RESEARCH REPORT

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Anticipating and managing the impact of change

Green, clean and keen to converge? A convergence analysis of environmental quality of life in the EU

Joint report by Eurofound and the European Environment Agency

Green, clean and keen to converge? A convergence analysis of environmental quality of life in the EU

European Environment Agency

Eurofound

European Foundation for the Improvement of Living and Working Conditions

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Abbreviations

AROPE	at risk of poverty or social exclusion
EAP	Environmental Action Programme
EEA	European Environment Agency
EU ETS	European Union Emissions Trading System
EU-SILC	European Union Statistics on Income and Living Conditions
GDP	gross domestic product
GHG	greenhouse gas
MFF	Multiannual Financial Framework
NEET	not in employment, education or training
RRF	Recovery and Resilience Facility
SDG	Sustainable Development Goal

Executive summary

Introduction

The growing need for environmental action has increased the number of pan-European targets and policies. These affect European citizens in their professional and private lives. This report monitors the environmental performance of the EU27 and looks at where the largest disparities between the Member States lie. Disparities occur because Member States have different environmental profiles, meaning that greening processes have not been happening at the same pace across Member States and across indicators.

The green transition entails more than improving eye-catching indicators that create news headlines, such as greenhouse gas emissions and use of renewable energy. Therefore, this report delves deeper into the environmental issues that most affect citizens' everyday lives. For example, it discusses the liveability of cities and residential areas, energy poverty and inadequate housing.

This work grew out of cooperation between Eurofound and the European Environment Agency. To our knowledge, this is one of the first reports analysing environmental convergence in Europe. Another report resulting from that collaboration, *The transition to a climate-neutral economy: Exploring the socioeconomic impacts*, was published in June 2023.

Policy context

The EU has set itself the ambitious goal of becoming carbon neutral by 2050. To achieve this, it aims to reduce greenhouse gas emissions, increase renewable energy use and improve recycling. The green transition would benefit European citizens' quality of life by addressing various types of pollution, such as air, noise, water, waste and soil pollution. It would also result in better regulation of energy markets, enabling access to clean energy for all.

These goals can be achieved only with the support of dedicated political initiatives. The European Green Deal has signalled a shift towards a carbon-neutral EU with a modern, resource-efficient and competitive economy. It sets out principles for a successful transition and calls on Member States to act swiftly, as the next 10 years will be critical in preserving the current fragile state of natural resources in Europe.

Key findings

- Disparities between the Member States have narrowed, and performance has improved in many environmental indicators over the past two decades. This suggests that EU-level environmental targets and policy are contributing to better national performance. It also suggests that cooperation between Member States – for example involving the export of clean electricity – facilitates the realisation of EU-level ambitions.
- The speed of progress towards achieving quantitative EU-wide targets has varied across the Member States. In addition, the energy crisis, food-supply issues and economic turbulence caused by the Russian invasion of Ukraine have strained commitments to the green transition.
- Geographical trends are evident in performance on several indicators. Northern and some western Member States (such as Sweden) tend to lead on indicators linked to energy efficiency and green energy systems, whereas many eastern European countries, and Malta, tend to lag behind. On a positive note, initially poor-performing Member States have been catching up with better performers for most indicators. No Member State excels in all indicators, indicating the heterogeneity of climate, transport and energy policies.
- Performance improved across all headline (macro-level) indicators analysed, signalling the importance of policy targets. There has been a reduction in disparities in respect of greenhouse gas emissions and in years of life lost due to particulate matter (PM2.5) air pollution. The reduction of disparities with regard to renewable energy and circular material use has been hindered by the exceptional performance of Sweden and the Netherlands. They have performed so well that they have outstripped other countries, leading to a rise in disparities.
- Improved performance on residential-level (meso-level) indicators shows that local settlements have become more liveable, but inequalities based on income remain. Member States' performance has improved, disparities in citizens' perceptions of pollution and grime in their environment have reduced, and municipal recycling rates have increased. In addition, noise pollution has reduced overall, but disparities across countries have remained steady or even increased. This is especially true for populations at risk of poverty.

- Household-level (micro-level) indicators, which measure energy poverty and housing quality, are closely tied to socioeconomic variables. Consequently, the economic downturn of 2008–2013 had a significant negative impact on these indicators, but the subsequent recovery signals that some economies are sufficiently resilient. However, in some instances there are great inequalities between the haves and the have-nots.
- Improvements in income and educational levels are related to improved environmental indicators. Reductions in poverty correlate with reductions in energy poverty and in exposure to environmental hazards such as air and noise pollution.

Policy pointers

- For many indicators, the EU should stay the course, sticking with the greening objectives it has set out. In recent years, the EU has made progress on headline indicators, for example reducing greenhouse gas emissions and increasing renewable energy use.
- The EU should diversify its energy and material dependencies and increase its autonomy through measures promoting the use of renewable energy and the circular economy. Such measures would increase energy resilience and cushion the effects of future energy and material crises, and would protect low-income citizens in particular.
- Residential- and household-level environmental goals may need more stringent or timely policy measures than those currently in place. Interventions should focus on three areas where divergence has been detected: housing, energy poverty and public transport.
- In line with the Renovation Wave strategy, urban design should provide adequate and affordable homes in areas free of environmental hazards for low-income populations, especially in densely populated areas. Financial support measures, such as subsidies, could incentivise citizens to improve their housing and should be better targeted at vulnerable consumers. National interventions to improve social housing should also be promoted. These measures would reduce the threat of energy poverty.
- More widespread and affordable public transport systems could increase mobility and reduce emissions. The Zero Pollution Action Plan encompasses measures to reduce transport emissions, while the Sustainable and Smart Mobility Strategy aims to improve public transport systems. People living in rural areas, senior citizens and people with underlying health conditions need connectivity the most, and transport policies should be designed with them in mind.
- Local and national authorities pursuing greening could follow established practices suggested by Member States or the EU. High-level solutions as well as everyday fixes are needed. For example, Slovenia aligned its waste management policies with EU directives and saw rapid improvements.
- The EU and its Member States need to work closely together to improve the EU’s environmental performance. Clear communication from the EU and national governments should help the public to adopt more sustainable behaviours. Cooperation between the Member States could foster the circular economy. Regulations concerning cross-country waste recycling need to be updated so that materials transported are not heavily taxed. For example, recycling out-of-use wind turbines is much more costly if during their transportation they are taxed as wind turbines instead of waste. However, stricter controls on cross-country waste disposal should be applied to avoid hazardous waste travelling to countries with poor environmental-protection laws.

Introduction

With energy and climate policies amassing at EU level (think of the European Green Deal, the Fit for 55 package and the environmental stipulations covering the use of NextGenerationEU funds), is it reasonable to expect the Member States to adhere to this emerging EU environmental *acquis*? And, just as importantly, can we expect the Member States to reach these goals at the same time?

Over the past two decades, there has been an improvement in the performance of the Member States on environmental issues and a reduction in the disparities among them, bringing them closer to the policy targets for most of the indicators considered in this study. However, some findings paint a less rosy picture; these are generally measures of residential quality and energy poverty, issues that have become increasingly salient in the last year as fuel prices have escalated and cost-of-living crises have swept Europe. The current economic and geopolitical conditions threaten to halt the progress made so far. Moreover, some of the improvements may be too small to have a long-term impact.

It is essential to ensure that reaching environmental targets does not have unwanted side effects, such as fostering disparities among and within the Member States. Countries that started greening their economies sooner will face fewer hurdles, while those that are still dependent on fossil fuels will foreseeably have more challenging transitions. Those with low incomes could suffer the most, as energy prices are currently high and green jobs require skills and training that are not immediately accessible. There is a risk that these inequalities will stoke discontent and distrust in the EU, turning citizens away from green policies. Including citizens as stakeholders in policy frameworks and during consultations would strengthen the perceived legitimacy of the green transition.

The first objective of this report is to measure environmental cohesion and performance using a convergence analysis. Upward convergence refers to a reduction in disparities among the Member States alongside improving performance on certain policy targets. Upward convergence is at the core of the European project and is a cornerstone of the legitimacy and cohesion of the Union. Moreover, Member States' performance with regard to key environmental indicators is correlated with their wealth and income poverty indicators over time; that is, growth in wealth and social protection is associated with an improvement in citizens' environmental quality of life. A second objective of the current analysis therefore is to capture the interrelationship of wealth and living environment.

This report presents a descriptive analysis. It does not assess the outcomes of policy interventions, nor suggest a causal relationship between EU environmental policies and improved performance measured through selected indicators, nor predict future trends.

Leave no one behind: A holistic approach to environmental quality of life

The deep and drastic transformations societies and economies must undergo in order to reach climate neutrality do not come without risks. While some policies could benefit the environment, they could leave some groups in society behind. In a period of high energy prices and inflation, shifting to green energy providers is not an option for everyone. General trends at EU level show a commitment to reducing emissions and increasing the capacity of the circular economy, but the impact on citizens' quality of life is unclear.

The focus of this report is environmental quality of life, determined by the interplay of several socioeconomic and environmental factors. It includes an analysis of the headline (macro-level) EU indicators, shown in Figure 1, but these alone fail to give a comprehensive picture of the environmental quality of life of European citizens, so indicators at meso and micro levels are examined too.

Material well-being is key to environmental quality of life. It is influenced by the quality of people's residential areas (meso level), including whether their municipality or neighbourhood has a good recycling system or struggles with pollution. Similarly, quality of housing (micro level) is important, especially for those at risk of poverty. Populations at risk of poverty are more likely to be vulnerable to energy poverty. They are more likely to experience inadequate housing and energy inefficiency, resulting in higher energy consumption relative to their incomes. In addition, people at risk of poverty are less resilient to crises. As previous Eurofound research has shown, material well-being is reduced by economic downturns (Eurofound, 2021a).

This report is built around the Sustainable Development Goals (SDGs), as 8 out of the 12 indicators studied are included in Eurostat's SDG indicators.[1] The use of these indicators enables the analysis of harmonised, consistent and quality-checked Europe-wide indicators that could be the beginning of a more detailed and recurrent analysis of economic, social and environmental convergence in Europe in the context of SDGs.

The indicators analysed represent three levels of analysis: headline (macro level), residential (meso level) and household (micro level). Each level and its policy targets are discussed below.

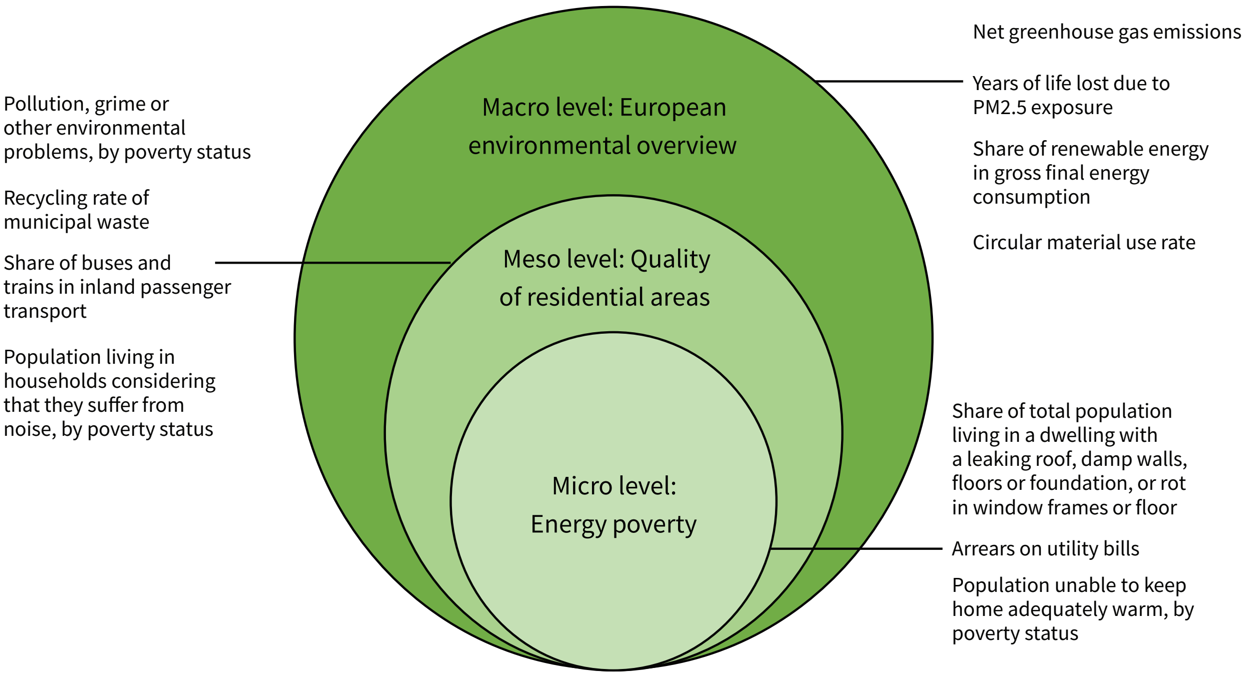
The variables and policies mentioned in this report are updated and revised regularly. As the cut-off date for data collection was September 2022, the report does not always contain the latest available information on policy developments.[2]

Headline (macro-level) indicators: European environmental overview

Headline (macro-level) indicators provide information on well-known environmental policy targets set at national and EU levels.

In its Fit for 55 package of 2021, one of the policy plans arising out the European Green Deal, the European Commission proposed to reduce net greenhouse gas (GHG) emissions by 55% by 2030 compared with 1990 levels. It also proposed to achieve a share of renewable energy in gross final energy consumption of 40% and a 9% reduction in energy consumption by 2030. However, in response to the current energy supply crisis, the 2022 REPowerEU plan raises these targets to a renewable energy share of 45% and a 13% reduction in energy consumption. The European Commission committed to improving air quality by reducing the number of premature deaths caused by air pollutants by at least 55% by 2030. In addition, the EU's Circular Economy Action Plan – again, part of the European Green Deal – aims to double the circular material use rate in the EU over the coming decade. Table 1 shows the indicators selected to best evaluate these macro-level policy targets.

Figure 1: Conceptualisation of European environmental quality of life



Source: *Authors*

1 For the full list of SDG indicators, please see https://ec.europa.eu/eurostat/web/sdi/database

2 Three indicators (years of life lost due to PM2.5 exposure, circular material use rate and recycling rate of municipal waste) were updated in April 2023, as Eurostat published the official data and not the estimates for 2020 and 2021.

Table 1: Macro-level indicators of environmental performance

Indicator	Eurostat code	Source(s)
Net greenhouse gas emissions	sdg_13_10	Eurostat/EEA
Years of life lost due to PM2.5 exposure	sdg_11_51	Eurostat/EEA
Share of renewable energy in gross final energy consumption	sdg_07_40	Eurostat
Circular material use rate	sdg_12_41	Eurostat

Residential-level (meso-level) indicators: Quality of residential areas

Reducing pollution and environmental problems would improve the health and well-being of the EU population. Health is a priority of the Zero Pollution Action Plan. Some of its targets are highly relevant at urban level, as three in four Europeans live in an urban area. For instance, it aims to achieve a 30% reduction in the share of people suffering from noise pollution and to reduce residual municipal waste by 50%. Another goal is to reduce GHG emissions from transportation by 90% by 2050, requiring a vast overhaul of public transport (see European Commission, 2020a). Other initiatives from the EU are the Green City Accord (which stimulates cooperation across cities and the sharing of sustainability practices) and the European Green Capital Award and European Green Leaf Award (which benefit green cities and towns through positive media coverage and sponsorship).[3] In the light of these targets and initiatives, the indicators in Table 2 were chosen to evaluate EU performance at residential level.

Household-level (micro-level) indicators: Energy poverty

Energy poverty is now a fiercely debated policy topic in EU politics. However, it was not substantially on the EU's policy agenda until the mid-2000s, although before that it was 'considered to be a growing risk' by the European Commission (European Commission, 2007).

The significance of energy was recognised in the Lisbon Treaty, the first EU legislation to include a dedicated title on energy (Bouzarovski, 2018). Key milestones in the political debate addressing energy poverty and vulnerability at EU level were the Third Energy Package[4] in 2009 and the 2019 Clean Energy for All Europeans package.[5] In the course of policy development, the Commission recommendation on energy poverty was published (European Commission, 2020b), the Energy Poverty Advisory Hub[6] was established, and the Commission's Energy Poverty and Vulnerable Consumers Coordination Group was set up (European Commission, 2022a).

Energy poverty is a challenge at the nexus of social protection and energy and climate policy, as people with low incomes are more likely to live in energy-inefficient housing, which leads to higher energy spending. Hikes in energy prices in 2021 in the

Table 2: Meso-level indicators of environmental performance

Indicator	Eurostat code	Source(s)
Pollution, grime or other environmental problems, by poverty status	ilc_mddw05	EU-SILC
Recycling rate of municipal waste	sdg_11_60	Eurostat
Share of buses and trains in inland passenger transport	sdg_09_50	Eurostat
Population living in households considering that they suffer from noise, by poverty status	sdg_11_20	EU-SILC

3 See https://environment.ec.europa.eu/topics/urban-environment_en

4 See https://energy.ec.europa.eu/topics/markets-and-consumers/market-legislation/third-energy-package_en

5 See https://energy.ec.europa.eu/topics/energy-strategy/clean-energy-all-europeans-package_en

6 See https://energy-poverty.ec.europa.eu/index_en

Table 3: Micro-level indicators of environmental performance

Indicator	Eurostat code	Source(s)
Share of total population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor	tessi292	EU-SILC
Arrears on utility bills	ilc_mdes07	EU-SILC
Population unable to keep home adequately warm, by poverty status	sdg_07_60	EU-SILC

aftermath of the COVID-19 pandemic and the subsequent increase in global energy demand revived concern over energy poverty. The Russian invasion of Ukraine in 2022 and the weaponisation of energy caused energy prices to escalate. The Commission has intervened on energy with the Fit for 55 package in 2021 and the REPowerEU plan in 2022. The Fit for 55 package proposes revisions to the Energy Efficiency Directive[7] and focuses on mitigating energy poverty. It also sets out to achieve net-zero emissions and fully decarbonised buildings by 2050, with a reduction in buildings emissions of 60% by 2030.

Table 3 shows the indicators selected to evaluate the micro-level outcomes of policy.

Upward convergence in EU environmental targets

The concept of upward convergence has been flagged as one of the key outcomes of the European project, one that gained relevance in the aftermath of the 2008–2013 economic crisis and its uneven impact on Member States.

Promoting upward convergence means reducing disparities and increasing cohesion among the Member States in relation to specified indicators while they improve their performance. Upward convergence was debated in the *Four Presidents' Report* in 2012 and explicitly mentioned in the *Five Presidents' Report* in 2015 (Juncker et al, 2015), which highlighted the need for efficient welfare systems able to reduce social inequities. The World Bank called the EU a 'convergence machine' due to its ability to push newer Member States towards higher-income markets (Ridao-Cano and Bodewig, 2018). Eurofound has adopted a set of tools and methodologies to monitor convergence.[8]

Quantitative targets set benchmarks for policies against which Member States' performance can be tested, and measuring how these targets are achieved is one way to monitor convergence. For example, in its Europe 2020 strategy for smart, sustainable and inclusive growth, the Commission set EU-wide targets, which were translated into national targets covering five thematic areas: employment, education, poverty and social exclusion, climate change and energy, and research and development and innovation. These largely demonstrate upward social convergence, as advocated by the European Pillar of Social Rights (Eurofound, 2021b; European Commission, 2022b). Similarly, the Maastricht criteria (also called the convergence criteria) set out the economic conditions for joining the euro area. These are quantitative targets in the fields of price stability, sound and sustainable public finance, exchange rate stability and long-term interest rates.

A critical concern in environmental governance is how to ensure the ambitious policies and targets are transposed into action at Member State level, as non-compliance from the Member States would undermine EU policies, and targets would not be achieved. As a result of EU-level environmental directives, national environmental policies are aligning with an emerging environmental *acquis*. It can therefore be expected that national environmental policies are becoming more alike, leading to widespread convergence in environmental policy.

This report analyses the extent to which the environmental outcomes in Member States have converged over the past two decades. In addition, the report goes a step further and integrates environmental and socioeconomic indicators, as previously done in Eurofound's flagship report on institutional convergence (Eurofound, 2021b). The dimensions are also linked by correlating economic and social indicators with environmental factors. One of the main hopes of the European Green Deal is to foster economic growth while improving environmental sustainability in the EU. By correlating socioeconomic and environmental indicators, the analysis aims to corroborate the link between an increase in wealth and improvements in living conditions.

7 See https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive_en

8 For further information regarding monitoring trends and disparities, see https://www.eurofound.europa.eu/data/convergence-hub/convergeu-app

Structure of the report

Chapter 1 presents an overview of the policy context of the EU environmental *acquis* and links environmental and economic factors, in particular through the latest aid packages aimed at tackling energy poverty.

