills is a welcome first step in this direction.

A broad and solid EU green industrial policy also requires a new EU-level funding strategy. To accompany the implementation of a broader green industrial policy, the EU will need a new funding strategy. Otherwise, public incentives to spur private investment in cleantech would come from national state aid, which would create risks of single-market fragmentation and fan political tensions between EU countries. A new EU strategy in the field should: (i) focus on supporting the development and scaling-up of pan-

European public-private ecosystems; (ii) support the whole innovation cycle of cleantech in an integrated manner, from disruptive innovation to deployment at scale; (iii) prioritise areas in which market, network and transition failures are most likely and government selection failures least likely, ensuring additionality and leveraging of other (member state) public and private funding; (iv) fit within a portfolio of funding instruments, which is well balanced between top-down and bottom-up solicited projects.

As suggested by the Draghi report, it will be key to "Europeanise" national State aid via instruments aimed at creating European ecosystems such as the Important Projects of Common European Interest (IPCEIs). Although the IPCEIs are financed by EU countries, they require cross-border EU cooperation and their formation and selection are coordinated by the European Commission and assessed for compatibility with state aid guidelines. That is, they are mainly designed to capitalise on EU scale and protect the single market. The further streamlining of IPCEIs will be key to ensure proper financing to clean tech manufacturing projects in Europe, without jeopardising the single market's level playing field.

More EU action is also required – as also suggested by the Draghi report – in the support of early stage, high-risk clean technologies, as well as for their early deployment. Delivering these subsidies at EU level would, again, avoid fragmenting the single market and better exploit the scale of the EU by harnessing EU-wide synergies, internalising knowledge spillovers and improving cost and risk sharing. On this regard, the EU could consider the creation of an EU version of the US Advanced Research Projects Agency (ARPA), with an emphasis on Energy and Climate ('ARPA-EC'), aimed at fostering high-risk, early-stage development projects for new cleantech manufacturing technologies. An EU ARPA-EC could also issue competitive tenders for new technological alternatives to critical components, products or services when there are supply concerns in existing green technologies, thus addressing the EU's demand for resilience and autonomy by calling on the EU's science and innovation capacity. ARPA-EC should connect to complementary funding schemes, both at national and at EU level, including the European Research Council (ERC) and European Innovation Council (EIC). The ERC and EIC should maintain their focus on supporting bottom-up ideas, thus balancing the top-down cleantech NZIA programmes.

Finally, to promote a broad and strong green industrial policy, the EU needs to take a step further on governance. This point has also been strongly emphasized in the Draghi report, based on the solid understanding that without a solid governance and coordination of efforts, the EU will never be able to deliver significant results in this space.

# Main conclusions

At the end of 2019, the European Commission adopted the European Green Deal (EGD) as its major strategy for regenerating the European economy and society thus giving rise to the most ambitious and complete sustainability transition strategy in the world. After four very difficult years for Europe, marked by the COVID-19 crisis, the Ukraine War and the following the energy shock, the new European Commission is facing a crossroads for the EGD pathways.

This report addresses this crossroads from the point of view of the major difficulties still affecting the EGD implementation, the issues emerging in financing the investment needs for the transition, and the new macro policy framework that can hinder or favour a 'new' EGD pathways in the next few years.

A first conclusion is about the implementation experience. Although the EGD is a grand design of structural change of the economy and the society also aimed at re-positioning the EU in the international system, the EGD policy approach has been largely based on a very intensive large-scale regulatory and legislation process, including some bold policies in sectors, like automotive and buildings, that are critical for the major target of Net Zero by 2050. The state of implementation highlights a mixed picture. While in the key areas of climate and energy the legislation process is very advanced, in other areas the implementation is lagging behind, with most of the foreseen legislations delayed or in stand-by. Leaving aside the slowdown effect due to the election year, this is the result of oppositions emerging in some key areas of the EGD. These oppositions reveal a weakening consensus from some EU countries and a part of the industrial and social stakeholders that perceive high short-term costs of the transition. The required large participation of political, industrial and social actors that the EGD called to commit themselves to invest resources for the transition has not been achieved. The narrative on the EGD has not been able, so far, to fully convince these actors of the net environmental (and then social) and economic benefits the transition can bring them in the medium to long term. However, this is not the main focus of this report, and analyses of the Just Transition and the possible inequality effects created by a sustainability strategy, which is selective by its very nature, have been dealt with in other reports (see Barbieri et al., 2021).

A second conclusion is about the financial dimension of the EGD-driven transition. The estimates on the investment needed to achieve the major objectives and targets of the EGD indicate that a huge amount of financial resources must be mobilised to deeply change the energy system and the other key areas. This brings to estimated investment gaps, as the distance between the investment needs and the present trends of investments, that are equally huge. The gap is particularly acute in some key sectors, most of them linked to energy and mobility. The needs and gaps are exacerbated by the new direction of the EU towards 'open strategic autonomy' in response to the risks emerging in the international system after the Ukraine war. The process towards the creation of domestic value chains in the Net Zero industries and critical materials for these industries, as driven by the NZIA and the CRMA, starts from a domestic manufacturing capacity that is good in some sectors of the clean tech system (e.g. wind technologies) but very problematic in others (e.g. solar technologies and batteries). This domestic manufacturing gap has to be seen vis à vis the self-sufficiency targets of the NZIA and the CRMA and the expected huge growth of domestic deployment required by the EU targets on renewables and automotive.

In front of these needs and gaps, the key question is about the overall availability of financial resources to be invested, the contribution from the public sector vis à vis the availability to invest by the private sector, and more in particular how much the European industrial system is available to invest in clean tech.