Chapter 2 presents Eurofound's definition of convergence and the methodology used to perform the convergence analysis.

Chapters 3, 4 and 5 present the results of the analysis of the macro-, meso- and micro-level indicators, respectively. For each of the three levels of analysis, policy takeaways are presented.

Chapter 6 examines the correlations between environmental and socioeconomic indicators, and discusses the interplay of socioeconomic and environmental factors.

The final chapter contains conclusions and policy pointers.

1 EU environmental *acquis* and its targets

Towards an EU environmental *acquis*: First steps

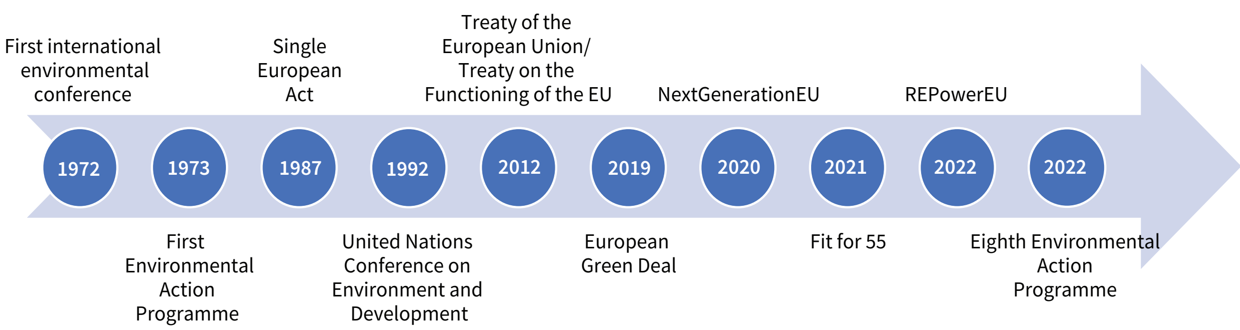
The European Economic Community (the precursor of the European Community) had no environmental policy in its agenda when it was founded by the Treaty of Rome. In fact, international environmental politics started much later at the first international environmental conference held by the United Nations in Stockholm in 1972. The year also marked the start of EU environmental policy, with the heads of state or government on the European Council declaring the need for a European Community environmental policy and calling for an environmental action programme. The first Environmental Action Programme (EAP) was adopted in November 1973 and discussed how economic development, prosperity and environmental protection are interdependent (Council of the European Communities, 1973). The legal basis for a common environmental policy was established in the Single European Act of 1987 with the introduction of the environment as a new policy area.

The next big milestone in international environmental politics was the United Nations Conference on Environment and Development, also known as the Earth Summit, which took place in Rio de Janeiro in 1992. The outcomes of the conference were of great significance; they acknowledged that sustainable development is an attainable global goal for all people, resulting in the adoption of Agenda 21, a programme of action focused on future strategies to achieve sustainable development in the 21st century (UN, 1992). Furthermore, the United Nations Framework Convention on Climate Change was established, and the Convention on Biological Diversity was opened for signature.

Several UN 'mega summits' followed in the 20 years after the Earth Summit. The most significant were the Millennium Summit in New York in 2000, the 2002 World Summit on Sustainable Development in Johannesburg and the Rio+20 summit in 2012. Together with other environmental and sustainable development conferences, these events combined environmental goals and targets into a 'single international sustainable development agenda', first in the Millennium Development Goals and then, with a much stronger environmental emphasis, in the SDGs established by the 2030 Agenda for Sustainable Development. The lessons learnt from the delayed and insufficient monitoring of the Millennium Development Goals steered the global community to include a comparable and well-established monitoring mechanism in the 2030 Agenda.

Drawing from this process and in parallel with the global SDG indicator framework, Eurostat has adapted its own sustainable development monitoring framework for the SDGs. It created an EU SDG indicator monitoring framework (on which the analyses in this report are based) through consultations with stakeholders.

Figure 2: Timeline of the EU environmental *acquis*



Source: *Authors*

The strengthening of environmental policymaking at EU level in recent decades stands to reason, as the functioning of the European common market depends on rules and standards that aim to level the playing field between the Member States and to harmonise national policies. The EU's environmental *acquis* seeks to achieve this by providing common rights and obligations that are binding for all Member States. Moreover, Article 3.3 of the Treaty on European Union specifies that the internal market

> *shall work for the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment and social progress, and a high level of protection and improvement of the quality of the environment.*

The global environmental policy dimension is stressed in Article 191 of the Treaty on the Functioning of the European Union, which includes the promotion of measures at international level to deal with environmental problems, especially combating climate change.

Setting targets: The road to 2030 and 2050

Numerous EAPs have guided European environmental policy since 1973. One of the key aspects of the seventh EAP, 'Living well, within the limits of our planet', adopted in 2013, was to establish a long-term vision of where the EU wanted to be by 2050 (European Parliament and Council of the European Union, 2013). This vision for the future was reiterated in the eighth EAP, which guides environmental policy until 2030 (European Parliament and Council of the European Union, 2022). The most prominent long-term goal is achieving a climate-neutral EU by 2050. This entails achieving an economy with net-zero GHG emissions, with an interim goal of reducing net GHG emissions by at least 55% by 2030 compared with 1990 levels. Other goals include doubling the EU circular material use rate and halving food waste at retail and consumer levels, both by 2030. In addition, the EU wishes to halve hazardous pesticide use, reduce the health impacts (premature deaths) of air pollution by at least 55% and legally protect at least 30% of the EU's land area (for a detailed overview of environmental objectives, see Paleari (2022)).

In the previous decade, public awareness of environmental and climate concerns increased, but environmental and climate policies did not feature prominently in the Juncker Commission's 10 priorities. This changed considerably with the appointment of Ursula von der Leyen as President of the European Commission. In December 2019, the European Green Deal was adopted as the flagship political initiative of her new European Commission, setting out a detailed vision to make Europe the world's first climate-neutral continent by 2050 and to tackle environmental challenges (European Commission, 2019a). The need for increased political commitment and ambition are also highlighted in the latest assessment report, *The European environment – State and outlook 2020*. Published by the European Environment Agency (EEA) in 2019, it states that despite incremental changes in some areas, faster progress is needed to meet the EU's long-term goals and that Europe's 2030 goals can only be reached if urgent actions are taken in the next decade to address the biodiversity loss, the impacts of climate change and the overconsumption of natural resources (EEA, 2019a).

Climate neutrality is at the top of the priorities of the European Green Deal and is key in the wider growth strategy of the European economy. Achieving the goals of the European Green Deal and making Europe the first climate-neutral continent by 2050 will require extensive economic and industrial transformations. Other environmental policy areas feature alongside climate action as components of the seven European Green Deal policy goals: supplying clean, secure and affordable energy; promoting sustainable mobility; encouraging the transition to a circular economy; creating a toxin-free environment; preserving Europe's natural capital; and designing a fair, healthy and environmentally friendly food system. Numerous strategic documents for achieving environmental, energy and climate goals have been issued since the European Green Deal was adopted at EU level (Barbieri et al, 2021; Paleari, 2022), which influence national environmental and climate policies.

EU policy response to COVID-19

The path to implementing the European Green Deal was obstructed by challenges from early on. The outbreak of the COVID-19 pandemic, in spring 2020, made it even thornier and slowed down the transposition of the deal. In response, the EU introduced an economic recovery package, NextGenerationEU, with the aim of supporting the Member States to recover from the pandemic. The centrepiece of this temporary recovery instrument is the Recovery and Resilience Facility (RRF), representing the core spending under the NextGenerationEU instrument and aiming 'to mitigate the economic and social impact of the coronavirus pandemic and make European economies and societies more sustainable, resilient and better prepared for the challenges and opportunities of the green and digital transitions' (European Commission, undated). After the EU's current long-term budget (the 2021–2027 multiannual financial framework (MFF)), NextGenerationEU is the largest stimulus package ever implemented in Europe. The policy ambition of Europe becoming the first climate-neutral continent is reflected in the budget allocation: the agreed target of the RRF is to allocate 37% of the funds for climate action, which exceeds the 30% allocation of the MFF.

The European Commission announced its Fit for 55 package in July 2021, encompassing a set of legislative proposals for achieving the long-term 2050 climate neutrality target set by the European Climate Law (European Commission, 2021a). An intermediate target of reducing net emissions by 55% at EU level by 2030 (compared with 1990) is probably the most discussed aspect of the package, in addition to the revision and introduction of policy measures needed to achieve the target. The Fit for 55 package includes a proposal for the introduction of a social climate fund (European Commission, 2021b). This fund has two objectives:

- to 'finance temporary direct income support for vulnerable households'
- to 'support measures and investments that reduce emissions in road transport and buildings sectors and as a result reduce costs for vulnerable households, micro-enterprises and transport users' (European Commission, 2021c)

The fund commits to ensuring a socially fair transition that promotes prosperity and social justice in the EU while maintaining its economic resilience (EEA and Eurofound, 2021). This will help the Member States to address future demographic and technological transitions and the challenges they entail.

On 17 December 2022, a provisional agreement between the European Parliament and the Council was reached to set up the Social Climate Fund.[9] The fund is expected to be introduced in 2026, one year before the European Union Emissions Trading System (EU ETS) is extended by establishing the EU ETS II, concerning buildings, road transport and fuels for certain industrial sectors. A total of €68.7 billion between 2026 and 2032 will be available to support vulnerable households, microenterprises and transport users that are particularly affected by energy and transport poverty. The fund will mainly be financed through revenues accrued by auctioning ETS allowances. Some 25% of the fund revenues will be co-financed by the Member States, thereby guaranteeing that they are committed and contribute to a fair and inclusive transition. Financial support will be disbursed based on social climate plans that the Member States must submit. Establishing these social climate plans requires the consultation of all stakeholders, such as regional and local authorities, economic and social partners, and civil society.

EU policy response to the war in Ukraine

As a response to Russia's invasion of Ukraine, the European Commission presented the REPowerEU plan in May 2022 (European Commission, 2022c). Among other measures, it proposes to boost long-term energy efficiency measures and to increase the renewable energy target for 2030 under the Fit for 55 package (European Commission, 2022c). The rise in global energy prices driven by increased demand for energy, triggered by the recovery from the COVID-19 crisis in 2021 and exacerbated by Russia's invasion of Ukraine in 2022, led to policy responses at EU and Member State levels to deal with the negative socioeconomic and environmental consequences of energy poverty in Europe.

9 For further information, see European Parliament (2022).

2 Upward convergence: Measures and definitions

Convergence in environmental indicators

Scholars studying convergence in EU environmental policy typically employ one of two approaches: assessing the similarities of policies or assessing the similarities of outcomes. Studies following the first approach inspect whether environmental policies are becoming more congruent over time. For example, Holzinger et al (2014) concluded that there has been a strong upward trend in convergence in environmental policies. Their study analysed the trend in 21 European countries and Japan, Mexico and the United States. Furthermore, the analysis showed that the degree of convergence differed with respect to actual policy settings and that 'homogeneity increased more strongly for obligatory policies than for non-obligatory ones, and more strongly for trade-related policies than for non-trade related ones' (Holzinger et al, 2014, p. 61).

This report follows the second approach, assessing the similarities of outcomes by analysing whether upward convergence of environmental performance is taking place in Europe. Although the focus of the convergence analysis differs from that of the abovementioned study, its findings are of interest, as it may be expected that convergence in policy will lead to convergence in outcomes.

The current literature on convergence in environmental policy outcomes primarily focuses on environmental performance related to CO_2 emissions (Gilli et al, 2017; Brännlund and Karimu, 2018; Fernández-Amador et al, 2018; Porada Rochón, 2021). These studies differ widely in terms of country coverage, time periods examined, and whether the analysis is based on national or sectoral environmental performance. Although they use different methodologies, the results reveal converging trends and faster convergence by low-income countries than high-income countries. Similar results were found regarding the environmental productivity of manufacturing sectors, with the poorest performers improving faster than the best performers. None of these studies, however, include all EU Member States or members of the Organisation for Economic Co-operation and Development.

Studies have also been published on topics such as renewable energy consumption in the United States (Payne et al, 2017), the energy consumption of EU Member States (Kounetas, 2018), environmental taxation (Delgado et al, 2022) and the estimation of ecological footprints (Ulucak and Apergis, 2017). Huang et al (2022) studied energy poverty in Europe and found evidence of beta-convergence, which indicates 'that countries with high levels of energy poverty tend to reduce energy poverty at higher rates than … countries with low energy poverty levels'. The analysis was conducted based on data from 2006 to 2018, and it would be interesting if these findings continued to be valid in the context of the massive energy price increases in Europe.

A recurrent subject in the literature is testing for club convergence, that is, whether convergence happened between countries or between economic sectors (Emir et al, 2019; Morales-Lage et al, 2019; Cialani and Mortazavi, 2021). This analysis examines whether countries or sectors are converging to different steady states based on distinct characteristics. The research affirms the presence of convergence clubs of Member States regarding CO_2 emissions for economic sectors such as energy and manufacturing, highlighting the existence of distinct characteristics and arguing that these differences should be acknowledged when designing policies.

Interplay of environmental, social and economic indicators

The analysis of Barbieri et al (2021) is of special interest, as it, like this report, goes beyond analysing convergence based on environmental data alone. The authors employ environmental, economic and social indicators to describe whether and to what extent Member States between 1995 and 2018 appear to have been converging in terms of environmental performance (measured through CO_2 productivity), economic growth (measured through gross domestic product (GDP) per capita) and inequality (measured through the Gini coefficient). They conclude from their descriptive analysis that heterogeneity in terms of environmental productivity is widening and, at the same time, they identified mixed evolutions of inequality over time. They argue that

> *The existence of heterogeneous economic and environmental performances, together with worsening inequality in some countries, suggest that particular attention should be paid to designing sustainability transition policies that properly [account] for Member State specificities, especially in matching environmental and social objectives.*
>
> (Barbieri et al, 2021, p. 30)

The authors test whether countries that were behind initially caught up with leading countries, and they state that neither beta-convergence nor sigma-convergence ‘provide information on whether countries are tending to a specific indicator’s value’ (Barbieri et al, 2021, p. 27). This is of significance insofar as achieving quantitative targets (indicator values) set either by EU policies or by national policies is not generally the object of investigation when carrying out convergence analyses.

The findings of a research project studying convergence as a function of multiple dimensions of life, such as happiness, the environment, and work and employment, were published by the European Commission in the note *Measuring social convergence across the EU* (European Commission, 2019b). The note discloses that while ‘most EU member states are converging in most relevant dimensions of life, many citizens do not necessarily experience that as such’ (European Commission, 2019b, p. 33).

The citizens’ perspective should be considered in convergence analyses. For this reason, the following analysis includes indicators measuring the quality of citizens’ everyday environments and their perceptions of it. To the best of our knowledge, this report is the first publication analysing these environmental indicators. It contributes to the current literature by adding the citizens’ perspective to a larger and richer discussion that sometimes fails to identify the everyday needs of people in relation to the green transition. Moreover, this report quantifies the extent to which residential-level and household-level policies are bearing the desired fruit and examines whether more intervention is needed to ensure a just transition.

Measuring upward convergence

Upward convergence combines two concepts: improving performance and reducing disparities. ‘Improving performance’ refers to Member States progressing in a desired policy direction (for instance, increasing employment rates or decreasing numbers of early leavers from education). Performance is generally measured by means of averages. In this report, the EU average is frequently reported, measured as the unweighted average of Member States. An improvement in performance towards policy targets is referred to as an upward trend (this means, for instance, that a decreasing rate of young people not in employment, education or training (NEET) would be an upward trend, as this is considered an improvement in performance). The opposite is a downward trend, which signals worsening performance (such as an increasing NEET rate).

‘Reducing disparities’ refers to convergence. The opposite is divergence, that is, an increase in disparities. For example, if two Member States’ employment rates become more similar, then the territories are said to have converged with regard to their employment rate. By the same logic, if the difference between the territories’ performance has increased, then they have diverged.

Based on the two concepts, three more scenarios can be observed, in addition to upward convergence. Downward convergence occurs when performance worsens, and disparities decrease. Upward divergence happens when performance improves, and disparities increase. Finally, worsening performance and increasing disparities characterise downward divergence.

Convergence is measured in three ways in this report: beta-, sigma- and delta-convergence. The ideas and methodologies behind each are explained below.

Beta-convergence

Beta-convergence is a process in which the poorest performers develop faster than the leading performers and therefore catch up to them. It is linked to the empirical definition of convergence postulated by growth models (Sala-i-Martin, 1996) and is used to measure if regions starting from initially poor performance develop faster than high-performing ones. Unconditional beta-convergence is estimated with the following regression model:

$$ln(\Delta y_{i,t}) = \alpha + \beta\ ln(y_{i,t-1}) + \varepsilon_{i,t}$$

where $y_{i,t}$ is the value of indicator y in country i at time t; $\Delta y_{i,t}$ is the growth rate of indicator y in country i at time t; α and β are the parameters to be estimated; and $\varepsilon_{i,t}$ is the error term. This equation analyses the relationship between the growth of an indicator over a certain period and its initial value. Beta-convergence exists if the relationship is statistically significant and negative; as such, countries in which the initial level is higher see a slower pace of growth. The magnitude of parameter β indicates the speed of the convergence process.

Sigma-convergence

Sigma convergence is characterised by an overall reduction in disparities among countries or regions over time. In this report, it is measured by the standard deviation and the coefficient of variation. The standard deviation is a measure of the dispersion of a set of data values. A low standard deviation for an indicator signals that the values recorded by Member States are close to the EU mean, while a high standard deviation indicates that they are spread out over a wider range. To have sigma-convergence, the standard deviation needs to have decreased. The coefficient of variation is a standardised measure of dispersion. It is defined as the ratio of the standard deviation to the mean and is often expressed as a percentage.

Delta-convergence

The term ‘delta-convergence’ was coined by Heichel et al (2005) to describe the analysis of countries’ distance from an exemplary model, for example the best performer or a set of best performers. Delta-convergence is measured through the sum of the distances between values for the top performers and the other countries:

$$\delta_{i,t} = \sum_{i=1}^{N} \left(MAX(x_{i,t}) - x_{i,t} \right)$$

where $\delta_{i,t}$ is delta-convergence and $x_{i,t}$ is the value of indicator x in country i at time t. A reduction in the distance from the frontrunner over time implies convergence.

If the sum of the distances decreases over time, delta-convergence can be identified, while an increase in the sum of the distances means that countries are diverging. Delta-convergence is a measure of how similar countries or other units are becoming to the top performer. While the presence of outliers can skew the data, it is a good quantitative measure of whether convergence towards a certain policy target has occurred.

3 Macro-level indicators: European environmental overview

Introduction

This chapter investigates the macro-level or headline indicators that are well known from policy debates and the news for providing an overview of environmental performance in the EU. The four indicators selected are:

- net greenhouse gas emissions
- years of life lost due to air pollution
- the share of renewable energy in final energy consumption
- the circular material use rate

For the periods analysed, we see upward trends for all indicators, meaning that performance improved. The dynamics of convergence are less clear. Table 4 (overleaf) presents a summary of the results.

Regarding beta-convergence, a significant catching-up process was seen for GHG emissions and the share of renewable energy in gross final energy consumption. For the circular material use rate and years of life lost due to air pollution, the poorest performers did not improve significantly faster than leaders.

When looking at the reduction of disparities (sigma-convergence), we see a more diverse picture. There was a reduction in disparities in GHG emissions and in the years of life lost due to particulate matter (PM2.5) air pollution. Unfortunately, disparities increased in the share of renewable energy in energy consumption and the circular material use rate. An increase in sigma-convergence can usually be attributed to one or several countries outperforming the rest, pulling away from the average. For example, Sweden outperformed other Member States in its use of renewable energy, and the Netherlands did the same regarding its circular use of materials.

Similar trends are seen for the distance of other Member States from the frontrunners (delta-convergence). While there was a reduction in the distance from top-performing countries for GHG emissions and air pollution, the distance increased for the other two indicators, indicating an increase in disparities between the top performers and the other Member States. This is in part encouraging, as it is preferable for divergence to occur due to the best performers improving their performance rather than due to poorest performers worsening.

For most indicators, no effect of the economic downturns caused by the 2008 financial crisis or the COVID-19 pandemic was apparent. If anything, the share of renewable energy in energy consumption increased in 2020, possibly in light of the launch of the European Green Deal. Similarly, the recent decline in emissions can be attributed to the COVID-19 pandemic and the accompanying drop in economic activity. Le Quéré et al (2020) found that the transport sector (especially aviation) was most affected, followed by the electricity and industry sectors.

Box 1: Convergence – the basics

Convergence analysis entails two aspects: performance and convergence.