After examining the financial forces on the ground, the conclusion of the report is that the available resources are overall insufficient at present, or their availability and accessibility is subject a deep uncertainty, or resources have to fulfil demanding requirements in order to be mobilized.

The EU funding potential is largely based on the combination of Multiannual Financial Framework 2021-2027 (MFF) and Next Generation EU (NGEU). The wide allocations of the MFF to sectors linked to climate change and the requirements on allocating 30% of NGEU (37% of Recovery and Resilience Facility – RRF)

to climate-related investments and expenses, seem to offer a large potential. This potential translates into Member States allocating to climate and energy a significant part the NGEU resources they are receiving. However, when compared to the estimated needs and gaps, these resources are largely insufficient. Furthermore, the picture of the funding channels available at the EU level is very complicated, with each EGD-related strategy possibly accessing a number of different funding channels in the range of the major 17 available at the EU level. This can create issues of insufficient information, search costs, uncertainty and asymmetric accessibility by the economic actors as well as the policy makers at different administrative levels, from national to local, that are called to put in place their investments.

As a consequence, resources from the private sector, and in particular industrial investments, are called for as an autonomous force that is necessary to complement insufficient public resources in covering the needs and gaps. The estimated ratio, or desired leverage effect, is 2 Euros and up to 5 Euros of private investments (companies and households) for each Euro of public resources. Even though the European companies are increasingly adopting sustainability strategies under the pressure of regulation and the 'sustainable finance' criteria, an increasing number of them are adopting Net Zero targets (also at Scope 3 level), and some of them increasingly see the transition as a major driver of their competitiveness, the required leverage effect on private investments cannot be taken for granted and can be, instead, highly uncertain. Manufacturing industries in the clean tech system, in particular those classified as 'Net Zero industries' and the industrial materials targeted by NZIA and CRMA, are pivotal actors for the possibility or not to achieve the required leverage effect. An often-disregarded key factor for mobilizing investments is the cost of capital. As highlighted by this report, high costs of capital in the financial market can make only few investments to pass the test of profitability. Therefore, the financial system, in parallel to playing a key role in sustainable finance, is called to support a transition strategy that requires huge industrial investments, in particular by the private actors. The difficulties in creating a true European Capital Market Union, as highlighthed as a critical factor by the Letta report (2024), can weaken this role of the financial system.

Another major conclusion of the report is about the large differences among EU countries in facing the transition process and its requirements. Countries differ in their path towards major EDG-related objectives and targets, and have different specific investments needs and gaps. They differ in terms of the existing and planned manufacturing capacity in key clean tech sectors, e.g. in energy and transports, with some countries dominating the overall European industrial capacity and others largely lagging behind in the same sectors, in spite of their possible large domestic deployment of clean energy and sustainable mobility technologies. Countries differ in terms of the cost of capital, which can favour the companies located in certain countries in accessing finance. The EGD-driven transition is going on within this framework of differences, and the risk is that the transition itself will end up in exacerbating the differences whereas it requires a widespread movement in the same direction across Member States. The country-level divergences arise from structural country-specific factors on which EU policies cannot operate, but also arise from diverging and fragmented national political and industrial attitudes on which EU policies can have a space of action.

This conclusion brings to the space a 'New EGD', however named, can have within the EU macro policy space. On this side, the report proposes a mix of pessimistic and optimistic insights. In general, within the overarching strategy of 'open strategic autonomy', the Union seems to be subject to a fundamental oscillation between different macro-policy directions. On the one hand, there is a return, in particular through the new SGP, to requirements of fiscal discipline for Member States in the Economic and Monetary Union, and this can exacerbate the 'fiscal competition' in the allocation of national public budgets to social spending, military spending, and sustainability transition spending. The issue is worsened, from the point of view of public and private investments, by the inability to create a true Capital Markets Union as suggested by the Letta report (2024). This can prevent countries, as well as their economic actors, to embark themselves in strong transition strategies that, in the present conditions, can entail high economic risks. On the other hand, there is the need, well highlighted by the Draghi report (2024), that the Union will boldly pursue a fundamental change of pace in which, to recover competitiveness in the global systems, a major process of investments in innovation has to be carried out

also exploiting the capacity of the EU to attract resources from the global financial system. In this framework, the climate and energy transition remain one of the major innovation and industrial opportunities in the EU portfolio, on which Europe should do massive investments.

Pursuing the latter pathway and not the first one, requires redesigning the EGD as an EU industrial strategy. A first step in this direction have been NZIA and CRMA and the announcement of a Green Deal Industrial Plan as one of the first major acts of the new European Commission. However, this is not, for the moment, an industrial strategy as broad and complete as required by the investment needs and gaps presented in this report, by the disparities in the capacity and speed of transition across countries, and by the achievement of 'open strategic autonomy' through a higher industrial self-sufficiency in key value chains. Ingredients of a true green industrial strategy can include, in addition to integrate and finalize different policy areas (innovation, regional development, and others), major EU-level initiatives to achieve the required European scale in clean tech industrial investments and capacities. At the same time, it can require rethinking the policy instruments to go beyond a central role of the regulatory approach, also looking at the US experience with the instruments adopted for the IRA and the use of 'mission oriented' EU-level agencies. A European industrial policy and a 'New EGD' must be redesigned together. The future of the EGD should be an EU-wide industrial strategy or the sustainability transition will have to face a difficult future.