Analysis of performance establishes whether there is improvement in an indicator towards a desired policy target, for example reducing GHG emissions. If performance improves, the trend is upward, whereas if performance worsens, the trend is downward.

Convergence is observed when there is a reduction in disparities between countries and is measured in three possible ways.

Beta-convergence measures whether the poorest-performing countries improve faster than the best-performing ones. This is described as a catching-up process. However, when the poorest-performing countries improve slower than best-performing ones, there is divergence.

Sigma-convergence entails a reduction in disparities measured by the standard deviation or the coefficient of variation. A decrease in the two measures of disparity over time, and hence a reduction in the differences among Member States, indicates convergence. An increase in disparities therefore signals divergence.

Delta-convergence measures the distance of countries from the best performer(s). It is measured as the sum of distances between the values for these countries. A reduction in distance signals convergence, whereas an increase shows divergence.

Table 4: Summary of convergence analysis of macro-level indicators

Indicator	Beta	Sigma	Delta
Net greenhouse gas emissions	Beta-convergence	Upward sigma-convergence	Delta-convergence
Years of life lost due to PM2.5 exposure	Beta coefficient not statistically significant	Upward sigma-convergence	Delta-convergence
Share of renewable energy in gross final energy consumption	Beta-convergence	Upward sigma-divergence	Delta-divergence
Circular material use rate	Beta coefficient not statistically significant	Upward sigma-divergence	Delta-divergence

Source: *Eurostat, authors' calculations*

Net greenhouse gas emissions

This indicator measures the total national emissions of the 'Kyoto basket' of GHGs.[10] Net emissions include those resulting from land use, land use change and forestry. Each gas's individual global warming potential is integrated into a single indicator and in this report is expressed in tonnes of CO_2 per capita. The indicator is used to monitor progress towards SDG 13 on climate action, which is embedded in the European Commission's priorities under the European Green Deal. The EU agreed on the European Climate Law in April 2021 and aims to reduce net GHG emissions by 55% compared with 1990 levels by 2030 (European Parliament and Council of the European Union, 2021). The law limits the contribution that carbon removal can make towards this target to ensure sufficient mitigation efforts are made.

GHG emissions from human activity have been the dominant cause of global warming since the 20th century (IPCC, 2014), and understanding the drivers of such anthropogenic emissions is key to tackling climate change. Despite GHG emissions being a global issue, a recent study found that Europe is the only region worldwide where emissions have declined since 2010 (Lamb et al, 2021). The study identifies the most important driver of emissions between 2010 and 2018 as economic growth (GDP) and its accompanying components (GDP per capita and population growth). It describes a decades-long trend of efficiency gains being outpaced by increases in affluence, a phenomenon that is well documented (Haberl et al, 2020; Wiedenhofer et al, 2020; Wiedmann et al, 2020). The main counteracting factor was a decrease in energy intensity thanks to technological innovation, regulation, structural change and increased efficiency. Emissions are also influenced by deindustrialisation and international agreements.

Convergence analysis

In 1990–2020, there was an improvement in performance and a reduction in disparities across the Member States. Despite a small increase in the years before the economic crisis, the trend signals the commitment in the EU to reducing GHG emissions.

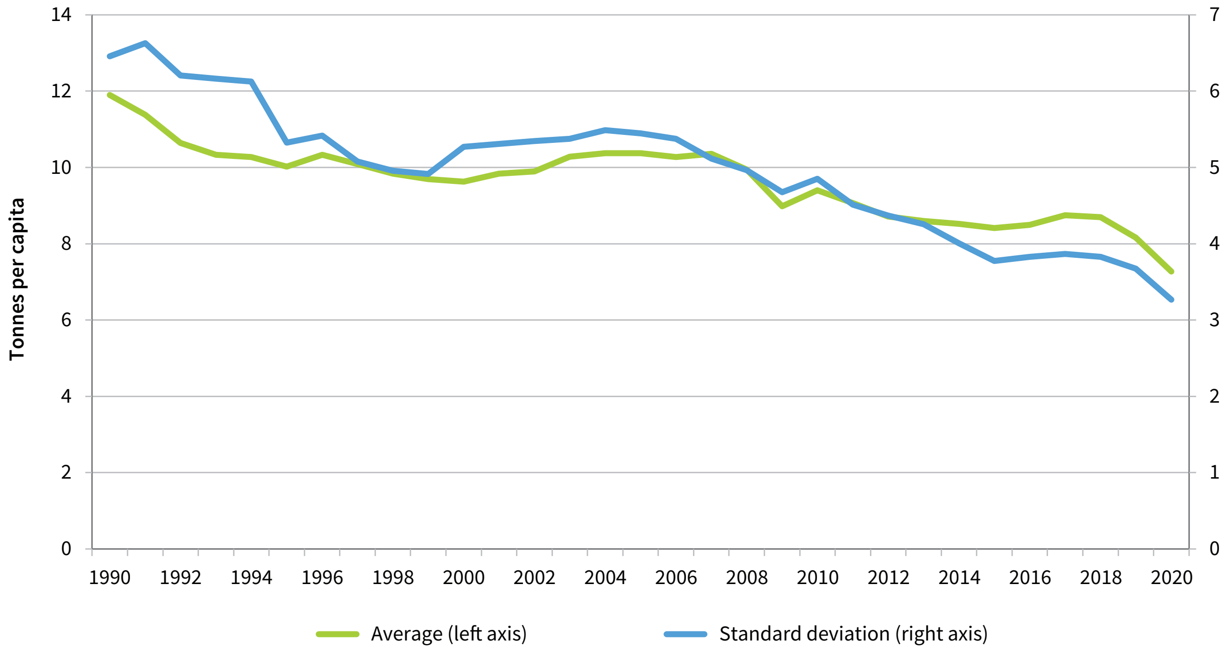
The unweighted EU average and the standard deviation decreased overall, signalling upward sigma-convergence (Figure 3); however, there was a prolonged period from 2000 to 2007 when both increased (signalling downward sigma-divergence).

The sum of distances from the best performer decreased overall; that is, there was delta-convergence. In the late 1990s, delta-divergence was caused by the then best performer (Latvia) pulling further ahead instead of by other states falling behind.

There was statistically significant beta-convergence; that is, there was a catching-up process among Member States, where the poorest performers improved their performance faster than the leaders.

10 The Kyoto basket encompasses the following six GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride (SF_6).

Figure 3: Sigma-convergence in net greenhouse gas emissions, EU27, 1990–2019



Source: *Eurostat, authors' calculations*

For the entire period of the analysis, Luxembourg had the highest rates of GHG emissions per capita. The best performers were Sweden, Latvia and Croatia (Figure 4).[11]

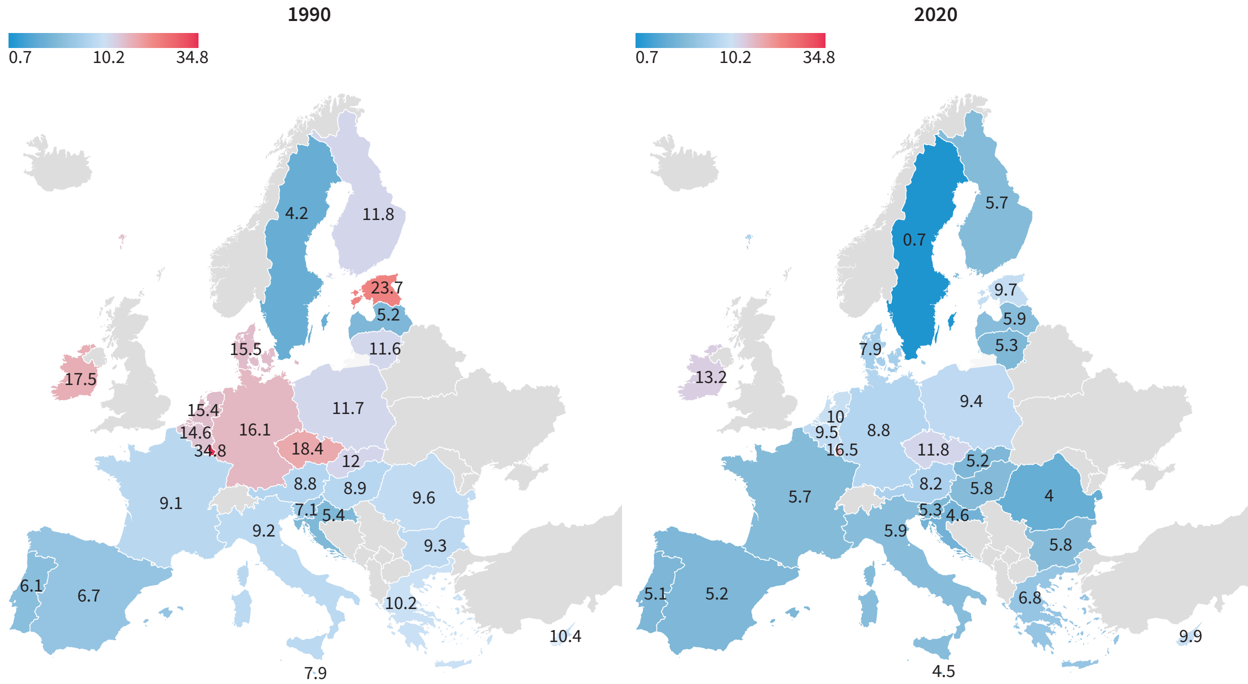
Luxembourg's high rates were driven by a boom in its economy and population. Its low energy prices disincentivise investment in energy efficiency and renewables, perpetuating the country's fossil fuel-intensive energy mix (which has a high proportion of transportation fuels, notably from transiting freight trucks) (IEA, 2020). However, recently Luxembourg has doubled down on the deployment of renewable energy and has set more ambitious energy targets: motivated by EU directives, it committed to reducing GHG emissions for sectors outside the EU ETS by 55% by 2030 compared with 2005 levels, proposed legislation for achieving a carbon-neutral economy by 2050, and plans to expand and upgrade its electricity grids (IEA, 2020).

Sweden is exemplary in its progress towards becoming a low-carbon society. Its nearly fossil-free electricity system relies on nuclear, hydroelectric and wind power. This puts it on track to reach its target of using 100% non-fossil-fuel-reliant energy for electricity generation by 2040.[12] The country is a large net exporter of electricity. Its carbon taxation in particular has been an effective driver of decarbonisation, and it has shown that high environmental taxes can be combined with sustained economic growth (IEA, 2019).

11 There are two ways to calculate the CO_2 emissions of a country. The production-based footprint is the emissions that are produced within a country. The consumption-based footprint concerns the emissions associated with the goods and services consumed within a country. Emission reduction targets, such as those outlined in the Paris Agreement, are based on the former approach. For further information, see Eurostat (2022a).

12 For more information, see European Commission (2019c).

Figure 4: Net greenhouse gas emissions, EU Member States, 1990 and 2020



Note: *GHG emissions are measured in tonnes per capita.*
Source: *Eurostat, authors' calculations*

Years of life lost due to PM2.5 exposure

This indicator measures the years of life lost due to exposure to PM2.5.[13] PM2.5 is particulate matter containing particles with a diameter of less than 2.5 micrometres. These particles can be carried deep into the lungs, causing inflammation and exacerbating heart and lung diseases. Years of life lost is defined as the years of potential life lost as a result of premature death. It is an estimate of the average number of years that a person would have lived if they had not died prematurely. The measure is strictly tied to air pollution.

The indicator monitors progress towards SDG 11 on making cities and human settlements inclusive, safe, resilient and sustainable, and SDG 3 on good health and well-being, which is embedded in the European Commission's priorities under the European Green Deal.

The EU addresses the problem of air pollution through specific air quality and industrial emissions legislation, such as the Clean Air Package and the directives adopted by the European Council and the European Parliament in relation to ambient air quality, and through co-benefits of climate, transport and energy policies.

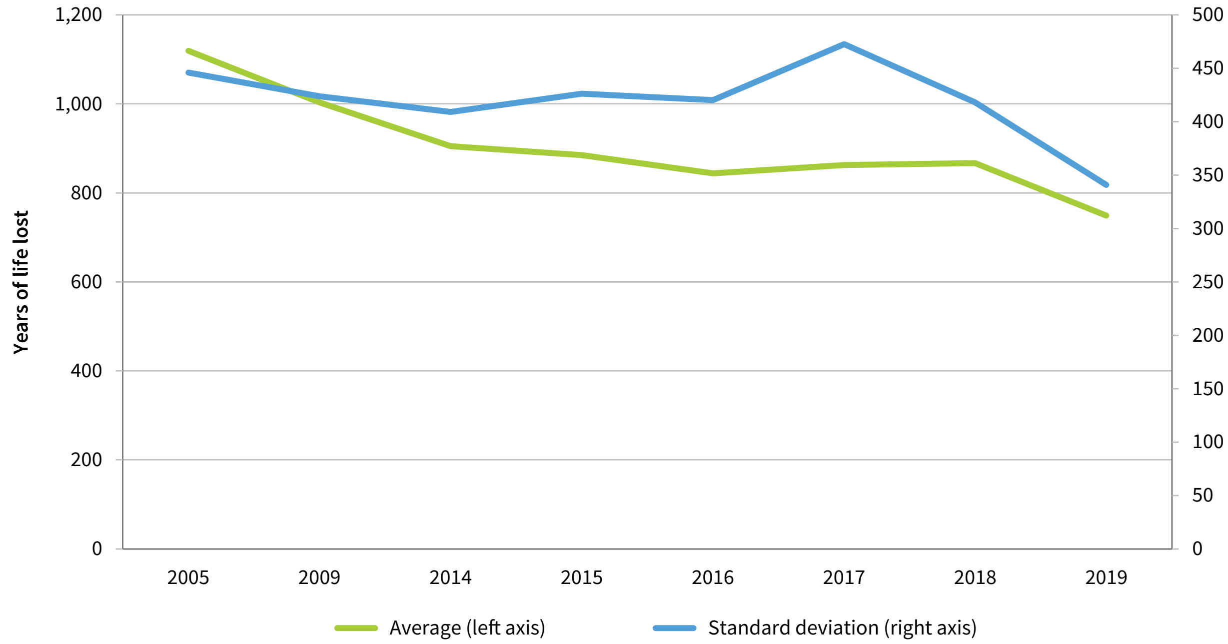
Convergence analysis

In 2005–2019, there was an increase in performance and a reduction in disparities across the EU. A geographical divide is apparent: eastern European countries performed worse than western and southern European countries. Bulgaria and Poland had the highest values, while Finland, Ireland and Sweden had the lowest values for the whole period.

As Figure 5 illustrates, the unweighted EU average and the standard deviation decreased (signalling upward sigma-convergence), albeit with a spike in 2017 that was mainly driven by a temporary drop in Greece's performance. There was delta-convergence due to poorly performing Member States closing the gap with the frontrunners. The beta coefficient was not significant; hence, a clear catching-up process was not found.

13 Data were revised in April 2023 in order to address changes to the data series. The data used resulted from prior changes, so there may be a mismatch for some countries. Nonetheless, the overall analysis stands.

Figure 5: Sigma-convergence in years of life lost due to PM2.5 exposure, EU27, 2005–2019



Note: *Years of life lost per 100,000 inhabitants.*
Source: *Eurostat, authors' calculations*

Bulgaria, Hungary and Romania showed the biggest improvements with regard to the reduction in years of life lost in absolute terms, with Bulgaria exhibiting the greatest decrease (Figure 6). The improvement in Bulgaria coincided with its adoption of the European Commission directive on air quality and cleaner air in 2010. This intervention was mostly aimed at reducing emissions in densely populated areas, where most of the pollution is concentrated.

In Poland, better air quality followed consistent investments in improving housing quality, including insulation and heating. Poland is the leading country in coal extraction and use, which is a key determinant of air quality and the presence of fine particles. Transitioning from coal to other fuels will take time, as coal is Poland's primary source of energy.[14] Notwithstanding, several measures addressing private and traffic emissions have been implemented, alongside the rapid alignment of national legislation with European Commission directives on the matter.

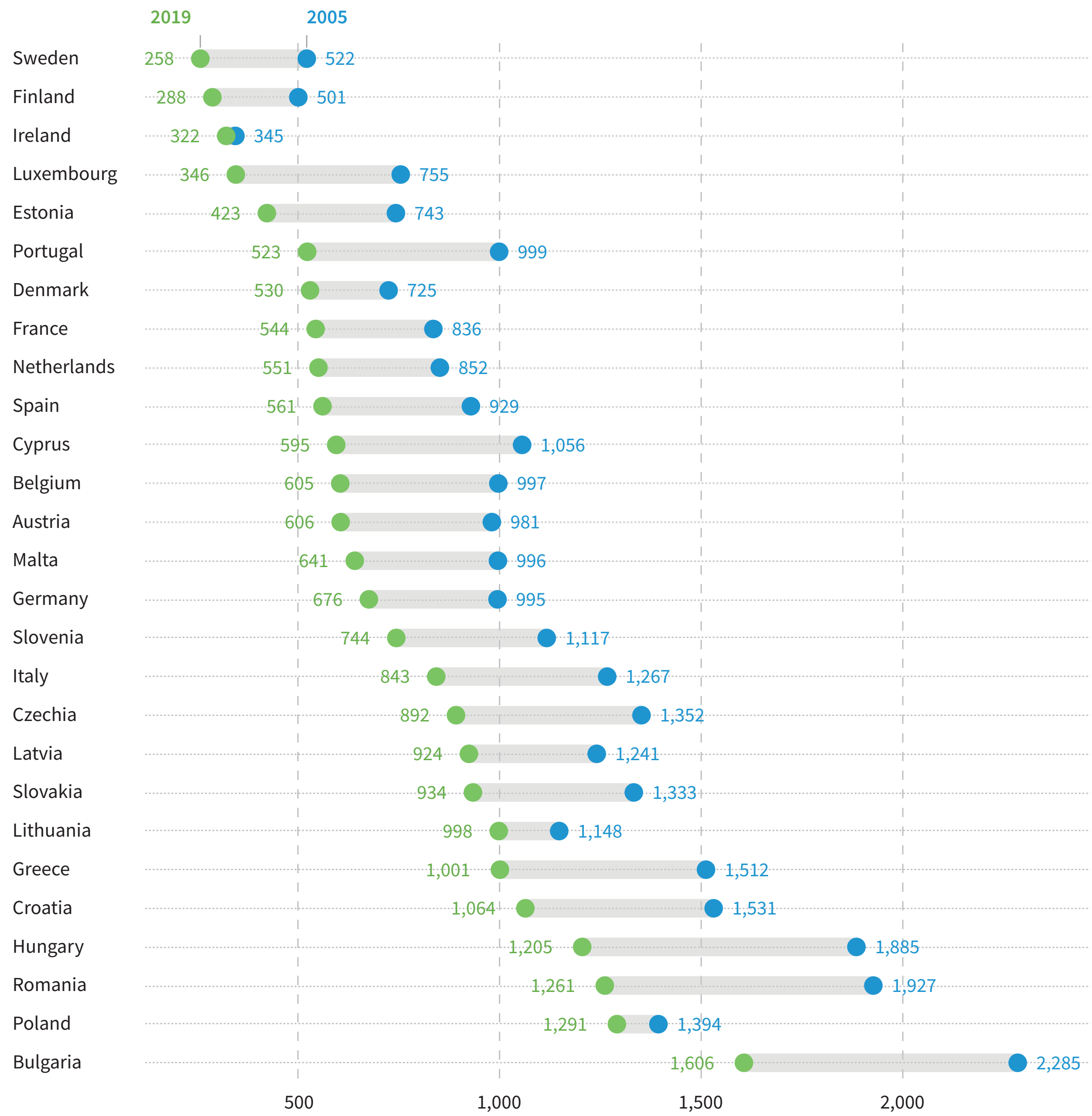
Conversely, countries such as Finland, Ireland and Sweden had low rates of years of life lost due to air pollution. Ireland strictly monitors emissions at local level, enforcing laws and a ban on the marketing of polluting fuel sources such as bituminous coal.[15] Similar measures have been taken in Finland and Sweden, both of which record low levels of air pollution. In Helsinki, personal air quality monitors have been distributed among citizens.[16] As one of the main pollutants in urban areas is traffic emissions, measures were taken to monitor and create ad hoc interventions. Moreover, traditional wood-burning stoves are slowly being replaced with more energy-efficient and cleaner heating systems. Sweden adopted similar measures concerning traffic emissions and wood-burning stoves (Gustafsson et al, 2022).

14 For more information, please see https://www.eea.europa.eu/themes/air/country-fact-sheets/2022-country-fact-sheets/poland-air-pollution-country.

15 For the Irish rules, see Government of Ireland (2021).

16 Finnish regulations can be found at https://www.iqair.com/finland.

Figure 6: Comparison of years of life lost due to PM2.5 exposure, EU Member States, 2005 and 2019



Note: *Years of life lost per 100,000 inhabitants.*
Source: *Eurostat, authors' calculations*

Share of renewable energy in gross final energy consumption

This indicator measures the share of renewable energy in gross final energy consumption in accordance with the Renewable Energy Directive. Gross final energy consumption is the energy used by end-consumers (final energy consumption) plus grid losses and consumption by power plants. The energy sources considered are hydroelectric, wind and solar power, and other renewable sources such as gaseous and liquid biofuels, renewable municipal waste, geothermal power, and tide, wave and ocean energy. Nuclear energy is not considered.

The indicator monitors progress towards SDG 7 on affordable and clean energy and SDG 13 on climate action, which are embedded in the European Commission's priorities under the European Green Deal. It is used to measure the EU's progress towards becoming a climate-neutral economy by 2050. The EU and its Member States set quantitative EU- and Member State-specific targets for 2020 and for 2030. The 2020 target was set at 20% and was exceeded (22.1%). The original 2030 target of 32% was agreed in 2018. However, as part of the Fit for 55 package, the target was revised upwards, as the EU aims to double the share of renewable energy to 40% compared with the 2020 target. This is now under negotiation in trilogue between the European Commission, the Member States within the European Council and the European Parliament.

Convergence analysis

In 2004–2020, there was a continuous improvement in performance and an increase in disparities between the Member States. Disparities were mostly driven by Sweden, which has a high use of renewable energy. There seems to be a strong geographical component in this indicator, with central and western European countries (with the notable exception of Austria) having low renewable energy shares.

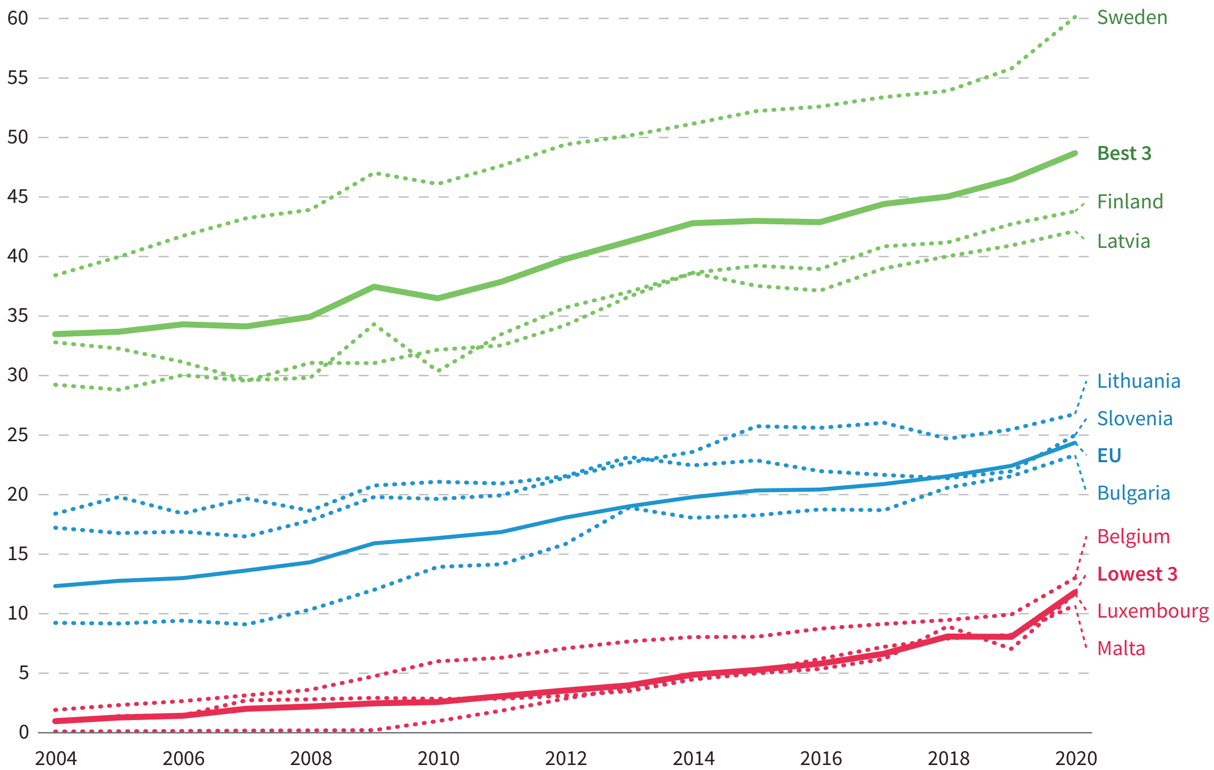
There was upward sigma-divergence, with the unweighted EU27 average of the share of renewable energy increasing as disparities between Member States grew minimally. There was statistically significant beta-convergence; that is, we observe a catching-up process. There was delta-divergence: the distance from the frontrunner increased because the top performer (Sweden) pulled ahead rather than because other Member States' performance dropped off (Figure 7).

Sweden's performance is partly due to the country having invested in biofuels and heat pumps and taxing CO_2 emissions since the 1990s. Furthermore, it follows a free market strategy in its energy supply, wherein increased competitiveness reduces renewable energy prices. Government action, such as the Electricity Certificate System, has also made renewable energy much more cost-efficient. The Swedish Energy Agency supports energy technology entrepreneurs who would struggle to scale up their outputs through grants, initially through conditional loans.[17]

Apart from Sweden, the best-performing Member States include Austria, Finland and Latvia (Figure 8). Croatia, Denmark and Portugal also made it into the top quintile multiple times throughout 2008–2020.

Malta and the Netherlands are among the poorest performers. The Netherlands has large natural gas reserves and has only recently begun investing in renewable energy sources. As such, it is among the last of the EU27 countries to do so. As for Malta, the island has not capitalised on its natural potential for wind, solar and sea-wave energy. As it does not have its own fossil fuel resources, it has historically imported natural gas and oil (Central Bank of Malta, 2021).

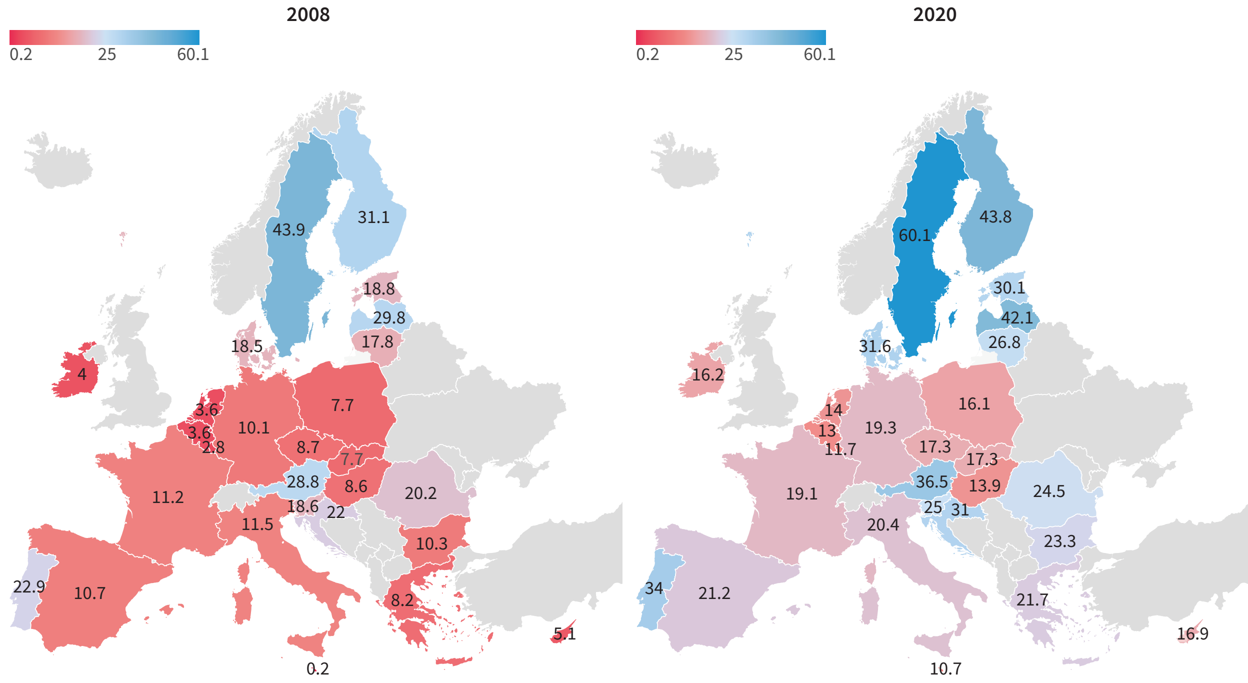
Figure 7: Share of renewable energy in gross final energy consumption, EU27, 2004–2020 (%)



Source: *Eurostat, authors' calculations*

17 https://www.iea.org/articles/swedish-energy-agency

Figure 8: Share of renewable energy in gross final energy consumption, EU Member States, 2008 and 2020 (%)



Source: *Eurostat, authors' calculations*

Box 2: Delta-convergence on national targets for the share of renewable energy in gross final consumption

Delta-convergence measures the sum of the distances of the poorest performers from the frontrunners. When data are available, the measure can be adapted to national targets and milestones. Therefore, delta-convergence can measure the sum of the distances of Member States from fixed policy targets. The Member States set goals for their renewable energy shares in 2009 (in response to Directive 2009/28/EC). Each target was decided based on 2005 levels (Table 5). Most countries were asked to increase their share of renewable energy by roughly 10% in the 11-year period to 2020. Croatia adopted the EU-wide target (20%) when it joined the EU in 2013. An assessment of Member States' performance has been conducted every two years.

Table 5: Share of renewable energy in gross final energy consumption in 2005 and targets for and effective rates in 2020, EU Member States

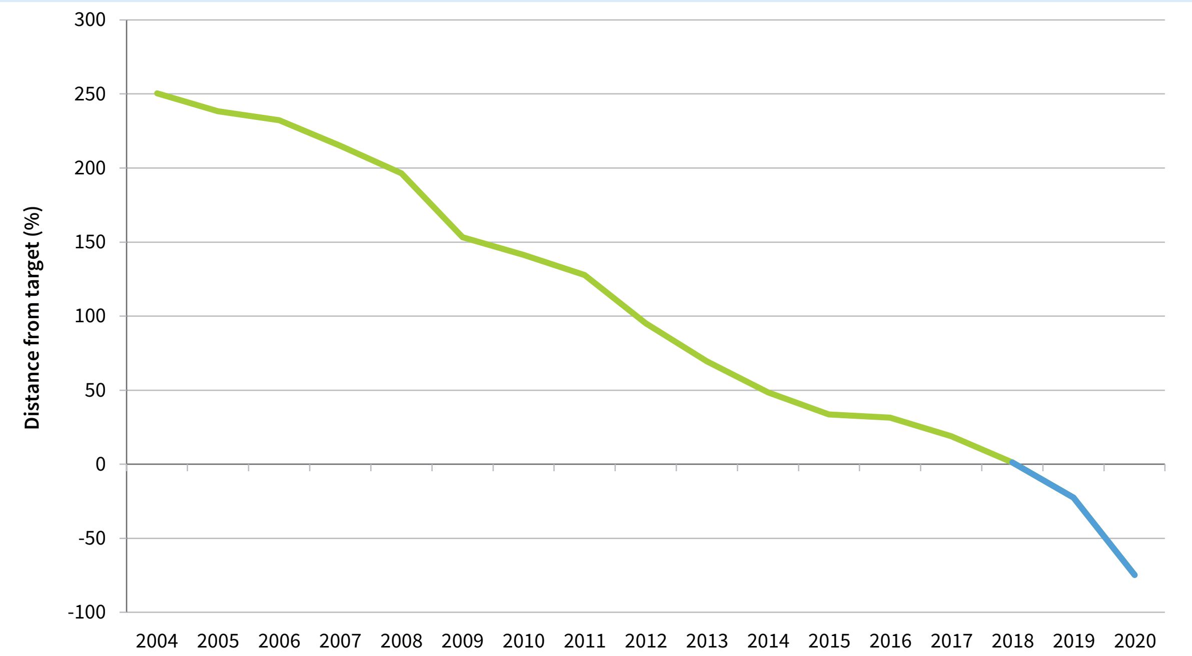
	Share of energy from renewable sources in gross final energy consumption in 2005 (%)	Target for share of energy from renewable sources in gross final energy consumption in 2020 (%)	Share of energy from renewable sources in gross final energy consumption in 2020 (%)
Austria	23	34	37
Belgium	2	13	13
Bulgaria	9	16	23
Croatia	–	20	31
Cyprus	3	13	17
Czechia	6	13	17
Denmark	17	30	32
Estonia	18	25	30
Finland	28	38	44
France	10	23	19
Germany	6	18	19
Greece	7	18	22

	Share of energy from renewable sources in gross final energy consumption in 2005 (%)	Target for share of energy from renewable sources in gross final energy consumption in 2020 (%)	Share of energy from renewable sources in gross final energy consumption in 2020 (%)
Hungary	4	13	14
Ireland	3	16	16
Italy	5	17	20
Latvia	33	40	42
Lithuania	15	23	27
Luxembourg	1	11	12
Malta	0	10	11
Netherlands	2	14	14
Poland	7	15	16
Portugal	20	31	34
Romania	18	24	24
Slovakia	7	14	17
Slovenia	16	25	25
Spain	9	20	21
Sweden	40	49	60

Sources: *Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, and Eurostat data*

The EU target of 20% by 2020 was met in 2018. Nonetheless, the big question is whether every Member State met its own national target. In the 11-year period, some Member States matched their targets (such as Belgium, the Netherlands and Slovenia), while others exceeded them (Sweden surpassed its target by 11.1%, followed by Bulgaria, which surpassed its target by 7.3%). France was the only country that did not meet its target, missing its goal of 23% by 3.9%. It is important to note that five countries (Belgium, Ireland, Luxembourg, the Netherlands and Slovenia) acquired some renewable energy shares from countries that exceeded their energy target by a procedure called statistical transfer (Czechia, Denmark, Estonia, Finland, Lithuania and Sweden) (EEA, 2022).

Figure 9: Delta-convergence in national targets for renewable energy, EU27, 2004–2020



Source: *Eurostat, authors' calculations*

Looking at delta-convergence on national targets, Figure 9 shows that the sum of distances of each country relative to its target steadily decreased to meet the EU target in 2018, two years before the 2020 deadline. By 2020, Member States outperformed the EU target by almost 74.7 points. The rapid increase in the share of renewable energy in final gross energy consumption may have been due to the EU directive drafted in 2018 setting the new EU target for 2030 at 32% (Directive 2018/2001/EU), pending possible further upward adjustment. The increase materialised in 2021 with the implementation of the Renewable Energy Directive, setting it at 40%. The target was further increased through the adoption of the REPowerEU plan, which set the 2030 target at 45%. In particular, the new targets are tailored to those areas in which the adoption of renewable energy has been slower, such as heating, cooling and transport.

Circular material use rate

This indicator measures the share of material recycled and fed back into the economy as the ratio of the circular use of materials to overall material use. A higher rate reduces the environmental impacts of extracting primary materials.

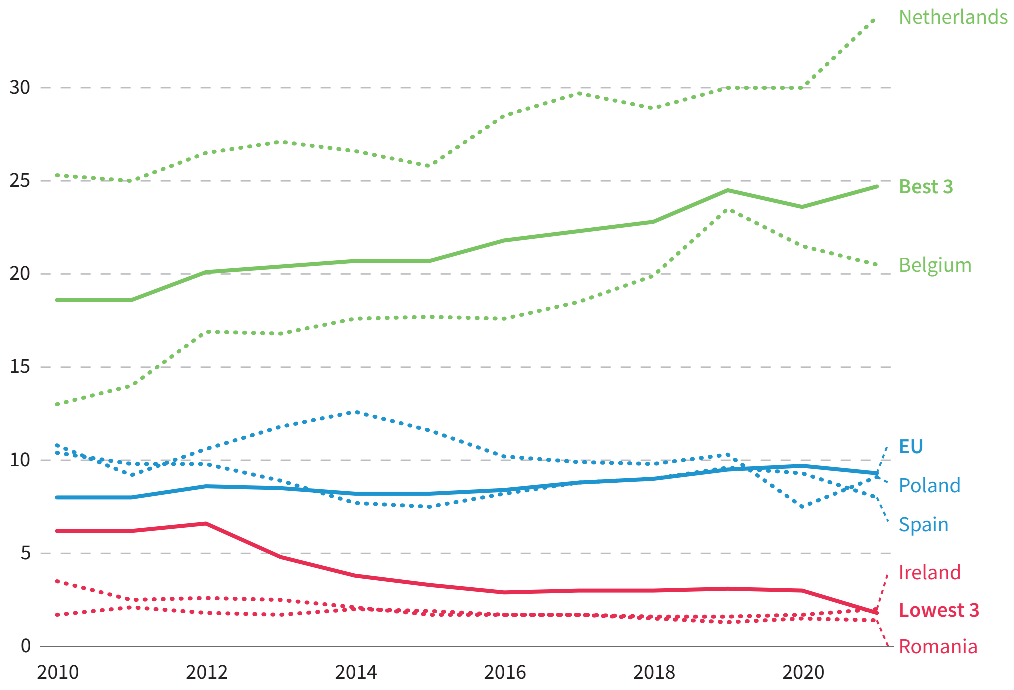
The indicator is used to monitor progress towards SDG 12 on ensuring sustainable consumption and production patterns. Increasing the circularity of Europe's economy is a priority of the new Circular Economy Action Plan of 2020, as one of the key elements of the European Green Deal; the EU Industrial Strategy, adopted in 2020; and the Commission communication updating the industrial strategy, published in 2021 (European Commission, 2020c, 2020d, 2021d).

Convergence analysis

In 2010–2021, there was an increase in performance but also an increase in disparities (Figure 10). The rise in disparities was mostly driven by the outstanding performance of the Netherlands. It consistently achieved a higher rate than other countries, reaching three times the EU average in 2021.

Upward sigma-divergence can be observed for the circular material use rate, as average performance increased in tandem with the rise in disparities (Figure 11). The beta coefficient is not statistically significant, meaning that there was no catching-up process between countries. There was delta-divergence due to the best performer, the Netherlands, pulling ahead of the other states (as opposed to the other nations' performance decreasing). By 2021, the Member

Figure 10: Circular material use rate, EU27, 2010–2021 (%)



Source: *Eurostat, authors' calculations*

States were sorted into three tiers: the first is occupied solely by the Netherlands, with a rate of more than 30%; the second is made up of Belgium, Estonia, France and Italy, achieving around 20%; and the third is all other Member States, whose rates have been below 15% since 2014.

The exceptional performance of the Netherlands can be attributed to a number of factors. In 2016, the Dutch government, in cooperation with several third parties and stakeholders, drew up and implemented an action plan (MoFE and MoEA, 2016), and it updated the implementation programme in 2021 (MoIWA, 2021). Similarly, the structural features of the Dutch economy allowed for better circularity (MoFE and MoEA, 2016).

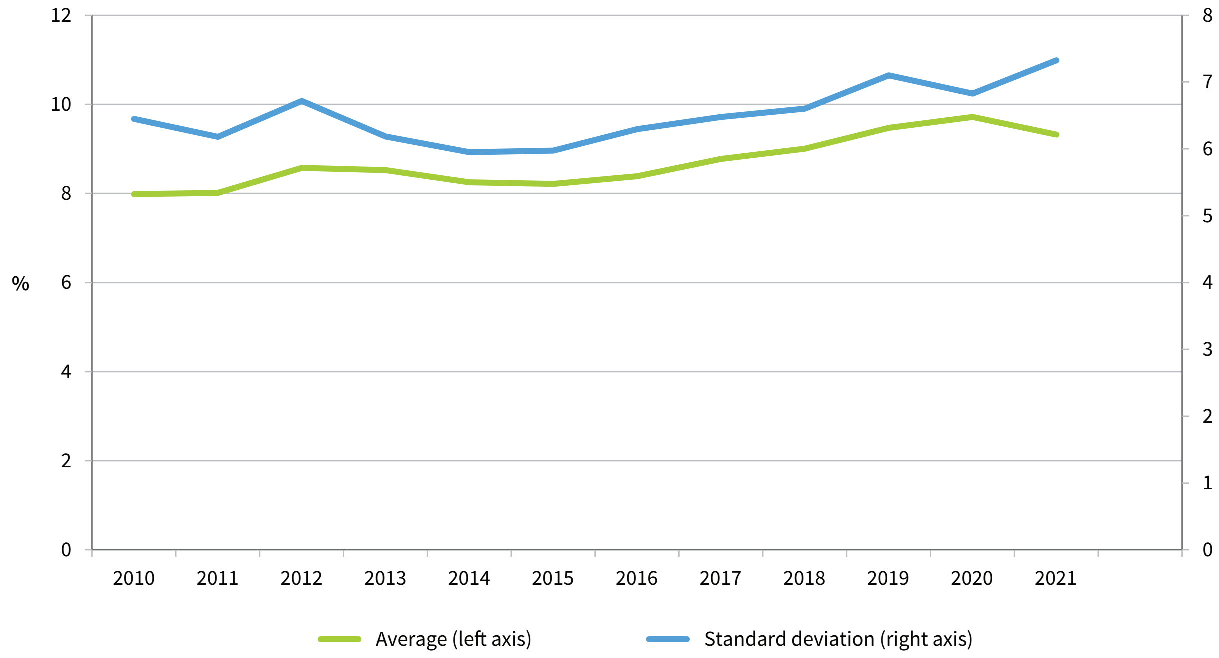
The poorest performers include Bulgaria, Cyprus, Ireland, Portugal and Romania. Finland gradually dropped lower and lower in the quintile groupings, while Czechia steadily improved its standing. Luxembourg's rate nosedived; it went from being a close-second-best performer to hitting a low of around 7% in 2016. This decrease in Luxembourg's circular use of materials could be associated with a reduction in the import of recyclable raw material and biowaste recycling.[18] Overall, there seems to be a tendency for eastern European and Baltic states, and Ireland and Portugal, to perform worse on this indicator.