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# Annex 1 Strategic goals of the EGDSF per environmental policy area

| **Climate and energy (excluding objectives specifically addressing GHG emissions from transport)** | |
|---|---|
| *Main relevant EGDSF strategies – Reference (chronological order)* | *Related strategic objectives and deadline (chronological order)* |
| European Green Deal, COM(2019)640 final | - 55% GHG emissions, including emissions and removals, compared to 1990 (**2030**)<br>EU Climate Law (Reg. EU 2021/1119) → Translated into a binding target by the EU Climate Law (Reg. EU 2021/1119) |
| | Climate neutrality (**2050**) → Translated into a binding target by the EU Climate Law (Reg. EU 2021/1119) |
| Hydrogen Strategy, COM(2020)301 final | Produce up to 1 million tonnes of renewable hydrogen in EU (**2020–2024**) |
| | Produce up to 10 million tonnes of renewable hydrogen in EU (**2025– 2030**) |
| | Renewable hydrogen technologies are deployed at large scale to reach all hard-to-decarbonize sectors (**2030**) |
| Renovation Wave Initiative, COM(2020)662 final | GHG emissions from buildings decrease by 60% compared to 2015 (**2030**) |
| | Buildings reduce final energy consumption by 14% and energy consumption for heating/cooling by 18% compared to 2015 (**2030**) |
| | Double the annual energy renovation rate of buildings (**2030**) |
| Methane Emissions Strategy, COM(2020)663 final | Methane emissions decrease by 35%–37% compared to 2005 (**2030**) |
| Strategy on offshore renewable energy, COM(2020)741 final | The EU has an installed capacity of at least 60 GW of offshore wind (which means multiply five-fold the current capacity) and at least 1 GW of ocean energy (**2030**) |
| | The EU has an installed capacity of 300 GW of offshore wind (which means multiply 30- fold the current capacity) and 40 GW of ocean energy (**2050**) |
| | Offshore renewable energy is a core component of Europe's energy system (**2050**) |
| EU Adaptation Strategy COM(2021)82 final | The EU is climate-resilient and adaptation is made smarter, more systemic and swifter (**2050**) |
| Fit for 55, COM(2021)550 final | Sectors covered by the revised EU ETS will reduce their GHG emissions by 61%, compared to 2005 levels (**2030;** objective also mentioned in the section on Transport) |
| EU Forest Strategy, COM(2021)572 final | Net sink of 310 million tons CO2eq. and planting planting at least 3 billion additional trees in the EU (**2030**) (objective also mentioned in the section on Biodiversity, Ecosystems and Agriculture) |
| EU Soil Strategy, COM(2021)699 final | Achieve a climate-neutral Europe and, as the first step, aim to achieve land-based climate neutrality in the EU by **2035** (objective also mentioned in the section on Biodiversity, Ecosystems and Agriculture) |
| | Achieve for EU a climate-resilient society, fully adapted to the unavoidable impacts of climate change by **2050** |
| Communication on Sustainable Carbon Cycles, COM(2021)800 final | By **2028**, any ton of CO2 captured, transported, used and stored by industries should be reported and accounted by its fossil, biogenic or atmospheric origin |
| | Carbon farming initiatives should contribute to the increase by 42 Mt CO2eq of the land sink that is required to meet the objective of 310 Mt CO2eq net removals by **2030** (objective also mentioned in the section on Biodiversity, Ecosystems and Agriculture) |
| | At least 20% of the carbon used in the chemical and plastic products should be from sustainable non-fossil sources by **2030** |
| | 5Mt of CO2 should be annually removed by industries from the atmosphere and permanently stored through frontrunner projects by **2030** |
| | The EU climate-neutrality objective would require to capture between 300Mt and 500 Mt of carbon dioxide by **2050** (objective also mentioned in the section on Biodiversity, Ecosystems and Agriculture) |
| EU Solar Energy Strategy, COM(2022)221 final | Double solar photovoltaic capacity by **2025** (over 320 GW, i.e. twice today's level) |
| | National objectives to set up renewables-based energy community in every municipality with a population of more than 10.000 people by **2025** |
| | Install an EU solar photovoltaic capacity of almost 600 GW by **2030** |
| EU 'Save Energy' Communication, COM(2022)240 final | 5% reduction in the demand for gas through voluntary measures in the short term |
| | 5% reduction in the demand for oil through voluntary measures in the short term |
| REPower EU Plan, COM(2022)230 final | Upward-revised 45% EU-level target for RES (from 40%, as previously set) in **2030** |
| | EU-level target of 13% for energy efficiency (from 9%, as previously established) in **2030** |
| | Objectives to produce renewable gases, in particular by contributing to boosting methane production to 35 bcm by **2030** |

| | |
|---|---|
| Energy Transition of the EU Fisheries and Aquaculture sector, COM(2023)100 final | EU fisheries should reduce the fossil-fuel consumption per kg of landed product for at least an additional 15% for the period **2019-2030.** |
| | By **2050** at the latest, the EU fisheries and aquaculture sector has a neutral footprint. |
| Delivering on the EU offshore renewable energy ambitions, COM(2023)668 final | Achieve 111 GW of offshore renewables by **2030** |
| Wind Power Action Plan, COM(2023)669 final | In line with the 42.5% RES target set by the RED III, the installed wind capacity (including onshore and offshore) should grow from 204 GW in 2022 to more than 500 GW in **2030** |
| Industrial Carbon Management Strategy, COM(2024)62 final | For **2030**, the strategic EU objective is the deployment of $CO_2$ storage capacity of at least 50 million tonnes per year, together with related transport infrastructure consisting of pipelines, ships, rail and road. |
| | Around 280 million tonnes of $CO_2$ would have to be captured by **2040** (close to half of the $CO_2$ that is captured annually would have to come from biogenic sources or directly from the atmosphere; up to a third of the captured $CO_2$ will be used). |
| | Around 450 million tonnes of $CO_2$ would have to be captured by **2050** (250 million tonnes of $CO_2$ that is captured would be put in underground storage, while the rest would be used). |
| 2040 Climate Target, COM(2024)63final | - 90% GHG emissions, including emissions and removals, compared to 1990 (**2040**) |
| **Transport (including objectives specifically addressing GHG emissions and air pollution from transport)** | |
| *Main relevant EGDSF strategies – Reference (chronological order)* | *Related strategic objectives and deadline (chronological order)* |
| Sustainable Mobility Strategy, COM(2020)789 final | 30 million zero-emission vehicles and 80 million zero-emission lorries are in operation (**2030**) |
| | 100 European cities are climate neutral (**2030**) |
| | High-speed rail traffic doubles (**2030**) |
| | Scheduled collective travel of under 500 km is carbon neutral within the EU (**2030**) |
| | Zero-emission ocean-going vessels are market-ready (**2030**) |
| | Transport by inland waterways and short sea shipping increases by 25% (**2030**) |
| | Zero-emission large aircraft are market-ready (**2035**) |
| | Nearly all cars, vans, buses as well as new heavy-duty vehicles are zero emission (**2050**) |
| | Rail freight traffic doubles (**2050**) |
| | High-speed rail traffic triples (**2050**) |
| | Transport by inland waterways and short sea shipping increases by 50% (**2050**) |
| | 90% reduction in GHG emissions from transport, compared to 1990 (**2050**) |
| Zero Pollution Action Plan, COM(2021)400 final | The EU should reduce by 30% the share of people chronically disturbed by transport noise (compared to 2017; **2030**) |
| Fit for 55, COM(2021)550 final | Sectors covered by the revised EU ETS will reduce their GHG emissions by 61%, compared to 2005 levels (**2030;** objective also mentioned in the section on Climate & Energy) |
| | 55% CO2 emission reduction by new cars compared to the 2021 target (**2030**) |
| | 50% CO2 emission reduction by new vans compared to the 2021 target (**2030**) |
| | Zero CO2 emissions from new cars and vans compared to 2021 targets (**2035**) |
| **Circular economy and industry (including pollution from waste)** | |
| *Main relevant EGDSF strategies – Reference (chronological order)* | *Related strategic objectives and deadline (chronological order)* |
| 2020 Circular Economy Action Plan, COM(2020)98 final | Reduce the EU consumption footprint (**2030**) |
| | Double the EU circular material use rate (**2030**) |
| Farm to Fork Strategy, COM(2020)381 final | Halve per capita food waste at retail and consumer levels (**2030**) |
| Zero Pollution Action Plan, COM(2021)400 final | Halve the amount of residual (non-recycled) municipal waste (reference year to be established; **2030**) |
| | The EU should reduce by 50% plastic litter at sea and by 30% microplastics released into the environment (compared to 2016; **2030**) |
| | The EU should significantly reduce total waste generation (reference year to be established; **2030**) |
| Strategy for sustainable and circular textiles, COM(2022)141 final | Textiles are long-lived and recyclable, to a great extent made of recycled fibres, free of hazardous substances (**2030**) |
| | Wide availability of reuse and repair services for textiles (**2030**) |
| | Development of capacities for innovative fibre-to -fibre recycling (**2030**) |
| | The incineration and landfilling of textiles is reduced to the minimum (**2030**) |
| **Pollution and chemicals (including pollution from agriculture, but excluding pollution from transport and waste)** | |
| *Main relevant EGDSF strategies – Reference (chronological order)* | *Related strategic objectives and deadline (chronological order)* |
| | No chemical pesticides are used in sensitive areas, such as EU urban green areas (**2030**) |