Policy takeaways for macro-level indicators

The Fit for 55 package, one component of the implementation of the European Green Deal, proposes policies to reduce net GHG emissions by at least 55% by 2030, compared with 1990 levels. This chapter examined progress on reducing GHG emissions. Other components of the European Green Deal are directly related to the other indicators analysed in this chapter: improving air quality and reducing the number of premature deaths caused by PM2.5 and other air pollutants by at least 55% by 2030; further increasing the share of renewable energy in energy consumption; and doubling the circular material use rate in the coming decade. Achieving these targets will require ambitious policies at EU and national levels.

- The revision and extension of the current EU ETS will be the central legislative mechanism in the reduction of GHG emissions. The ETS has contributed to reducing emissions from power generation and energy-intensive industries by 43% since 2005. The proposed 2030 emission reduction target in the sectors covered by the EU ETS was increased to 62% in 2030 (compared with 2005 levels). It has been agreed that a separate, new ETS

Figure 11: Sigma-convergence in circular material use rate, EU27, 2010–2021 (%)



Source: *Eurostat, authors' calculations*

18 Data are available at https://ec.europa.eu/eurostat/databrowser/view/CEI_SRM020/default/table?lang=en&category=cei.cei_srm

(ETS II) for buildings, road transport and fuels for certain industrial sectors will be established by 2027, with a target of reducing emissions by 42% by 2030 compared with 2005 levels. Reaching these reduction goals will require additional funding and investment, which will require changes to Member States' economies. A communication from the European Commission advocates for an increase of annual investments of €520 billion to meet the European Green Deal's objectives (see European Commission, 2022d). This would include energy-related investments in the building and transport sectors and in key technologies (such as batteries and solar panels) as well as workforce reskilling. This increase in investment is in the best interest of Member States, as the cost of non-action is expensive from both economic and social perspectives.

- One of the aims of the REPowerEU plan is to build a new energy system that is independent from Russia as a fuel producer. The estimated additional investment needed to reduce the dependence to zero, complementing the Fit for 55 package, amounts to €300 billion from now until 2030 (European Commission, 2022c). The European Commission put in place a broader green investment strategy linked to the post-COVID-19 recovery, centred on the decision to devote 30% of the current EU long-term budget (MFF) and 37% of the NextGenerationEU fund to climate action and thereby accelerate the implementation of the European Green Deal. This is a direction that the EU and its Member States should adhere to.
- One of the barriers to accelerating the take-up of renewables in the EU is the lengthy processes for permissions to be granted to new renewable infrastructure. The EU energy ministers agreed in November 2022 on the content of a Council regulation to speed up the permit-granting process and the deployment of renewable energy projects.[19]
- Although emissions of key air pollutants and their concentrations in ambient air have been falling for more than two decades, further reductions are required. These are set out in the European Commission's Zero Pollution Action Plan. Improving air quality has positive effects on the health of people and natural ecosystems. Cities all over Europe have created 'low-emission zones' to improve air quality by regulating the entry of the most-polluting vehicles into the zones.[20]
- Improving the circular material use rate, as one of the policy objectives of the EU's Circular Economy Action Plan, can have economic, environmental and social benefits. The circular material use rate can be increased through policy instruments, such as taxes on primary natural resources or landfill taxes, giving recycled materials a price advantage. It can also be increased by other means: the more widespread introduction of extended producer responsibility schemes; by setting standards for the design of products and processes to decrease in the amounts of materials used; or by introducing minimum requirements for the recycled content of products, as the packaging directive already does. Reducing the EU's reliance on primary natural resources would strengthen its 'strategic autonomy' in relation to raw materials, which are crucial components for the energy transition and for the transformation of the EU economy, and would reduce environmental degradation from resource extraction and conversion.[21] In addition, it would create new jobs in Europe.

19 See Council of the European Union (2022).

20 For further information and a list of cities with low-emission zones, see https://urbanaccessregulations.eu/

21 The European Raw Materials Alliance was launched by the European Commission in 2020, with the aim of increasing the EU's strategic autonomy in sourcing raw materials such as rare earth elements; see https://erma.eu/

4 Meso-level indicators: Quality of residential areas

Introduction

In this chapter, convergence across the Member States at meso level, regarding the quality of residential areas, is investigated using four indicators:

- pollution, grime or other environmental problems, which was analysed separately for the total population and the population at risk of poverty to capture differences between them
- the recycling rate of municipal waste
- the share of buses and trains in inland passenger transport
- the population living in households that report they suffer from noise, again for both the total population and the population at risk of poverty

In addition to the obvious environmental impact (such as the threat to animal and plant species and soil degradation), pollution is responsible for one in eight deaths in the EU (European Commission, 2021e). Better air and clean water have been proven to reduce public health expenditure (Jennings et al, 2019). Similarly, noise pollution has been linked to detrimental health outcomes (King and Murphy, 2016; EEA, 2019b). Improving on these aspects of the environment (following the World Health Organization's One Health approach) is important for planetary and individual well-being.[22]

Between 2008 and 2020 or 2021 (depending on indicator), results were favourable across almost all indicators, with an improvement in performance coupled with a reduction in disparities observed in most types of convergence analysis conducted (Table 6). For noise pollution, there was an improvement in performance, but disparities remained or even worsened. For public transport, performance worsened, especially during the COVID-19 pandemic, while disparities reduced.

Pollution, grime or other environmental problems, by poverty status

This indicator measures the share of people reporting pollution, grime or other environmental problems – such as smoke, dust, unpleasant smells and polluted water – in their local area. It is one of the indicators included in the European Union Statistics on Income and Living Conditions (EU-SILC) survey and assesses whether the responding households feel that these factors are a problem.

Table 6: Summary of convergence analysis of meso-level indicators

Indicator	Beta	Sigma	Delta
Pollution, grime or other environmental problems (total population)	Beta-convergence	Upward sigma-convergence	Delta-convergence
Pollution, grime or other environmental problems (population at risk of poverty)	Beta-convergence	Upward sigma-convergence	Delta-convergence
Recycling rate of municipal waste	Beta-convergence	Upward sigma-convergence	Delta-convergence
Share of buses and trains in inland passenger transport	Beta-convergence	Downward sigma-convergence	Delta-convergence
Population living in households considering that they suffer from noise (total population)	Beta coefficient not statistically significant	Upward sigma-divergence	Delta-convergence
Population living in households considering that they suffer from noise (population at risk of poverty)	Beta coefficient not statistically significant	Upward sigma-divergence	Delta-divergence

22 https://www.who.int/europe/initiatives/one-health

Convergence analysis

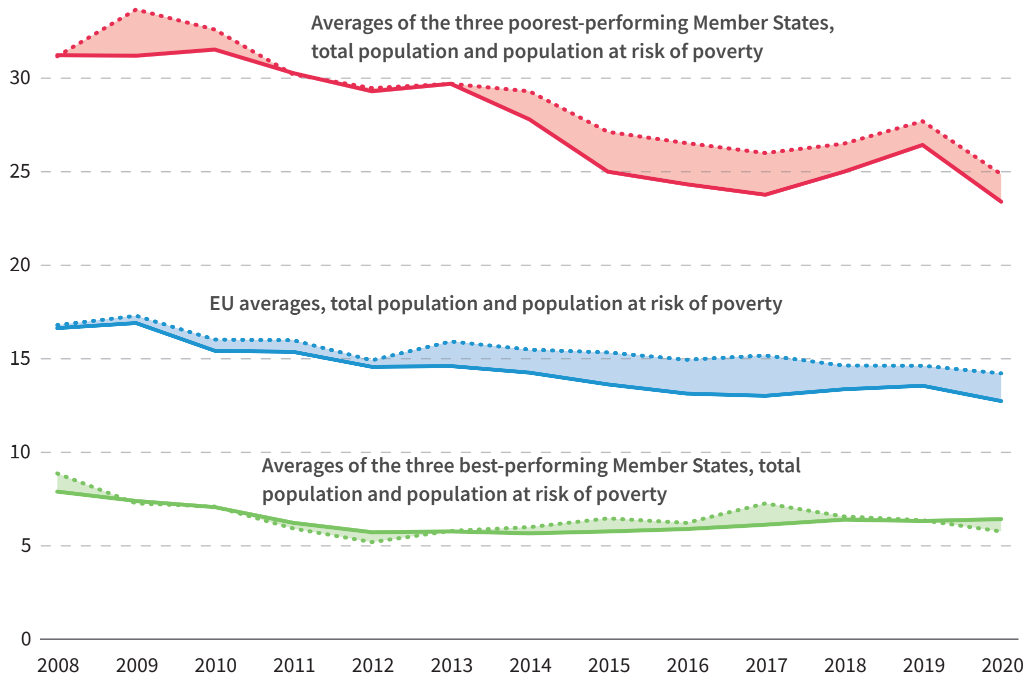
Overall, for both the total population and those with low incomes (below 60% of median equivalised income), there has been an improvement in performance and a reduction in disparities.

For both the total population and those with low income, the unweighted EU average fell, although not consistently: there was a slight increase from 2017 to 2019, but the decreasing trend resumed afterward (Figure 12). The worsening performance from 2017 to 2019 was due in part to Malta's share increasing and driving the average upwards. The recent improvement occurred due to a steep decrease in the shares for two of the poorest performers – Malta and Germany. As the standard deviation also decreased, there was upward sigma-convergence. For both the entire population and those at risk of poverty, the beta coefficient was negative and statistically significant, meaning that there was a catching-up process among the Member States.

There was delta-convergence as the sum of distances from the best-performing countries – Croatia, Denmark and Ireland – decreased.

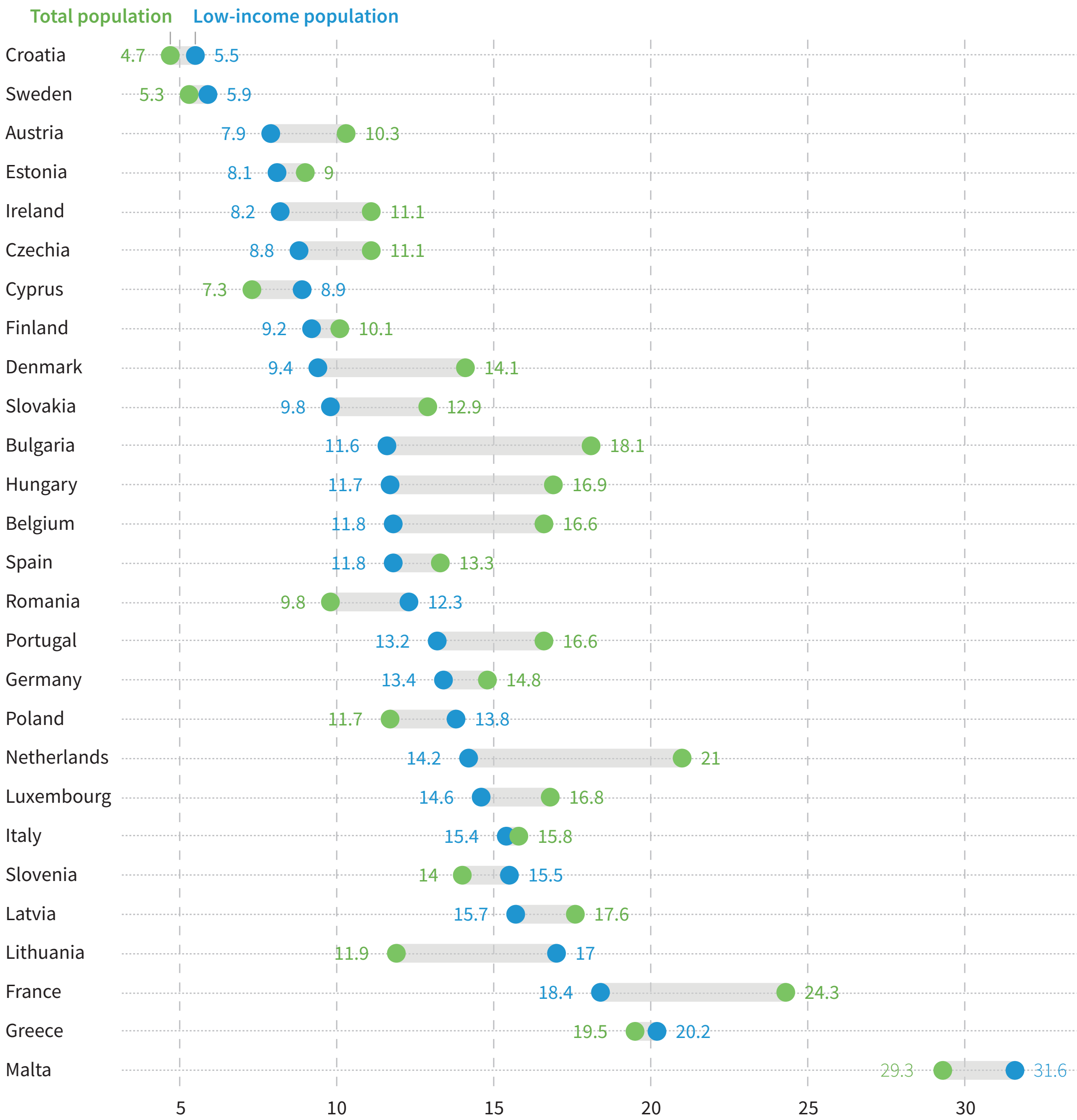
The divide between the total population and those with low incomes in relation to pollution is not the same as for energy poverty (where low earners clearly experienced more energy poverty – see Chapter 5). Instead, in multiple instances, low earners reported environmental problems at a lower rate than the population as a whole (Figure 13). This may be because richer urban centres are denser and more polluted than less affluent towns and rural settings, or the perception of what constitutes an environmental problem may be different between the two groups.

Figure 12: Share of population reporting pollution, grime or other environmental problems, for total population and population at risk of poverty, EU27, 2008–2020 (%)



Note: *A solid line represents the total population, whereas a dotted line represents the population at risk of poverty.*
Source: *Eurostat, authors' calculations*

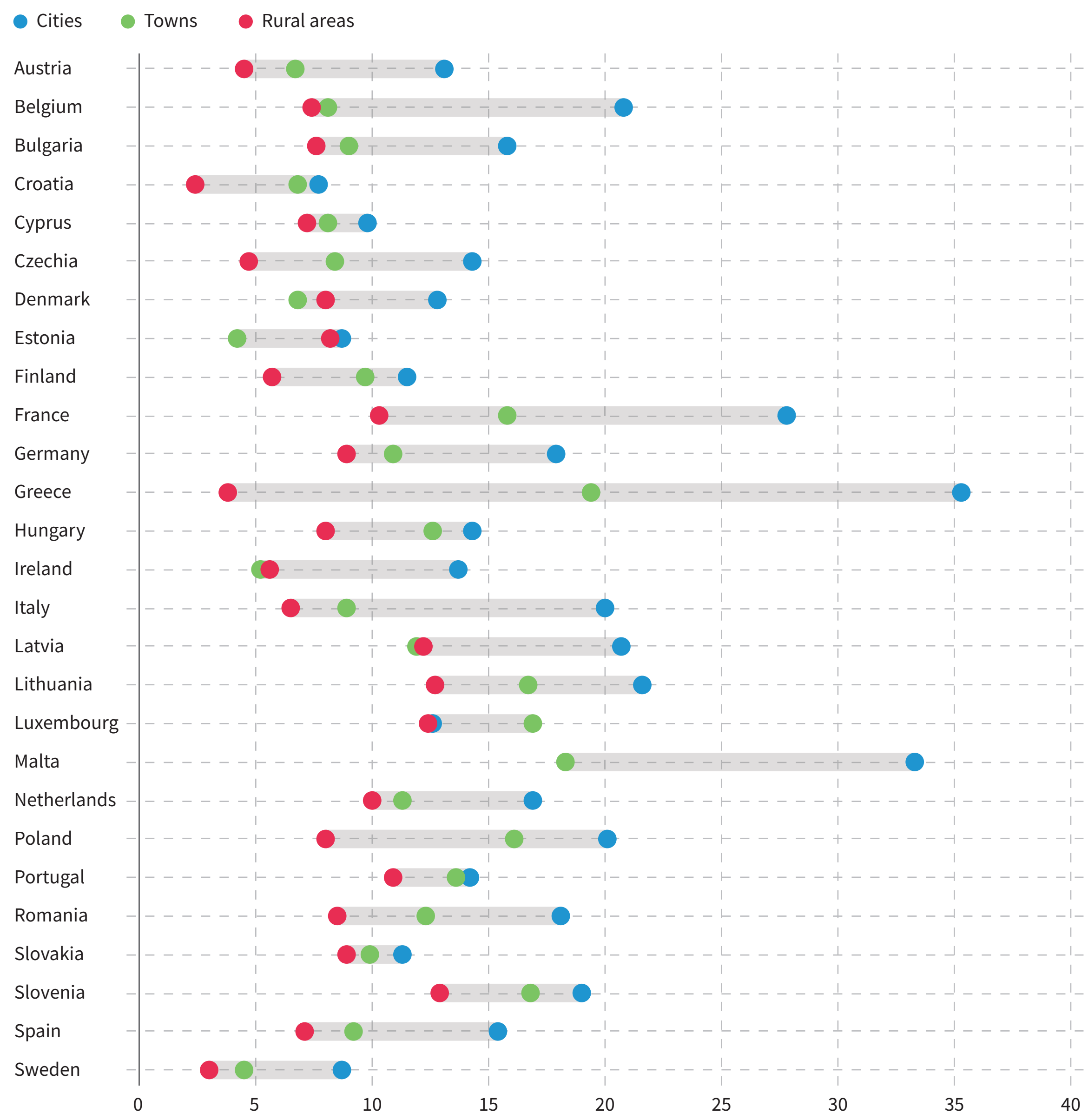
Figure 13: Share of population reporting pollution, grime or other environmental problems, by total population and population at risk of poverty, EU Member States, 2020 (%)



Source: *Eurostat, authors' calculations*

Luckily, the data can be disaggregated into cities, towns and rural areas (Figure 14), which is a clearer breakdown for this indicator than separating the population by income level. And, indeed, we see that people in cities more frequently reported pollution, grime or other environmental problems than those in towns and rural areas (Figure 14). As a result, disparities between Member States and between urbanisation levels are more noticeable than disparities between income groups.

Figure 14: Share of population reporting pollution, grime or other environmental problems, by degree of urbanisation, EU Member States, 2020 (%)



Source: *Eurostat, authors' calculations*

Recycling rate of municipal waste

This indicator measures the recycled tonnage of municipal waste as a percentage of total municipal waste. The recycling rate of municipal waste provides a good indication of the quality of the overall waste management system. Municipal waste accounts for around 10% of total waste generated in the EU, and its heterogeneous composition makes managing it challenging.