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| EU Biodiversity Strategy, COM(2020)380 final | Nutrients losses from fertilizers are halved, resulting in the reduced use of fertilizers by 20% (**2030**) |
| | Reduce overall EU sales of antimicrobials for farmed animals and in aquaculture by 50% (**2030**) |
| Zero Pollution Action Plan, COM(2021)400 final | Reduce by more than 55% the health impacts (premature deaths) of air pollution (compared to 2005; **2030**) |
| | Reduce by 25% the EU ecosystems where air pollution threatens biodiversity (compared to 2005; **2030**) |
| | The risk/use of chemical pesticides and the use of more hazardous pesticides are reduced by 50% (**2030**) |
| | By **2030**, 75% of soils are healthy (objective also mentioned in the section on Biodiversity, Ecosystems, and Agriculture). |
| EU Soil Strategy, COM(2021)699 final | Soil pollution should be reduced to levels no longer considered harmful to human health and natural ecosystems and respect the boundaries our planet can cope with, thus creating a toxic-free environment (**2050**) (objective also mentioned in the section on Biodiversity, Ecosystems, and Agriculture). |
| **Biodiversity, ecosystems and agriculture (excluding pollution from agriculture)** | |
| *Main relevant EGDSF strategies – Reference (chronological order)* | *Related strategic objectives and deadline (chronological order)* |
| EU Biodiversity Strategy, COM(2020)380 final | Legally protect a minimum of 30% of the EU's land area (**2030**) |
| | Strictly protect at least a third of the EU's protected areas (**2030**) |
| | Legally protect a minimum of 30% of the EU's sea area (**2030**) |
| | Effectively manage all protected areas (**2030**) |
| | Significant areas of degraded and carbon-rich ecosystems are restored; habitats/ species show no deterioration in conservation trends and 30% reach favourable conservation status or at least show a positive trend (**2030**) |
| | At least 25,000 km of free-flowing rivers are restored (**2030**) |
| | The negative impacts on sensitive species and habitats, including on the seabed, through fishing and extraction activities, are substantially reduced to achieve good environmental status (**2030**) |
| | The by-catch of species is eliminated or reduced to a level that allows species recovery and conservation (**2030**) |
| | 50% reduction in the number of Red List species threatened by invasive alien species (**2030**) |
| | The decline in pollinators is reversed (**2030**) |
| | At least 25% of agricultural land is under organic farming management and the uptake of agro-ecological practices is significantly increased (**2030**) |
| | Quantified 10% of agricultural area is under high-diversity landscape features (**2030**) |
| | Significant progress is made in the remediation of contaminated soil sites (**2030**) |
| | Biodiversity thrives and ecosystems/natural capital are protected, restored and valued in ways that enhance resilience to climate change and other environmental risks (**2050**) |
| Zero Pollution Action Plan, COM(2021)400 final | By **2030**, 75% of soils are healthy (objective also mentioned in the section on Pollution and Chemicals) |
| EU Forest Strategy, COM (2021)572 final | Net sink of 310 million tons CO2eq. and planting planting at least 3 billion additional trees in the EU (**2030**) (objective also mentioned in the section on Climate and Energy) |
| EU Soil Strategy, COM(2021)699 final | Reach good ecological and chemical status in surface waters and good chemical and quantitative status in groundwater by **2027**. |
| | Combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world (**2030**) |
| | Achieve a climate-neutral Europe and, as the first step, aim to achieve land-based climate neutrality in the EU by 2035 (objective also mentioned in the section on Climate and Energy) |
| | Reach no net land take (**2050**) |
| | Soil pollution should be reduced to levels no longer considered harmful to human health and natural ecosystems and respect the boundaries our planet can cope with, thus creating a toxic-free environment (**2050**) (objective also mentioned in the section on Pollution and Chemicals) |
| | By **2050**, all EU soil ecosystems are in healthy condition and are thus more resilient |
| | By **2050**, biodiversity thrives and ecosystems/natural capital are protected, restored and valued in ways that enhance resilience to climate change and other environmental risks |
| Communication on Sustainable Carbon Cycles, COM(2021)800 final | Carbon farming initiatives should contribute to the increase by 42 Mt CO2eq of the land sink that is required to meet the objective of 310 Mt CO2eq net removals by **2030** (objective also mentioned in the section on Climate & Energy) |
| | The EU climate-neutrality objective would require to capture between 300Mt and 500 Mt of carbon dioxide by **2050** (objective also mentioned in the section on Climate & Energy) |

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| EU Action Plan on sustainable and resilient fisheries, COM(2023)102 final | Phase out mobile bottom fishing in all Marine Protected Areas by **2030** at the latest |

Note: a single reference is reported for each strategic objective, even if strategic objectives are frequently mentioned/recalled by multiple strategies. Each objective is generally referred to a single main policy area (when, instead, it is double counted under different policy areas, this is explicitly mentioned in the Table). This operation involves a certain degree of subjective evaluation. As of April 2024.
Source: own elaboration based on the sources quoted in the Table.

# Annex 2 Adopted, ongoing, and planned EGDSF legislative initiatives per environmental policy area

| **Climate and energy (excluding GHG emissions from transport)** | | | |
|---|---|---|---|
| *Legislative initiatives which have been adopted (chronological order)* | *Reference* | | |
| Just Transition Fund | Reg. (EU) 2021/1056 | | |
| EU Climate Law | Reg. (EU) 2021/1119 | | |
| Coordinated demand reduction measures for gas | Reg. (EU) 2022/1369 | | |
| ETS aviation (legislation also mentioned in the section on Transport) | Dir. (EU) 2023/958 | | |
| Emissions trading system (ETS) (main) – including maritime, buildings and transport (legislation also mentioned in the section on Transport) | Dir. (EU) 2023/959 | | |
| Revision of LULUCF Reg. | Reg. (EU) 2023/839 | | |
| ETS Market Stability Reserve | Reg. (EU) 2023/852 | | |
| Revision of Effort Sharing Reg. | Reg. (EU) 2023/857 | | |
| Social Climate Fund (legislation also mentioned in the section on Transport) | Reg. (EU) 2023/955 | | |
| Carbon Border Adjustment Mechanism | Reg. (EU) 2023/956 | | |
| Recast of the Energy Efficiency Dir. | Dir. (EU) 2023/1791 | | |
| Revision of the RES Dir. | Dir. (EU) 2023/2413 | | |
| Reg. on fluorinated greenhouse gases | Reg. (EU) 2024/573 | | |
| Reg. on substances that deplete the ozone layer | Reg. (EU) 2024/590 | | |
| *Ongoing legislative initiative (chronological order of the proposals)* | *Reference - Proposal on time / delayed (year it was initially scheduled)** | *Status of the proposal* | *Date of latest step in the legislative procedure*** |
| Revision of the Energy Taxation Dir. | COM(2021)563 final | Negotiation at Council*** | 25.11.2022 |
| Recast Energy Performance of Buildings Dir. | COM(2021)802 final | Provisional agreement | 03.04.2024 |
| Revision hydrogen/gas Dir. | COM(2021)803 final | Provisional agreement | 20.02.2024 |
| Revision hydrogen/gas Reg. | COM(2021)804 final | 1st reading | 20.02.2024 |
| Proposal for a Reg. to prevent methane leakage in the energy sector | COM(2021)805 final | Provisional agreement[44] | 10.04.2024 |
| Amendments to Renewable Energy, Energy Performance of Buildings and Energy Efficiency Dir. (to take into account of REPowerEU objectives) | COM(2022)222 final | 1st reading | 14.12.2023 |
| Proposal for a Reg. establishing a Union certification framework for carbon removals | COM(2022)672 final | Provisionl agreement | 08.03.2024 |
| Proposal for a Reg. amending Regulations (EU) 2019/943 and (EU) 2019/942 as well as Dir. (EU) 2018/2001 and (EU) 2019/944 to improve the Union's electricity market design | COM(2023)148 final - Planned for Q1/2023 (but no initial schedule by strategies available) | 1st reading | 19.04.2024 |
| *Planned legislative initiative not yet launched* | *Planned year of adoption (on time/delayed - year it was initially scheduled)** | | |

[44] https://www.europarl.europa.eu/news/it/press-room/20240408IPR20309/methane-parliament-adopts-new-law-to-reduce-emissions-from-energy-sector

| **Transport (including GHG emissions and air pollution)** | | | |
|---|---|---|---|
| *Legislative initiatives which have been adopted (chronological order)* | *Reference* | | |
| Revised TEN-E Reg. | Reg. (EU) 2022/869 | | |
| ETS as regards notification on CORSIA | Dec. (EU) 2023/136 | | |
| Reg. $CO_2$ emission performance standards for new passenger cars and new light commercial vehicles | Reg. (EU) 2023/851 | | |
| Social Climate Fund (legislation also mentioned in the section on Climate and Energy) | Reg. (EU) 2023/955 | | |
| ETS aviation (legislation also mentioned in the section on Climate and Energy) | Dir. (EU) 2023/958 | | |
| Emissions trading system (ETS) (main) – including maritime, buildings and transport (legislation also mentioned in the section on Climate and Energy) | Dir. (EU) 2023/959 | | |
| Dir. on deployment of alternative fuels infrastructure | Reg. (EU) 2023/1804 | | |
| FuelEU Maritime | Reg. (EU) 2023/1805 | | |
| RefuelEU Aviation | Reg. (EU) 2023/2405 | | |
| Revision of the Dir. on Intelligent Transport Systems, including a multimodal ticketing initiative | Dir. (EU) 2023/2661 | | |
| *Ongoing legislative initiative (chronological order of the proposals)* | *Reference - Proposal on time / delayed (year it was initially scheduled)** | *Status of the proposal* | *Date of latest step in the legislative procedure*** |
| Revision of the Reg. on the trans-European transport network EU 1315/2013 (TEN-T) and the Rail Freight Corridor Reg. EU 913/2010 | COM(2021)812 final | 1st reading | 19.01.2024 |
| Proposal for a Reg. on type-approval of motor vehicles and engines and of systems with respect to their emissions and battery durability (Euro 7) | COM(2022)586 final - Scheduled for 2021 | Provisional agreement[45] | 13.03.2024 |
| Reg. $CO_2$ emission performance standards for new heavy-duty vehicles | COM(2023)88 final - Scheduled for 2021 | Provisional agreement | 14.02.2024 |
| Revision of the Dir. on ship-source pollution (Dir. 2005/35/EC) | COM(2023)273 final – Scheduled for 2022 | Provisional agreement | 04.03.2024 |
| Accounting of greenhouse gas emissions of transport services | COM(2023)441 final – Scheduled for Q2 2023 | 1st reading | 10.04.2024 |
| Use of railway infrastructure capacity | COM(2023)443 final – Scheduled for Q2/2023 | 1st reading | 07.02.2024 |
| Revision of the weights and dimensions Dir. (EU 2015/719) | COM(2023)445 final – Scheduled for 2022 and moved to Q2/2023 | 1st reading | 12.03.2024 |
| Revision of the combined transport Dir. (92/106/EEC) | COM(2023)702 final – Scheduled for 2022 | 1st reading | 25.04.2024 |
| Revision of EU rules on harmonised river information services | COM(2024)23 final - Planned for Q3/2023 (but no initial schedule by strategies available) | 1st reading | 22.03.2024 |
| *Planned legislative initiative not yet launched* | *Planned year of adoption (on time/delayed - year it was initially scheduled)** | | |
| Proposal for a possible future $CO_2$ transport regulatory package | Preparatory work to be started in 2024 | | |
| Eventual revision of the Dir. on environmental noise, with the possible introduction of EU noise reduction targets (2002/49/EC) | No year indicated | | |
| **Circular economy and industry (including pollution from waste)** | | | |
| *Legislative initiatives which have been adopted (chronological order)* | *Reference* | | |
| Common charging interface for mobile phones and similar devices | Dir. (EU) 2022/2380 | | |

[45] https://ec.europa.eu/commission/presscorner/detail/en/IP_24_287

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|---|---|---|---|
| Reg. concerning batteries and waste batteries, repealing Dir. 2006/66/EC and amending Reg. (EU) No 2019/1020 | Reg. (EU) 2023/1542 | | |
| Restrictions on microplastics in products placed on the EU/EEA market within the REACH framework | EC Reg. (EU) 2023/2055 | | |
| *Ongoing legislative initiative (chronological order of the proposals)* | *Reference - Proposal on time / delayed (year it was initially scheduled)** | *Status of the proposal* | *Date of latest step in the legislative procedure*** |
| Proposal for a Reg. on shipments of waste and amending Reg. (EU) No 1257/2013 and (EU) No 2020/1056; | COM(2021)709 final | Signature | 12.04.2024 |
| Proposal for a Reg. establishing a framework for setting ecodesign requirements for sustainable products and repealing Dir. 2009/125/EC | COM(2022)142 final – Scheduled for 2021 | Provisional agreement[46] | 18.03.2024 |
| Development of new end-of-waste criteria for plastics and textiles | Since 2021[47] | Scoping assessment to identify priority list of waste | April 2022 |
| Proposal for a Dir. amending Dir. 2005/29/EC and 2011/83/EU as regards empowering consumers for the green transition through better protection against unfair practices and better information | COM(2022)143 final – Scheduled for 2021 | Signature | 28.02.2024 |
| Proposal for a Reg. laying down harmonised conditions for the marketing of construction products, amending Reg. (EU) 2019/1020 and repealing Reg. (EU) 305/2011 | COM(2022)144 final | 1st reading | 09.02.2024 |
| Proposal for a Dir. amending Dir. 2010/75/EU on industrial emissions and Council Dir. 1999/31/EC on the landfill of waste (legislative proposal also mentioned in the section on Chemicals & Pollution) | COM(2022)156 final | 1st reading | 05.04.2024 |
| Proposal for a Reg. on packaging and packaging waste, amending Reg. (EU) 2019/1020 and Dir. (EU) 2019/904, and repealing Dir. 94/62/EC | COM(2022)677 final – Scheduled for 2021 | Provisional agreement[48] | 14.03.2024 |
| Proposal for a Dir. on common rules promoting the repair of goods and amending Reg. (EU) 2017/2394, Dir. (EU) 2019/771 and (EU) 2020/1828 | COM(2023)155 final – Scheduled for 2021 | Provisional agreement | 22.02.2024 |
| Proposal for a Reg. establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/1020 | COM(2023)160 final | Signed | 11.04.2024 |
| Proposal for a Reg. on establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act) | COM(2023)161 final | Provisional agreement[49] | 16.02.2024 |