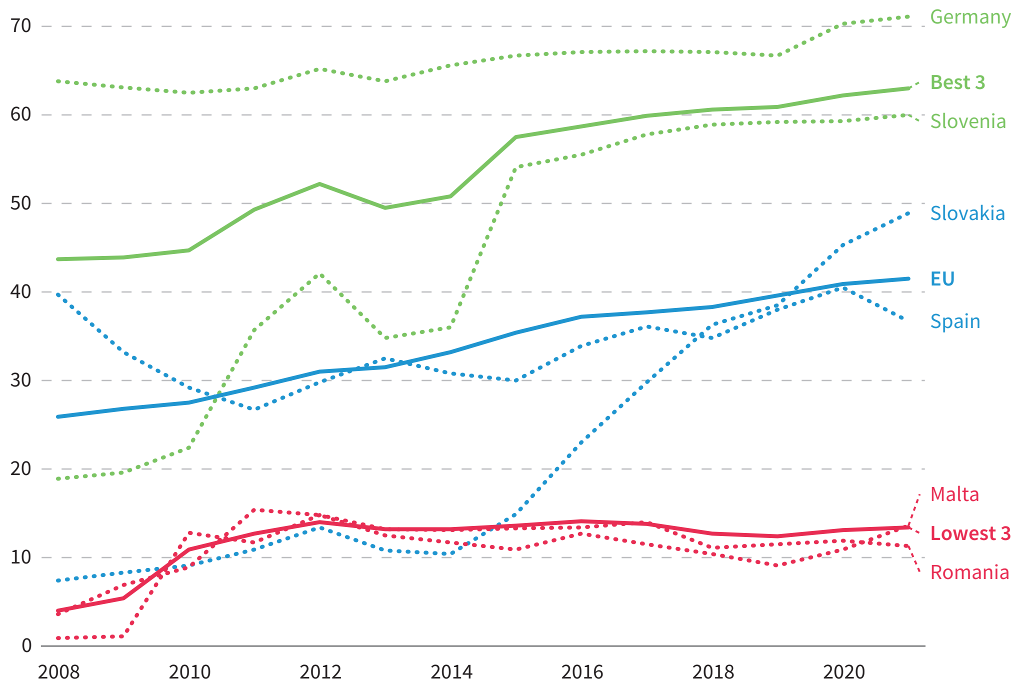
EU waste policy aims to enable waste to be managed in an environmentally sound manner to facilitate the transition to a more circular economy. In 2018, legally binding targets for the recycling and reuse of municipal waste entered into force. Member States will now be required to recycle at least 55% of their municipal waste by 2025, 60% by 2030 and 65% by 2035.

Convergence analysis

There was convergence and an increase in the recycling rate of municipal waste in the EU27 between 2008 and 2021. Although a handful of countries' performance deteriorated slightly, cohesion increased mainly because Member States that were initially lagging behind improved their performance and caught up with better-performing states.

The unweighted EU average steadily increased between 2008 and 2021 (Figure 15).

Figure 15: Recycling rate of municipal waste, EU27, 2008–2021 (%)

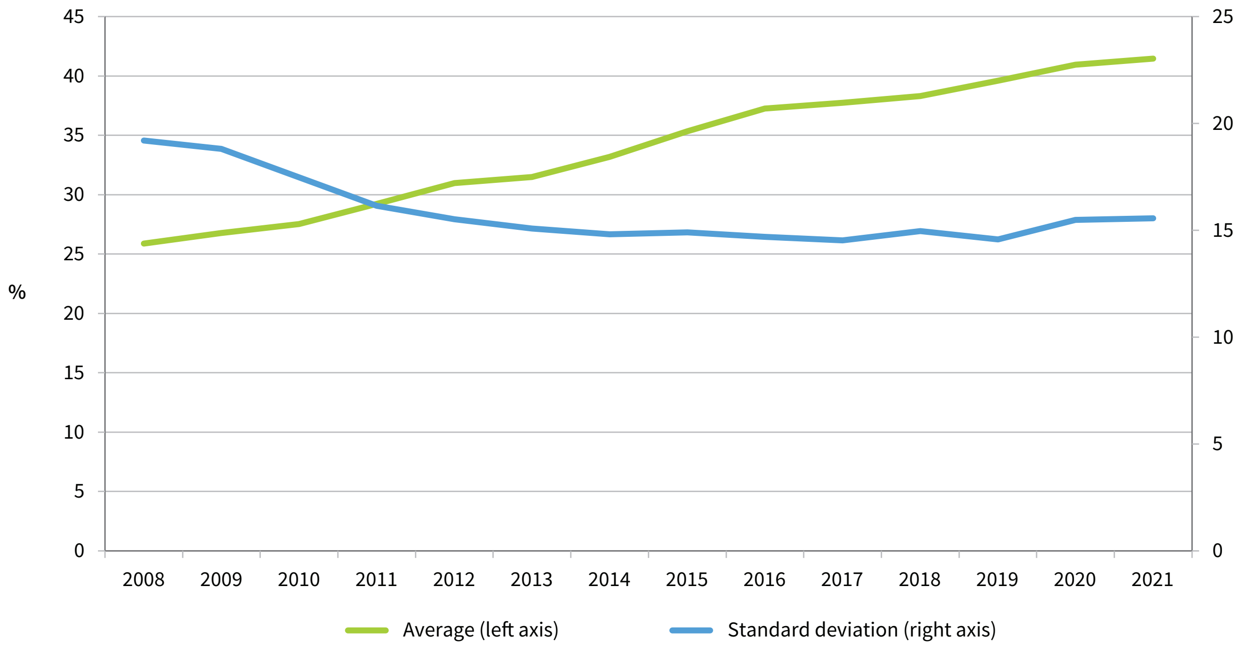


Source: *Eurostat, authors' calculations*

The standard deviation steadily decreased until 2014 and stagnated afterwards (Figure 16). Nonetheless, there was upward sigma-convergence. The beta coefficient is negative and significant; this shows that there was a catching-up process within the EU27.

Throughout the entire period, Germany was consistently the best performer. It gradually increased the gap between itself and the second-place Member States. However, there was steady delta-convergence, meaning that the sum of differences between Germany and the other countries kept shrinking.

Figure 16: Sigma-convergence in the recycling rate of municipal waste, EU27, 2008–2021



Source: *Eurostat, authors' calculations*

There is a geographical divide, with the eastern European and Baltic Member States typically performing worse than their western counterparts. The best-performing Member States were Germany and Austria. The performance of both Slovenia and Slovakia improved rapidly over the timeframe, with Ljubljana becoming the first European capital to commit to creating no waste (The Guardian, 2019). The poorest performers include Cyprus, Greece, Malta and Romania.

Between 2008 and 2021, three countries (Denmark, Spain and Sweden) decreased the proportion of municipal waste they recycled, Austria and Belgium remained steady, and the other Member States increased their recycling rates.

The convergence in the indicator is due to Member States that were initially lagging behind improving and catching up with better-performing states.

Share of buses and trains in inland passenger transport

This indicator measures the share of passenger-kilometres travelled in total inland passenger transport by collective transport mode. As environmental policy aims to promote use of collective transport over private car use, an increase in this indicator is considered improved performance. The collective transport modes monitored are buses, including coaches and trolley-buses, and trains. Total inland passenger transport includes transport by passenger cars, buses and coaches, and trains. Other collective transport modes, such as trams and metro systems, are not included due to a lack of harmonised data. All data are based on movements within national territories, regardless of the nationality of the vehicle. Road transport and private vehicles are not included in the analysis.[23]

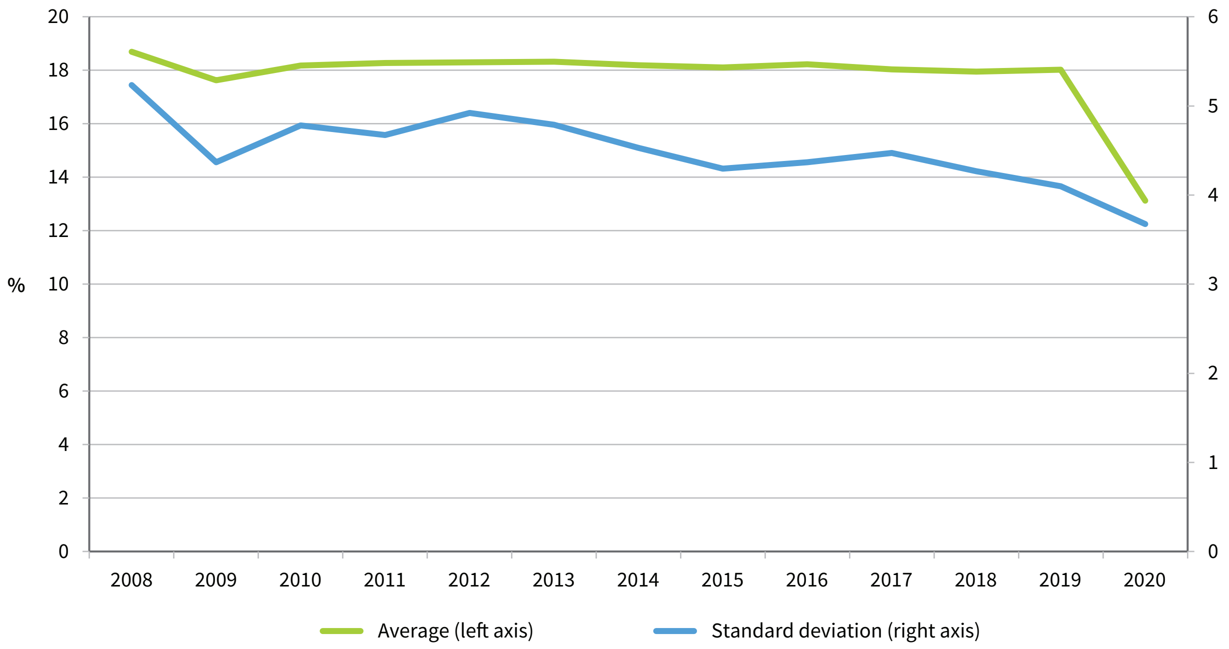
The indicator is part of the SDG indicator set, monitoring progress towards SDG 9 and SDG 11. It is also useful in reviewing progress made in three of the European Commission's priorities for 2019–2024: a European Green Deal, a Europe fit for a digital age, and an economy that works for people.

Convergence analysis

Overall, in 2008–2020, there was a reduction in disparities among the Member States in the share of buses and trains in total inland passenger transport. The share of trains and buses declined during the COVID-19 pandemic but is likely to recover in the future.

The scale of change in the unweighted EU average is small, and the standard deviation decreased between the start and end years, meaning there was downward sigma-convergence (Figure 17). The beta coefficient is negative and significant; that is, there was a catching-up process among the Member States. And there was delta-convergence as the sum of distances between the best performer (Hungary) and other countries decreased.

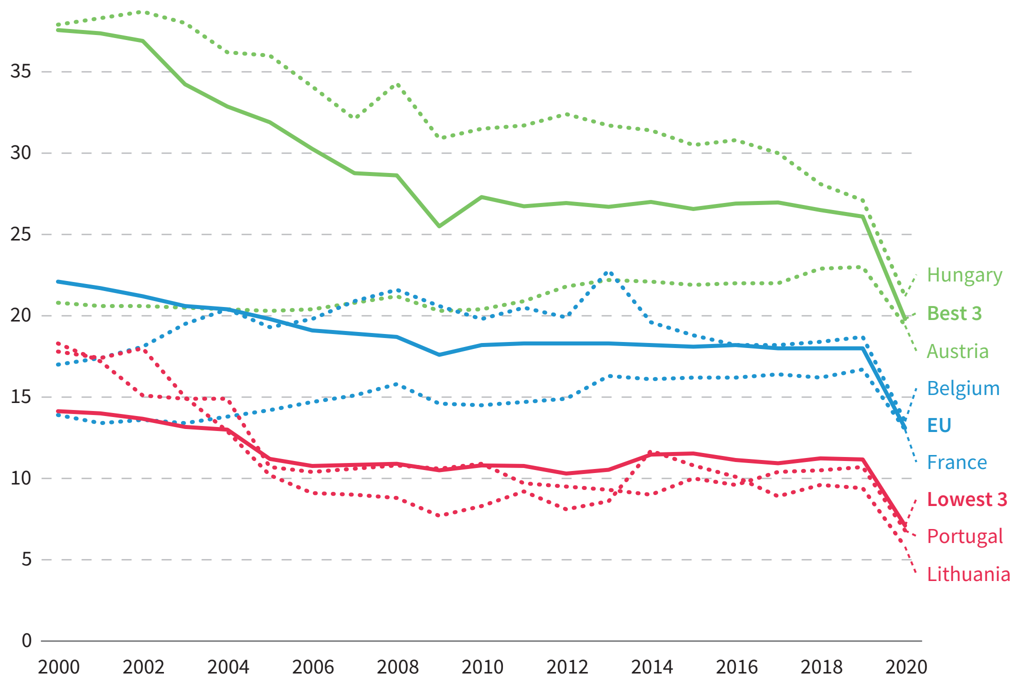
Figure 17: Sigma-convergence in the share of buses and trains in inland passenger transport, 2008–2020, EU27



Source: *Eurostat, authors' calculations*

23 The transition of road transport, including private transport, towards electrification is not covered in this report for two reasons: firstly, the transition is so new that longitudinal data are not available to carry out a convergence analysis, and secondly, official data on electric vehicle infrastructure are not available or accessible for all Member States.

Figure 18: Share of buses and trains in inland passenger transport, EU27, 2000–2020 (%)



Source: *Eurostat, authors' calculations*

While the share of buses and trains in total passenger transport increased in a number of Member States, Hungary was the best performer over the entire period (Figure 18). However, the share in Hungary decreased slightly after 2014, becoming closer to the shares of other Member States. After Hungary, the best-performing countries were Czechia, Poland and Slovakia, while the poorest performers included Lithuania and Portugal, which trailed during the entire period.

Note that these results should be interpreted with caution, as metro systems are not included in total inland passenger transport.

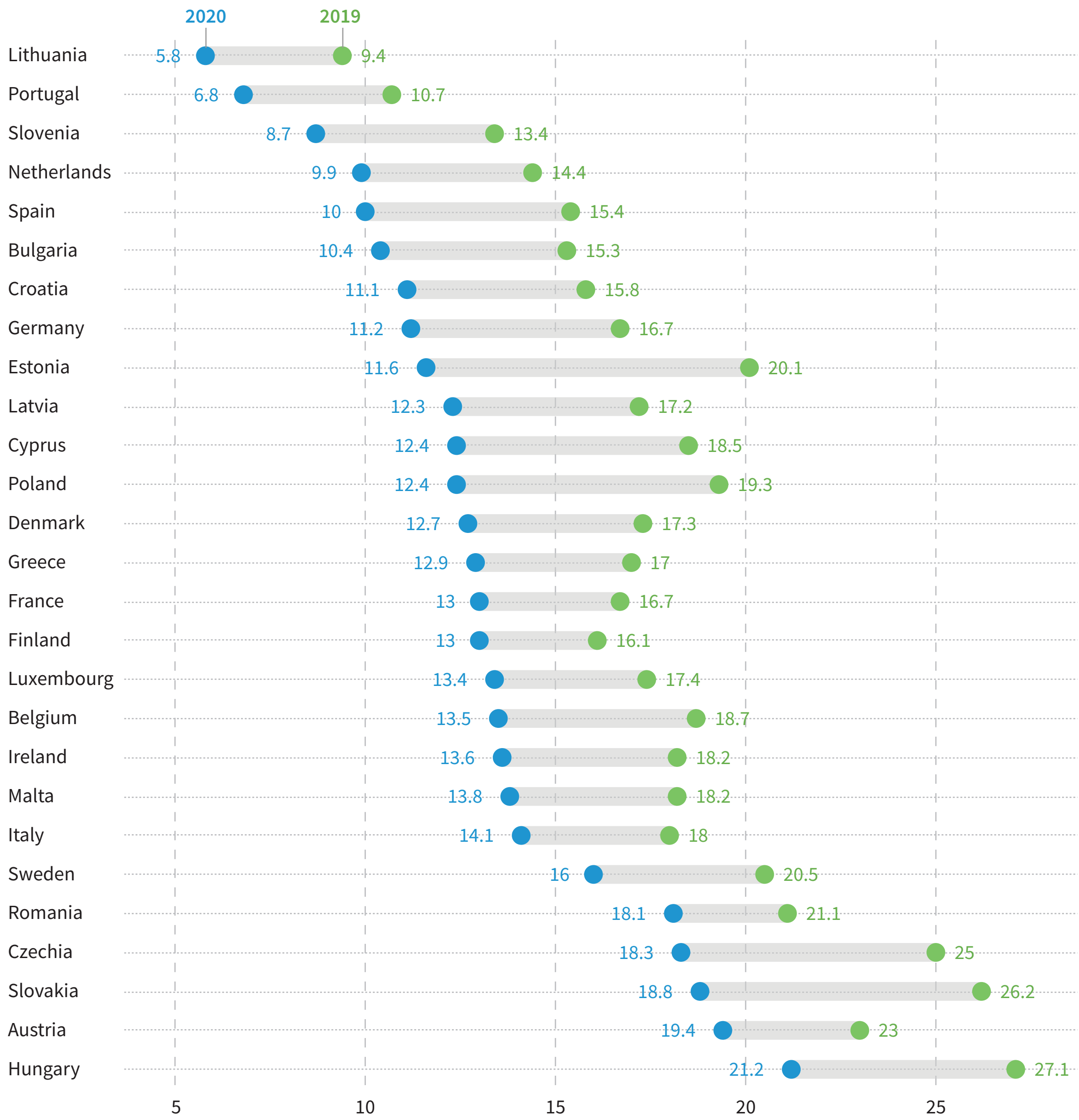
Across the Member States, there was a decline in the share of trains and buses between 2019 and 2020, when the COVID-19 virus struck (Figure 19). This is likely to recover in the future, spurred by a return to work and a possible fall in car use due to high energy prices.

The COVID-19 pandemic also had an effect on the number of passenger-kilometres travelled by buses and trains. Between 2019 and 2020, the number decreased in all Member States, indicating that a greater proportion of travelling was done by different means of transport. To explain this, we turn to the literature.

Almlöf et al (2021) examine the use of public transport in Stockholm during the pandemic. They find substantial variation in the use of public transport between socioeconomic groups: those with the fewest resources continued to use public transport the most. The probability of citizens stopping their use of public transport was greater in areas where income and education levels were higher or in areas with a higher share of men. The reason is probably that those who continued to use public transport did so because they had to continue to commute to work (unlike white-collar workers, who could telework) and did not own a car. Senior citizens avoided using public transport (perhaps due to fear of infection), and ridership was also lower in rural areas, where more people own cars and trips are longer than in more urban areas.

Ton et al (2022) clustered Dutch workers by their willingness and need to telework and examined their public transport use during the pandemic. Those most eager to telework were employed in 'organisations that are prepared for teleworking and have a job, personality, and home situation that fits teleworking'. This group decreased their public transport use the most and frequently travelled by train. The authors also found a cluster who had to transition to teleworking but wished to return to their workplace when possible.

Figure 19: Changes in the share of buses and trains in inland passenger transport during the COVID-19 pandemic, EU Member States, 2019 and 2020 (%)



Source: *Eurostat, authors' calculations*

It is probable that the share of buses and trains in total passenger transport will increase after the COVID-19 pandemic as people telework less and become less fearful of using public transport (IEA, 2022). However, as remote working will probably continue to be an option in many workplaces, the share may not fully recover.

A final factor to consider is whether the number of passenger-kilometres travelled by car will be driven down by high energy costs. If so, there would be an increase in Member States' shares of buses and trains in passenger transport, but it would be questionable whether this could be labelled an improvement in performance.

Population living in households considering that they suffer from noise, by poverty status

This indicator measures the proportion of the population who say that they are affected by noise either from neighbours or from the street. Because the assessment of noise pollution is subjective, it should be noted that the indicator accounts for both the levels of noise pollution and people's standards of what level they consider to be acceptable. Therefore, an increase in the value of the indicator may not only indicate an increase in noise pollution levels but also a decrease in the levels citizens are willing to tolerate, and vice versa. The indicator is included in the EU-SILC survey.