[46] https://www.consilium.europa.eu/en/press/press-releases/2023/12/05/products-fit-for-the-green-transition-council-and-parliament-conclude-a-provisional-agreement-on-the-ecodesign-regulation/

[47] https://environment.ec.europa.eu/news/commission-starts-develop-end-waste-criteria-plastic-waste-2022-04-05_en

[48] https://www.consilium.europa.eu/en/press/press-releases/2024/03/04/packaging-council-and-parliament-strike-a-deal-to-make-packaging-more-sustainable-and-reduce-packaging-waste-in-the-eu/

[49] https://www.consilium.europa.eu/en/press/press-releases/2024/02/06/net-zero-industry-act-council-and-parliament-strike-a-deal-to-boost-eu-s-green-industry/

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|---|---|---|---|
| Proposal for a Dir. on substantiation and communication of explicit environmental claims | COM(2023)166 final – Scheduled for 2020 | 1st reading | 12.03.2024 |
| Revision of the Waste Framework Dir. (with reference to food waste and textiles; Dir. 2008/98/EC) | COM(2023)420 final - Planned for Q2/2023 | 1st reading | 14.03.2024 |
| Revision of ELVs Dir. 2000/53/EC | COM(2023)451 final – Planned for 2021; moved to Q4/2022 | 1st reading | 12.01.2024 |
| Measures to reduce the release of microplastics in the environment ) | COM(2023)645 final - Planned for 2021, moved to Q4/2022 | 1st reading | 23.04.2024 |
| *Planned legislative initiative not yet launched* | *Planned year of adoption (on time/delayed - year it was initially scheduled)** | | |
| Legislative initiative on re -use in food services to substitute single -use food packaging, tableware and cutlery by re -usable products | Planned for 2021 | | |
| Revision of the Dir. on restrictions of hazardous substances in EEE (Dir. 2011/65/EC). | Planned for 2021. On 07.12.2023 the EC published a report on the review of the RoHS Directive in which it proposes that the responsibility for reviewing the list of restricted substances is attributed to the European Chemicals Agency (ECHA). | | |
| Food labelling - Revision of the EU rules on date marking to reduce food waste (Reg. EU 1169/2011) | Planned for Q4/2022 | | |
| Revision of the EU rules on food contact materials (to promote reusable-recycling solutions) | Planned for 2022 → Moved to Q2/2023 | | |
| EU framework for giving transparent and science-based information to EU consumers on the welfare of food-producing animals. | Planned for Q3/2023 | | |
| Legislative framework for sustainable food systems (legislative proposal also mentioned in the section on Biodiversity, Ecosystems, and Agriculture) | Planned for Q3/2023, but not mentioned in the EC Work Programme for 2024. It remains uncertain when this proposal will be tabled. | | |
| Review of the Landfill Dir. (1999/31/EC) | Planned for 2024 | | |
| Revision of the textile labelling Reg. (Reg. EU 1007/2011) to introduce specifications for physical and digital labelling of textiles, including sustainability and circularity parameters | Q4/2023 → Moved to Q1/2025 | | |
| **Pollution and chemicals (including pollution from agriculture, but excluding pollution from transport and waste)** | | | |
| *Legislative initiatives which have been adopted (chronological order)* | *Reference* | | |
| Reg. on general product safety, amending Reg. (EU) No 1025/2012, Dir. 87/357/EEC and Dir. 2001/95/EC | Reg. (EU) 2023/988 | | |
| Dir. Amending Dir. 2004/37/EC and Dir. 98/24/EC as regards the limit values for lead and its inorganic compounds and for diisocyanates | Dir. (EU) 2024/869 | | |
| *Ongoing legislative initiative (chronological order of the proposals)* | *Reference - Proposal on time / delayed (year it was initially scheduled)** | *Status of the proposal* | *Date of latest step in the legislative procedure*** |
| Proposal for a Dir. amending Dir. 2010/75/EU on industrial emissions and Council Dir. 1999/31/EC on the landfill of waste (legislative proposal also mentioned in the section on CE and industry) | COM(2022)156 final | Signature | 05.04.2024 |
| Revision of the E-PRTR Regulation (Reg. (EC) No 166/2006), to create the Industrial Emissions Portal) | COM(2022)157 final | To be withdrawn | 05.04.2024 |
| Proposal for a Reg. on the sustainable use of plant protection products and amending Reg. (EU) 2021/2115 | COM(2022)305 final | 1st reading | 22.02.2024 |
| Integrated water management – revised lists of surface and groundwater pollutants – Dir. 2007/60/EC, 2006/118/EC, 2008/105/EC | COM(2022)540 final | 1st reading | 24.04.2024 |
| Proposal for a Dir. concerning urban wastewater treatment (recast) – Dir. 91/271/EEC | COM(2022)541 final | Provisional agreement | 11.03.2024 |