Convergence analysis

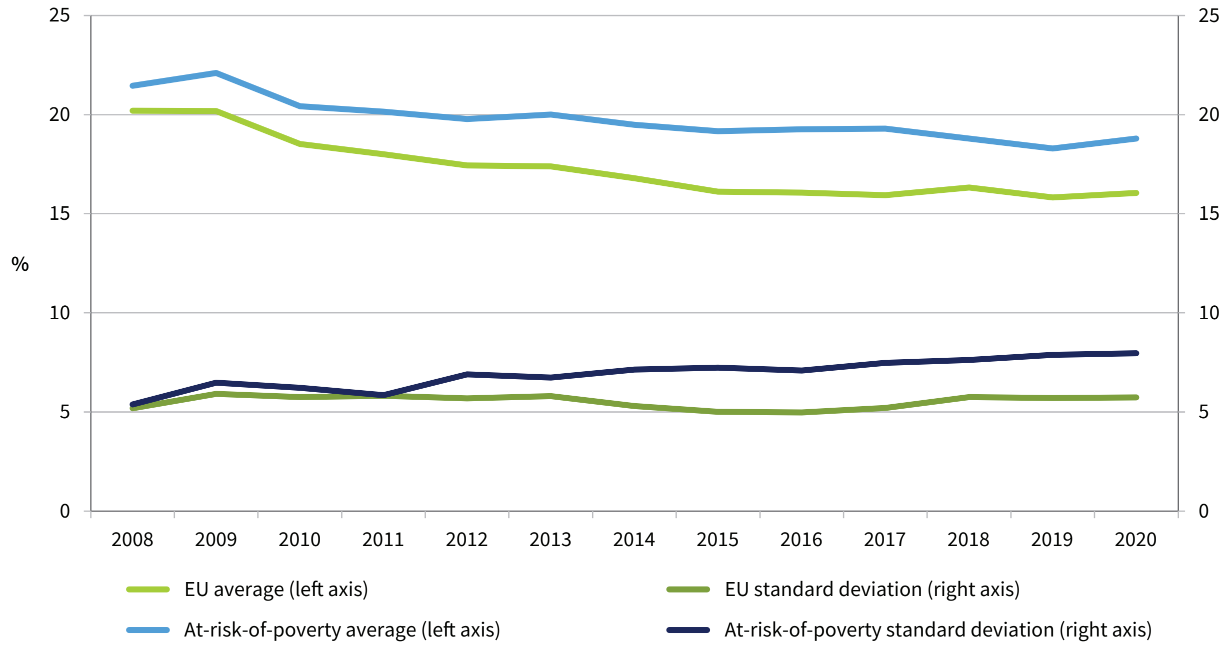
For the total population, there was an improvement in EU performance but no clear trend of convergence or divergence in 2008–2020. For people with low incomes, there was evidence of divergence. Differences between the total population and those with low incomes were greater for the poorest-performing countries. These were more likely to be western European Member States, while the leading countries were in the Baltic states and central Europe. This divergence may have occurred because noise is a by-product of transportation and economic activity and receives relatively little policy attention.

For the total population, the unweighted EU average decreased, and differences between countries did not change greatly (Figure 20). The decrease in disparities from 2013 to 2016 was driven by Cyprus, Greece, Malta and Romania catching up with better performers. The beta coefficient was not statistically significant. There was an uneven process of delta-convergence.

Among the population at risk of poverty, the unweighted EU average decreased, while the standard deviation and coefficient of variation increased (signalling upward sigma-divergence). The beta coefficient was not statistically significant. There was delta-divergence, with the sum of distances from the best performer (Croatia) increasing considerably between 2011 and 2014, due to both worsening performance of individual Member States and Croatia further improving its performance.

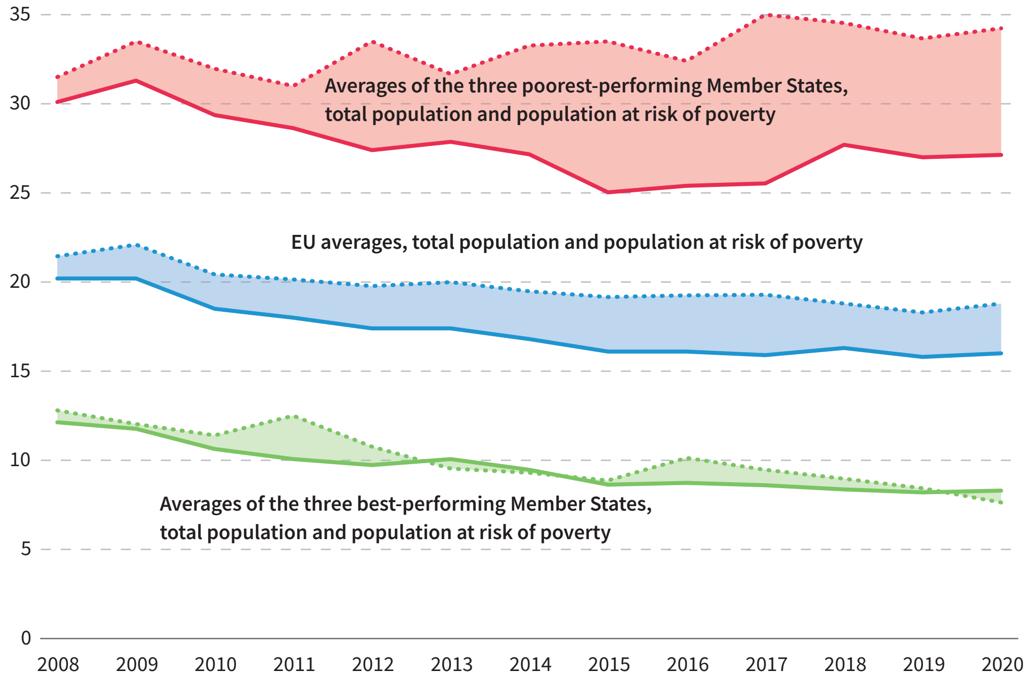
All in all, average performance improved but disparities between the leading countries and the poorest performers increased.

Figure 20: Sigma-convergence in the share of the population experiencing noise pollution, by total population and population at risk of poverty, EU27, 2008–2020



Source: *Eurostat, authors' calculations*

Figure 21: Share of households experiencing noise pollution, by total population and population at risk of poverty, EU27, 2008–2020 (%)



Note: *A solid line represents the total population, whereas a dotted line represents the population at risk of poverty.*
Source: *Eurostat, authors' calculations*

Differences between the total population and the population at risk of poverty are greater in poor-performing countries (Figure 21). In multiple instances, those with low incomes reported issues with noise at a lower rate than the population as a whole. This may be because richer urban centres are denser and more polluted, or because the perception of what is considered an environmental problem may be different between the two groups.

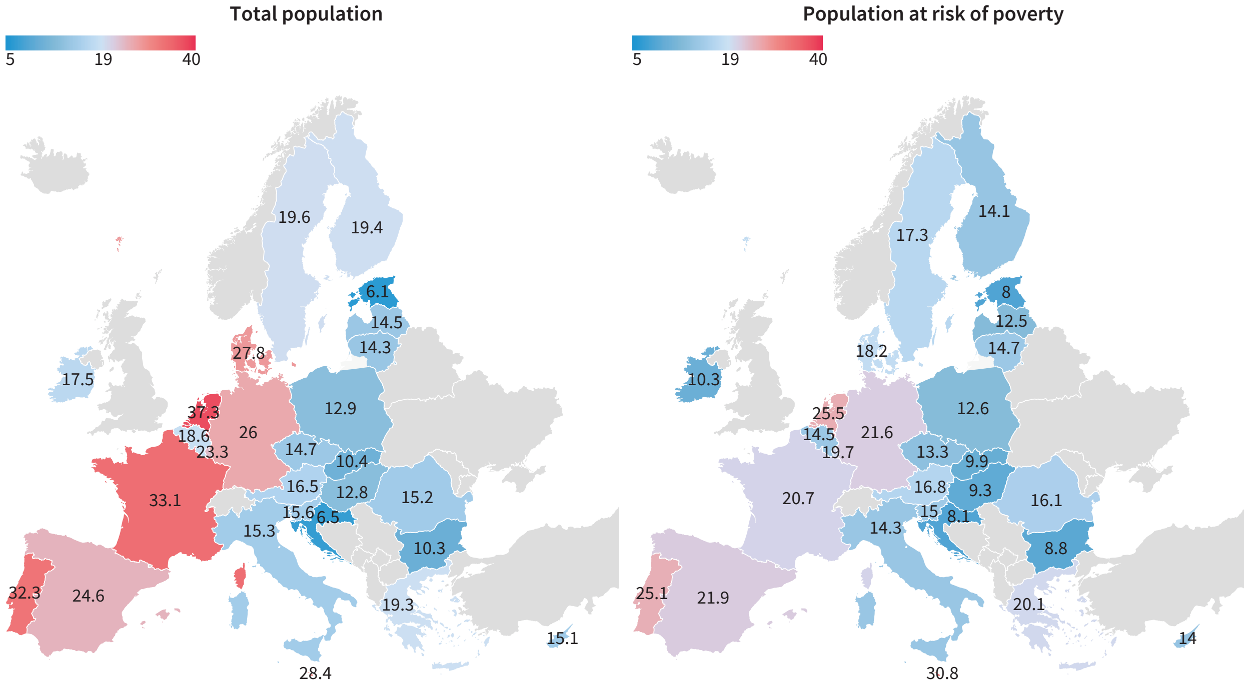
The share of people experiencing noise pollution is lowest in eastern and central European and Baltic states (Figure 22). This is because noise pollution is more common in urbanised countries, and the presence of necessary noise pollutants (such as traffic or construction) is more prevalent in western Europe. Road transport is the biggest contributor to noise.[24]

In addition, the method and quality of data collection could also influence results, as the indicator is perception-based and opinions on what counts as noisy may vary in Member States.

The Environmental Noise Directive, adopted in 2002, is the main EU instrument for identifying noise pollution levels. The directive does not set any quantitative EU targets, but a review of people's exposure to noise finds that significant progress towards its objectives has been made (Eurostat, 2022b). However, the EU's Zero Pollution Action Plan of 2021, which is a key deliverable of the European Green Deal, is more ambitious. It sets out targets for reducing the share of people chronically disturbed by transport noise by 30% by 2030, compared with 2017 levels. To achieve this, greater attention will need to be paid to noise pollution, which is an often-overlooked determinant of quality of life (King and Murphy, 2016).

24 For further information, please see https://www.eea.europa.eu/en/topics/in-depth/noise

Figure 22: Share of households experiencing noise pollution, by total population and population at risk of poverty, EU Member States, 2020 (%)



Source: *Eurostat, authors' calculations*

Policy takeaways for meso-level indicators

Reducing pollution and environmental problems would lead to improved health and well-being. Improving Europeans' health is one of the priorities of the Zero Pollution Action Plan, which sets important targets for 2030 and 2050. These goals can be achieved with tailored policies, some of which have been applied with positive outcomes in the Member States.

- Europeans on average perceive their environments as cleaner than in the past. However, dense urban areas suffer the most from smoke, smells and noise. Although this is an inevitable consequence of living in areas with a high population density, local authorities could prioritise construction projects and urban designs that are greener and minimise disruption to everyday life. For example, local authorities can find reliable information on improving the energy performance of buildings in the EU Building Stock Observatory.[25] In addition, Gothenburg, Madrid, Milan, Munich and Stockholm have implemented congestion taxes or low-emission zones, or both, to limit car pollution and improve air quality in the inner-city regions (Euronews, 2019).
- To reduce pollution and environmental problems, urban design should provide accessible, affordable and low-emission public transport systems and affordable houses in hazard-free areas for the low-income population, especially in densely populated areas.
- There were improvements in recycling municipal waste in the EU27, particularly in the Baltic states and eastern European Member States, with the largest increases in the rate of recycling in Slovakia and Slovenia. Future governments should stay the course and keep investing in their waste management systems to meet the EU reuse and recycling targets for 2030 and 2040. The targets aim to reduce non-recycled municipal waste by half, alongside providing general recycling recommendations such as wider plastic use reduction and reuse. In addition, circular economy actions, such as improving eco-design and extending the lifespans of products, for example by enforcing the right to repair, will be important approaches to bettering waste management.

25 See https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/eu-bso_en#document

- Reform should be encouraged with regulatory and economic incentives and through cultural shifts in citizens' values. It is not enough for local authorities to provide recycling systems; citizens also need to use them. The rules for sorting waste should be clear and easy to follow.
- Authorities pursuing greening should follow established practices in the EU that are best suited to their ambitions and pursue high-level solutions as well as everyday fixes. For example, Slovenia announced its zero-waste plans and built Ljubljana's modern waste treatment plant, the Regional Waste Management Centre, and provides recycling bins and reusable bottles in shops.
- Regulations concerning the cross-country recycling of waste need to be updated so that materials transported across borders are not heavily taxed. For example, recycling out-of-use wind turbines is much more costly if during their transportation they are taxed as wind turbines instead of waste. However, strict controls on cross-country waste disposal should be put in place to deter the shipment of hazardous waste to regions with poor environmental protection laws.
- Transport is one of the main energy users and sources of emissions. Road transport accounts for a fifth of the EU's GHG emissions, and public and private transport will have to contribute to the target of reducing GHG emissions by 55%. One of the ways in which this could be achieved is by increasing the capacity and use of public transport, as it releases fewer emissions per passenger-kilometre than private transport. Hence, making public transport more sustainable and accessible is in line with the EU green transition goals. This would improve air quality, employment and economic growth.
- When expanding public transport systems, it is important to keep in mind that rural areas have the greatest need for connectivity.
- Furthermore, public transport needs to accommodate senior citizens and those with underlying health conditions, who may be reluctant to expose themselves to health risks.
- Greening transport would lead to job creation, achieving the goals of the EU green mobility transition.

5 Micro-level indicators: Energy poverty

Introduction

This chapter focuses on EU convergence in respect of energy poverty, measured using the following three indicators:

- the share of the population living in an inadequate dwelling (with a leaking roof; damp walls, floors or foundations; or rot in window frames or floors)
- arrears on utility bills (for the total population and the population at risk of poverty)
- the population unable to keep their house adequately warm (for the total population and the population at risk of poverty)

Energy poverty is a key issue for Europe in the 21st century. Individuals or families are energy impoverished if they are forced to spend a disproportionate amount of their total income on paying for energy services (IEA, 2010). Bouzarovski (2014) defines energy poverty as the inability of a household to secure a socially and materially required level of energy services. Energy poverty poses a problem because it has a negative impact on individual health and well-being and the economy (Halkos and Gkampoura, 2021). Polimeni et al (2022) examined the effect of energy poverty (measured by arrears on utility bills and an inability to heat one's home) on personal health in the EU. They found that energy poverty has a bidirectional causal relationship with poor health: being unable to pay utility bills makes people more susceptible to illness, and being sick or incapable of working prevents people from earning enough to pay for energy, leading to a vicious cycle.

As arrears on utility bills and inability to keep the home adequately warm are strongly correlated with socioeconomic factors (as shown in Chapter 6, which examines the interplay between environmental and socioeconomic factors), the timeframe of the analysis of these two indicators has been divided to capture the effect of the economic downturn between 2008 and 2013. Previous Eurofound research has shown that the economic crisis interrupted or even reversed a process of convergence in Member States' employment rates and youth NEET rates (Eurofound, 2021b). In addition, the effect of the COVID-19 pandemic was considered, but due to a lack of data a new subperiod was not created. Note also that data for Croatia are missing until 2010.

Over the full period analysed, there was an improvement in EU performance across most of the indicators, but the results on disparities were mixed (Table 7). There was no significant catching-up process, but there was usually a reduction in disparities, as measured by the standard deviation and the sum of distances of the poorest performers from the frontrunners. Overall, performance improved and disparities stagnated or decreased.

During the economic crisis, the Member States' performance worsened, which had an impact lasting several years. There was an increase in disparities among Member States and among different income groups with regard to arrears on utility bills, whereas there was a reduction in disparities and a drop in performance as regards the share of the population unable to keep their homes warm. The decrease in disparities was possibly due to a greater deterioration in performance among the best performers than among poorest-performing countries.

Box 3: Intersecting inequalities in energy poverty

Several studies have shown that exposure to energy vulnerability is not uniform. Recalde et al (2019) grouped European countries according to their structural vulnerability to energy poverty and found that northern and western EU Member States tended to have low structural vulnerability, compared with Mediterranean and eastern European countries. Other studies came to the same conclusion when Member States were separated into core and periphery groups according to their susceptibility to energy poverty (Bouzarovski, 2014; Bouzarovski and Tirado Herrero, 2017).

Moreover, inequalities in energy poverty are not only regional. Groups who are already vulnerable or marginalised – such as older people, people who are chronically ill or dependent, women, and people with low incomes – are hit worst by energy poverty. Its effects are aggravated by their existing situation of vulnerability (Thomson et al, 2013; Clancy et al, 2017; Marí-Dell'Olmo et al, 2017; Eurofound, 2023a). Disentangling the different aspects of energy poverty was prioritised by the European Parliament, which proposed a gendered approach to energy poverty (EPRS, 2023).

Table 7: Summary of convergence analysis of meso-level indicators

Period	Indicator	Beta	Sigma	Delta
2009–2020	Share of population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor	Beta coefficient not statistically significant	Upward sigma-divergence	Delta-convergence
Pre-crisis (2004–2008)	Arrears on utility bills (total population)	Beta coefficient not statistically significant	Upward sigma-convergence	Delta-convergence
	Arrears on utility bills (population at risk of poverty)	Beta coefficient not statistically significant	Upward sigma-divergence	Delta-convergence
	Population unable to keep their homes adequately warm (total population)	Beta coefficient not statistically significant	Upward sigma-convergence	Delta-convergence
	Population unable to keep their homes adequately warm (population at risk of poverty)	Beta coefficient not statistically significant	Upward sigma-convergence	Delta-convergence
Economic crisis (2008–2013)	Arrears on utility bills (total population)	Beta coefficient not statistically significant	Downward sigma-divergence	Delta-divergence
	Arrears on utility bills (population at risk of poverty)	Beta coefficient not statistically significant	Downward sigma-divergence	Delta-divergence
	Population unable to keep their homes adequately warm (total population)	Beta coefficient not statistically significant	Downward sigma-convergence	Delta-divergence
	Population unable to keep their homes adequately warm (population at risk of poverty)	Beta coefficient not statistically significant	Downward sigma-convergence	Delta-divergence
Recovery (2013–2021)	Arrears on utility bills (total population)	Beta-convergence	Upward sigma-convergence	Delta-convergence
	Arrears on utility bills (population at risk of poverty)	Beta-convergence	Upward sigma-convergence	Delta-convergence
	Population unable to keep their homes adequately warm (total population)	Beta-convergence	Upward sigma-convergence	Delta-convergence
	Population unable to keep their homes adequately warm (population at risk of poverty)	Beta-convergence	Upward sigma-convergence	Delta-convergence

After the economic crisis, Member States' performance improved, and the pre-crisis convergence process resumed for both income groups.

These findings are in line with previous research, which has shown that the prevalence of energy poverty increased during the economic crisis of 2008–2013 and then decreased and returned to pre-crisis levels, following a 'peak pattern'. Furthermore, the effects of the crisis were exacerbated by fiscal austerity measures and weak social protection (Oliveras et al, 2021). It seems that those most vulnerable recovered slower from the effects of the crisis, with the share of women and residents of countries with high structural vulnerability remaining energy poor for longer (Oliveras et al, 2021).

The COVID-19 pandemic mainly had an impact on the share of people reporting leaking roofs, damp and rot. There was an increase in disparities and a worsening in performance between 2019 and 2020, especially among western European countries. The pandemic surprisingly did not result in divergence in arrears on utility bills and the population's ability to heat their homes. Performance on both indicators improved in 2020 and in 2021, ruling out a possible lag in the economic impact of the pandemic. Unfortunately, the way in which Member States recover from increased energy vulnerability arising from the pandemic will probably not be uniform. Carfora et al (2022) warn that the changes in energy poverty levels will be reabsorbed very slowly and with 'substantial differences between countries'.

We find similar geographical differences to those documented in previous studies. Eastern and southern EU Member States have greater issues with energy poverty than other Member States (Oliveras et al, 2021) and are also more vulnerable due to greater income poverty and worse infrastructure (Bouzarovski et al, 2012; Polimeni et al, 2022). The accessibility and affordability of low-carbon technologies, factors that have an impact on the shift to and prices of low-carbon energy, vary between countries.

Karpinska and Śmiech (2021) conducted a comparative analysis of 17 EU Member States regarding the likelihood of households escaping energy poverty and the drivers of that escape. They found the European average probability of staying in energy poverty was 51%, with large disparities between countries. The Member States with the lowest likelihood of escaping energy poverty were Bulgaria, Greece, Lithuania and Romania (where the chances of remaining in energy poverty were 80%). Housing conditions, age, being at risk of poverty and employment status were all determinants of escaping energy poverty.

The effect of the recent energy crisis and the war on Ukraine on these indicators is unfortunately not captured, as the most recent year for which data are available is 2021.