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|---|---|---|---|
| Revision of EU ambient air quality legislation – Dir. 2004/107/EC, 2008/50/EC, EU 2016/2284 | COM(2022)542 final | 1st reading | 24.04.2024 |
| Revision of Reg. (EC) No 1272/2008 on classification, labelling and packaging | COM(2022)748 final – Scheduled for 2021 | Provisional agreement | 11.01.2024 |
| ECHA PFAS restriction proposal | | Submitted by ECHA[50] | 27.11.2023 |
| Revision of the Detergents Reg. (EC 648/2004) | COM(2023)217 final – Scheduled for for Q4/2022 | 1st reading | 27.02.2024 |
| Revision of the EU Reg. on mercury EU 2017/852 | COM(2023)395 final - Scheduled for Q4/2022 | Provisional agreement | 11.03.2024 |
| Revision of the Toy Safety Dir. 2009/48/EC | COM(2023)462 final – Scheduled for Q4/2022 | 1st reading | 13.03.2024 |
| Revision of the EU rules - improving access to and availability, sharing and re-use of chemical data for the purpose of chemical safety assessments | COM(2023)779 final | 1st reading | 23.04.2024 |
| *Planned legislative initiative not yet launched* | *Planned year of adoption (on time/delayed - year it was initially scheduled)** | | |
| Revision of the Cosmetic Products Reg. EC 1223/2009 | Planned for Q4/2022 | | |
| Bathing water quality – Review of EU rules (Dir. 2006/7/EC) | Planned for Q1/2023 | | |
| REACH revision (Reg. EC 1907/2006; 2021/2022) | Planned for 2021/2022 → Moved to Q4/2023 (EC Work programme 2023). Uncertain when the proposal will be presented. | | |
| Proposal for a Reg. prohibiting production for export of (hazardous) chemicals banned in the EU | Planned for Q4/2023 | | |

| **Biodiversity, ecosystems and agriculture (excluding pollution from agriculture)** | | | |
|---|---|---|---|
| *Legislative initiatives which have been adopted (chronological order)* | *Reference* | | |
| Reg. to minimise the risk of deforestation and forest degradation associated with products placed on the EU market | Reg. (EU) 2023/1115 | | |
| *Ongoing legislative initiative (chronological order of the proposals)* | *Reference - Proposal on time / delayed (year it was initially scheduled)** | *Status of the proposal* | *Date of latest step in the legislative procedure*** |
| Proposal for a Reg. on nature restoration | COM(2022)304 final – Scheduled for 2021 | 1st reading | 22.03.2024 |
| Legislation for plants produced by certain new genomic techniques | COM(2023)411 final - Scheduled for Q2/2023 | 1st reading | 22.03.2024 |
| Revision EU rules on plant reproductive material | COM(2023)414 final - Scheduled for Q2/2023 | 1st reading | 12.01.2024 |
| Revision EU rules on forest reproductive material | COM(2023)415 final - Scheduled for Q2/2023 | 1st reading | 12.01.2024 |
| Proposal for a Dir. on soil health | COM(2023)416 final - Scheduled for Q2/2023 | 1st reading | 22.12.2023 |
| Adoption of new EU rules on animal welfare during transport (Reg.) | COM(2023)770 final | 1st reading | 07.03.2024 |
| Proposal for a Reg. to develop an EU-wide forest observation framework | COM(2023)728 final | 1st reading | 28.11.2023 |
| *Planned legislative initiative not yet launched* | *Planned year of adoption (on time/delayed - year it was initially scheduled)** | | |
| Revision of the Marine Strategy Framework Dir. 2008/56/EC | Planned for Q1/2023 | | |
| Animal welfare – revision of Reg. (EC) 1831/2003 on additives for use in animal nutrition | Planned for Q3/2023 – Scheduled in 2021 | | |

[50] https://echa.europa.eu/it/registry-of-restriction-intentions/-/dislist/details/0b0236e18663449b

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|---|---|
| Legislative framework for sustainable food systems (legislative proposal also mentioned in the section on Circular economy and industry) | Planned for Q3/2023, but not mentioned in the EC Work Programme for 2024. It remains uncertain when this proposal will be tabled. |
| Revision of the EU legislation on welfare of animals kept for economic purposes | Planned for Q4/2023 |

Note: the overview is updated to April 2024. Apart from a few exceptions that are highlighted in the tables, each (proposed) legislation is referred to a single (main) policy area. This operation involves a certain degree of subjective evaluation. * With reference to ONGOING PROPOSALS: Green cell= proposal on time compared to the initial schedule; red cell= proposal delayed (year for which it was initially scheduled provided in brackets); white cell= no information available with regard to the planned time of adoption. With reference to PLANNED INITIATIVES: red cell= planned initiative delayed; green cells=planned initiative that can still be adopted according to the initial schedule; white cell= no information available with regard to the planned time of adoption ** Red cells=the latest step in the legislative procedure dates back to before October 2023 (i.e. more than 6 months ago). *** Consultation procedure
Source: own elaboration based on the sources quoted in the Table.

European Topic Centre on
Circular economy and resource use
https://www.eionet.europa.eu/etcs/etc-ce

The European Topic Centre on Circular economy and resource use (ETC CE) is a consortium of European institutes under contract of the European Environment Agency.

European Environment Agency
**European Topic Centre**
**Circular economy and resource use**