Share of population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor

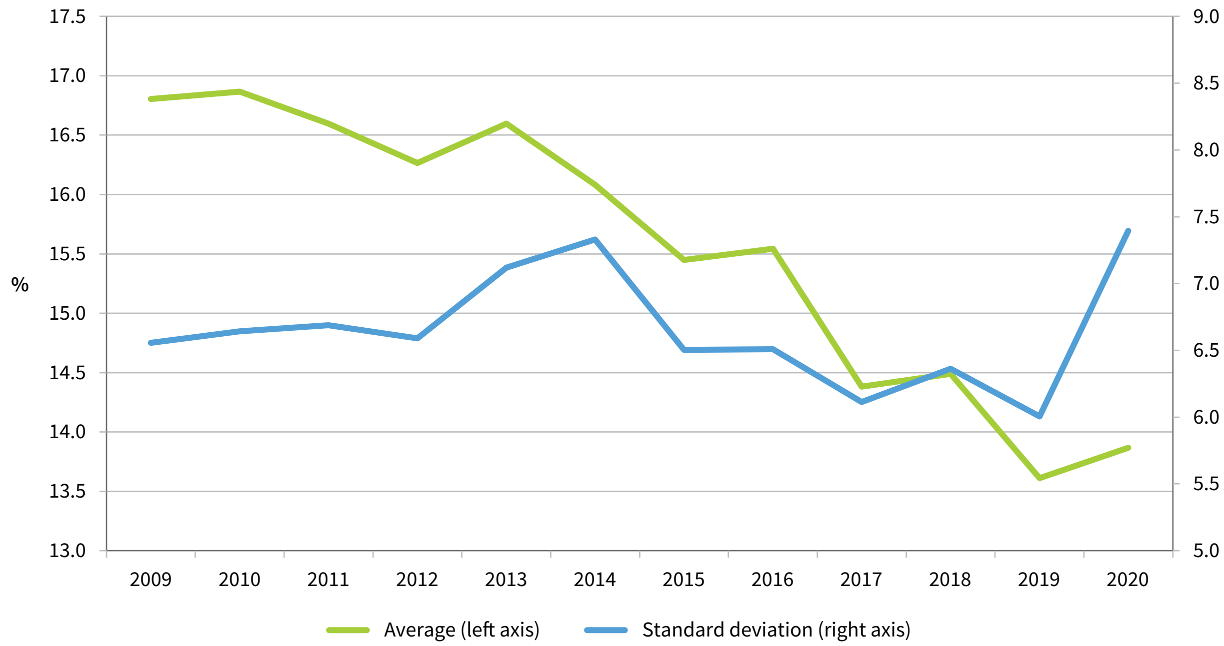
This indicator is defined as the percentage of the total population living in a dwelling with a leaking roof; damp walls, floors or foundations; or rot in window frames or floors. Included in EU-SILC, it is a key indicator measuring poverty as part of the European Semester, and it is used to track the implementation of the social protection and inclusion dimensions of the European Pillar of Social rights. Furthermore, the indicator is used to monitor progress towards SDG 1, on ending poverty in all its forms, and SDG 11, on making cities and human settlements inclusive, safe, resilient and sustainable. It addresses severe housing deprivation and complements the at risk of poverty or social exclusion (AROPE) indicator.

Convergence analysis

There was an improvement in housing quality and an increase in cohesion in this area in the EU27 in 2009–2020 (Figure 23). However, the COVID-19 pandemic had a detrimental effect on both performance and cohesion.

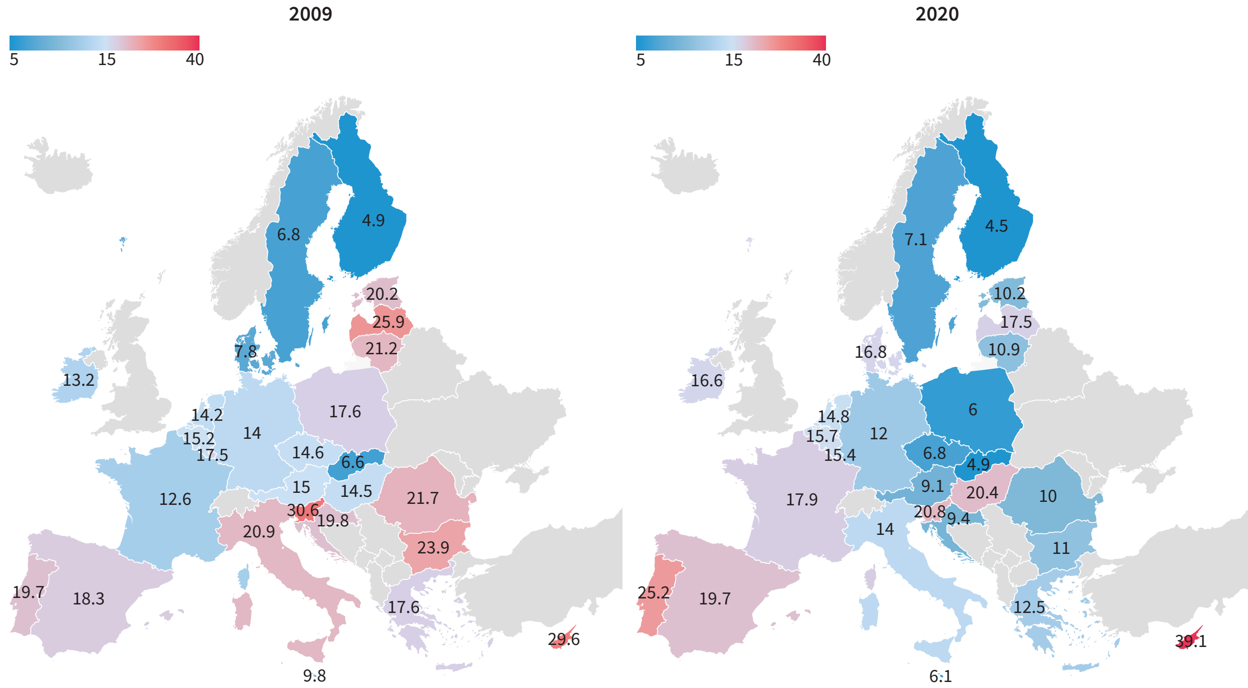
The unweighted EU average tumbled unevenly downwards throughout the analysis period, while the standard deviation fluctuated. There was a spike in disparities in 2012–2014, when the poorest-performing countries fell even further behind. This was probably due to a combination of frequent storms and poor residential infrastructure. The beta coefficient is not statistically significant. There was delta-convergence between 2009 and 2020.

Figure 23: Sigma-convergence in population living in dwellings with damp, leaks or rot, EU27, 2009–2020 (%)



Source: *Eurostat, authors' calculations*

Figure 24: Share of the population living in dwellings with damp, leaks or rot, EU Member States, 2009 and 2020 (%)

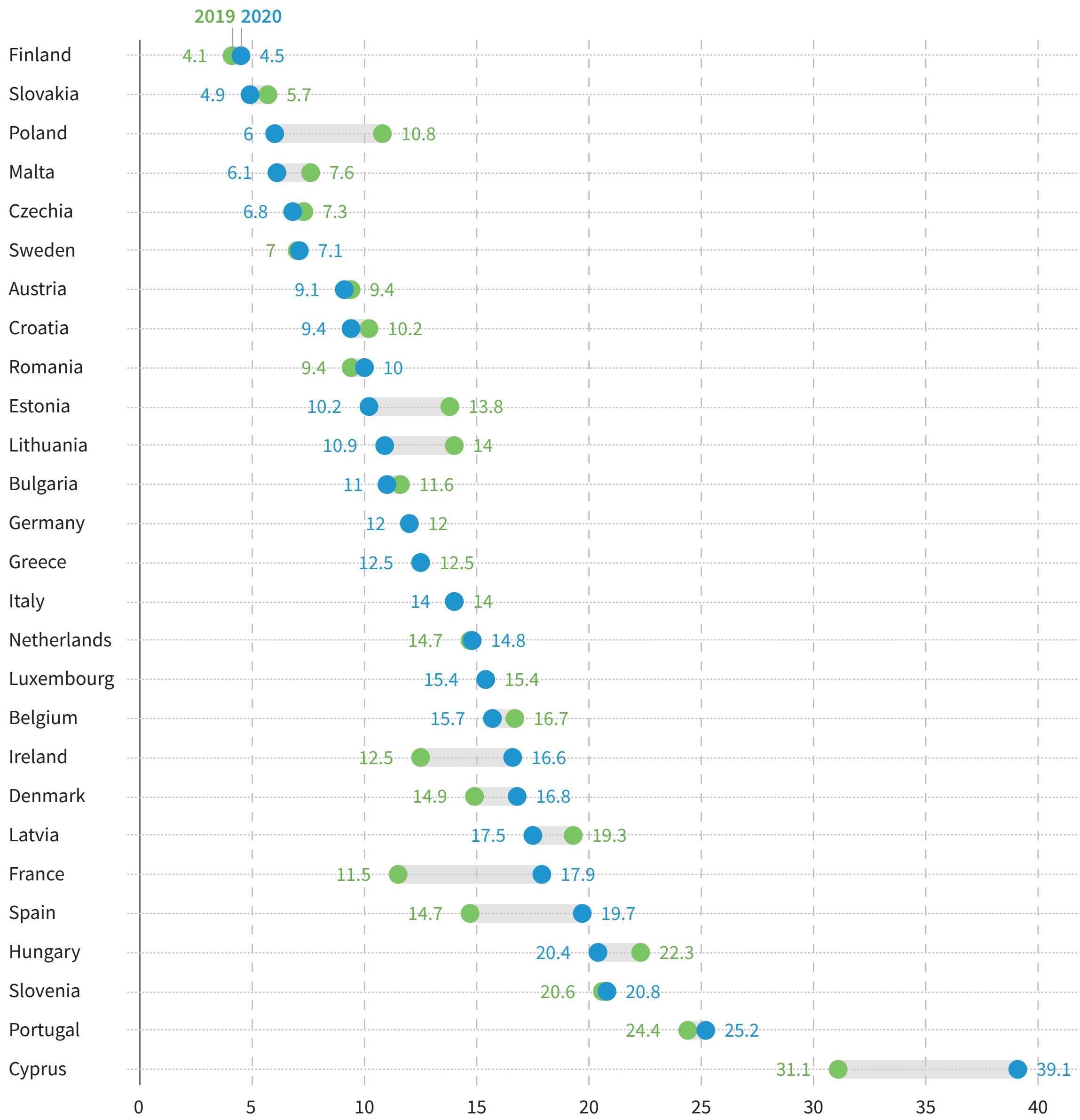


Source: *Eurostat, authors' calculations*

Finland and Sweden were the top performers, and many eastern European and Baltic Member States caught up with or overtook their western counterparts (Figure 24).

Worryingly, both performance and cohesion worsened during the COVID-19 pandemic. The increase in divergence between Member States was partly due to the share of the population reporting damp, leaks or rot in Cyprus increasing from 31.1% to 39.1% (Figure 25). When Cyprus is removed from the analysis, divergence is still present, but the scale is smaller (Figure 26).

Figure 25: Share of the population living in dwellings with damp, leaks or rot, EU Member States, 2019 and 2020 (%)

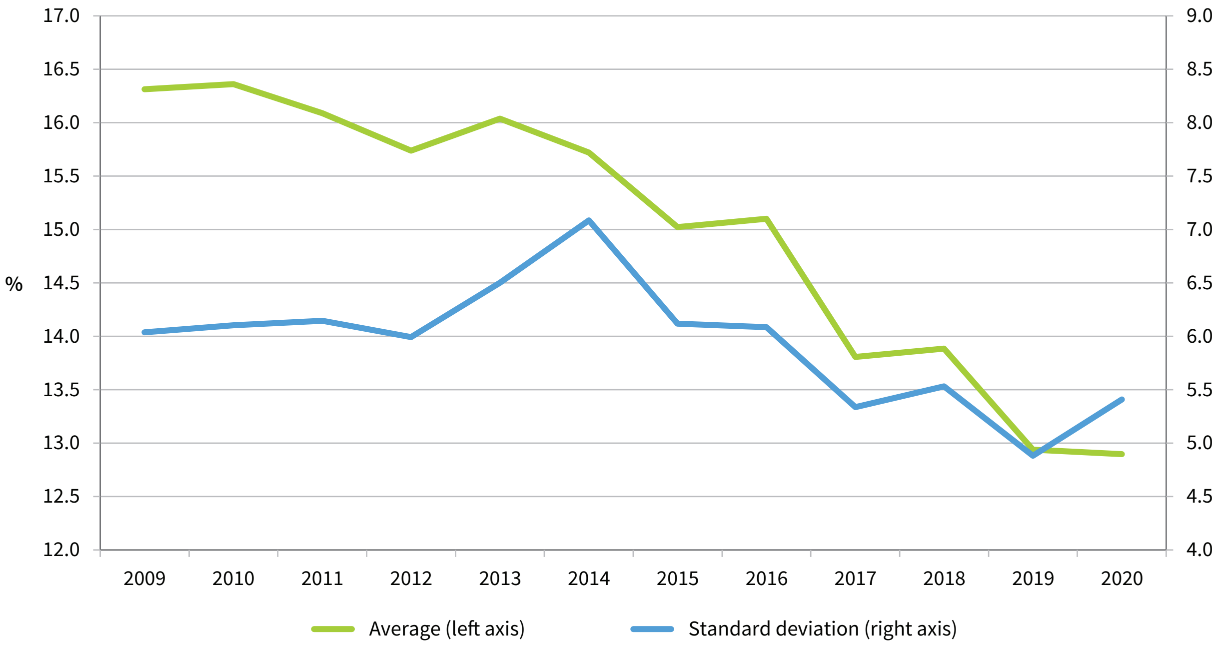


Source: *Eurostat, authors' calculations*

Larger shares of people living in poor housing is concerning, as more of our time has been spent at home since the pandemic. Furthermore, poor-quality housing is linked to health problems. For example, Gibney et al (2018) investigated the housing conditions of older people in Ireland. They found that poor housing and poor heating were strongly associated with respiratory and bone conditions that could not be explained by social or demographic variables or health behaviours.

Ayala et al (2022) found that housing deprivation varies across the Member States, and that the lockdowns did not affect all Europeans equally. When national governments told their populations to stay at home for extended periods, existing inequalities in housing became more prominent and pertinent. As D'Alessandro et al (2020) noted, the pandemic lockdowns changed the way we live, work and interact, and it is necessary that our built environments reflect this.

Figure 26: Sigma-convergence in the share of the population living in dwellings with damp, leaks or rot, EU27 without Cyprus, 2009–2020



Source: *Eurostat, authors' calculations*

Arrears on utility bills

This indicator measures the share of households that indicate that they have been in arrears on utility bills (heating, electricity, gas, water and so on) in the year before the data were collected. It is included in EU-SILC, and its significance is rooted in the social policy goals of the EU and its Member States. Policy targets to combat poverty and social exclusion were set in the Europe 2020 strategy for smart, sustainable and inclusive growth, but they were not achieved. In 2021, as part of the European Pillar of Social Rights Action Plan, a new target of reducing the number of people in poverty by at least 15 million by 2030 was established.[26]

Convergence analysis

During the economic crisis of 2008–2013, the share of the EU population in arrears rose, and disparities between Member States increased both in the total population and among those at risk of poverty. After the crisis, countries returned to or even improved upon their pre-crisis performance, and they began converging again. The COVID-19 pandemic does not seem to have adversely affected performance or cohesion. The effect of the war on Ukraine and increased energy prices on this indicator remains to be seen.

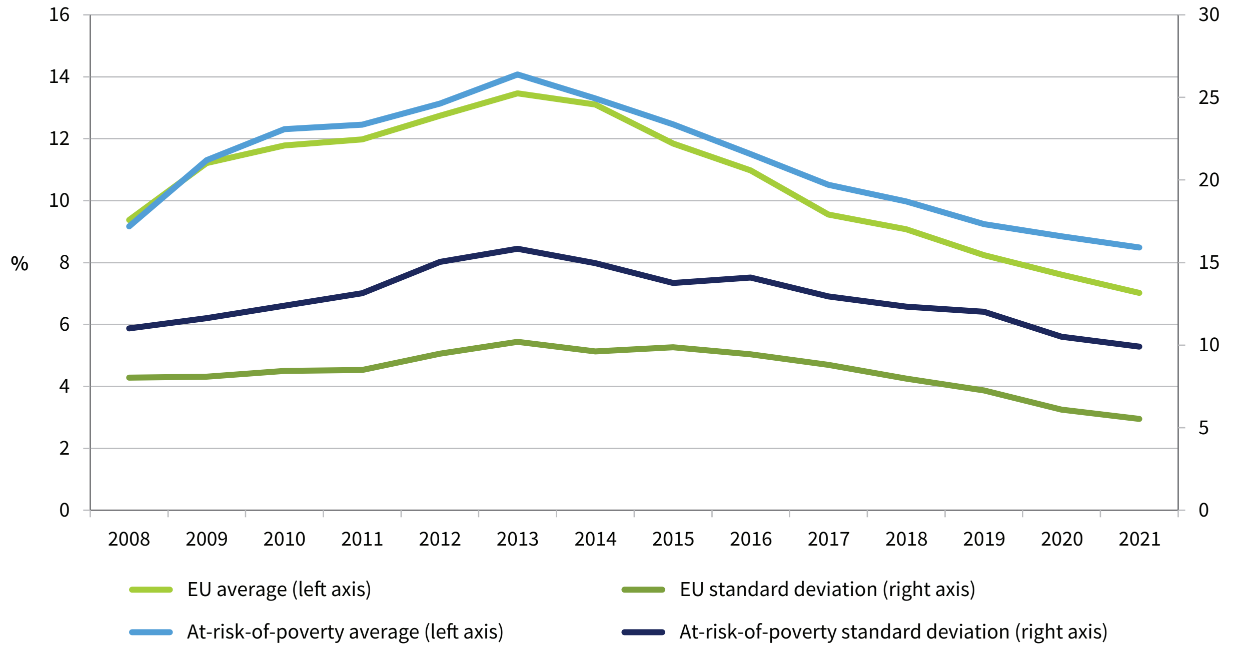
This indicator is examined in subperiods relating to the economic crisis (pre-crisis, during the crisis and post-crisis). It is analysed for both the total population and the population with low incomes (earning below 60% of the median equivalised income for their country), also referred to as people at risk of poverty.

For the total population, in the years before the economic crisis, there was upward sigma-convergence, delta-convergence and no significant beta-convergence. During the crisis, there was downward sigma-divergence, delta-divergence and no significant beta-convergence. After the crisis, there was upward sigma-convergence, delta-convergence and beta-convergence.

The results for people with low incomes are almost identical except that, pre-crisis, there was upward sigma-divergence in arrears instead of upward sigma-convergence. Figure 27 shows the results for the sigma-convergence analysis.

26 https://op.europa.eu/webpub/empl/european-pillar-of-social-rights/en/

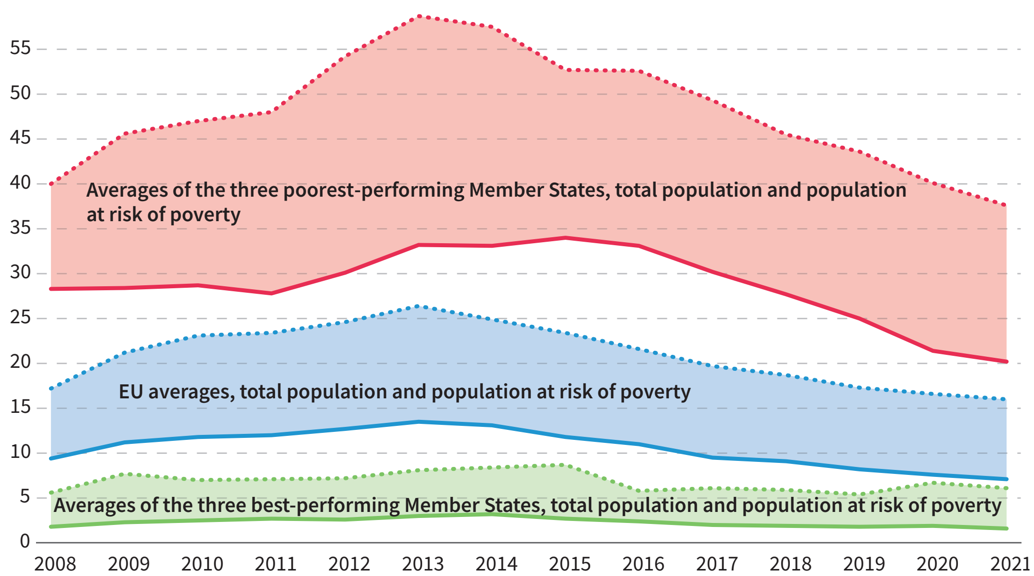
Figure 27: Sigma-convergence in share of households in arrears on utility bills, by total population and population at risk of poverty, EU27, 2008–2021 (%)



Source: *Eurostat, authors' calculations*

Throughout the entire period, the population with low incomes fared worse than the population as a whole, and the difference was greater in the poorest-performing countries (Figure 28). In addition, this gap increased towards the end of the economic crisis, providing further evidence of the detrimental effect of the crisis on social cohesion in the EU. Furthermore, there was greater disparity between countries in respect of the population with low incomes.

Figure 28: Share of households reporting arrears on utility bills, by total population and population at risk of poverty, EU27, 2008–2021 (%)



Note: *A solid line represents the total population, whereas a dotted line represents the population at risk of poverty.*
Source: *Eurostat, authors' calculations*

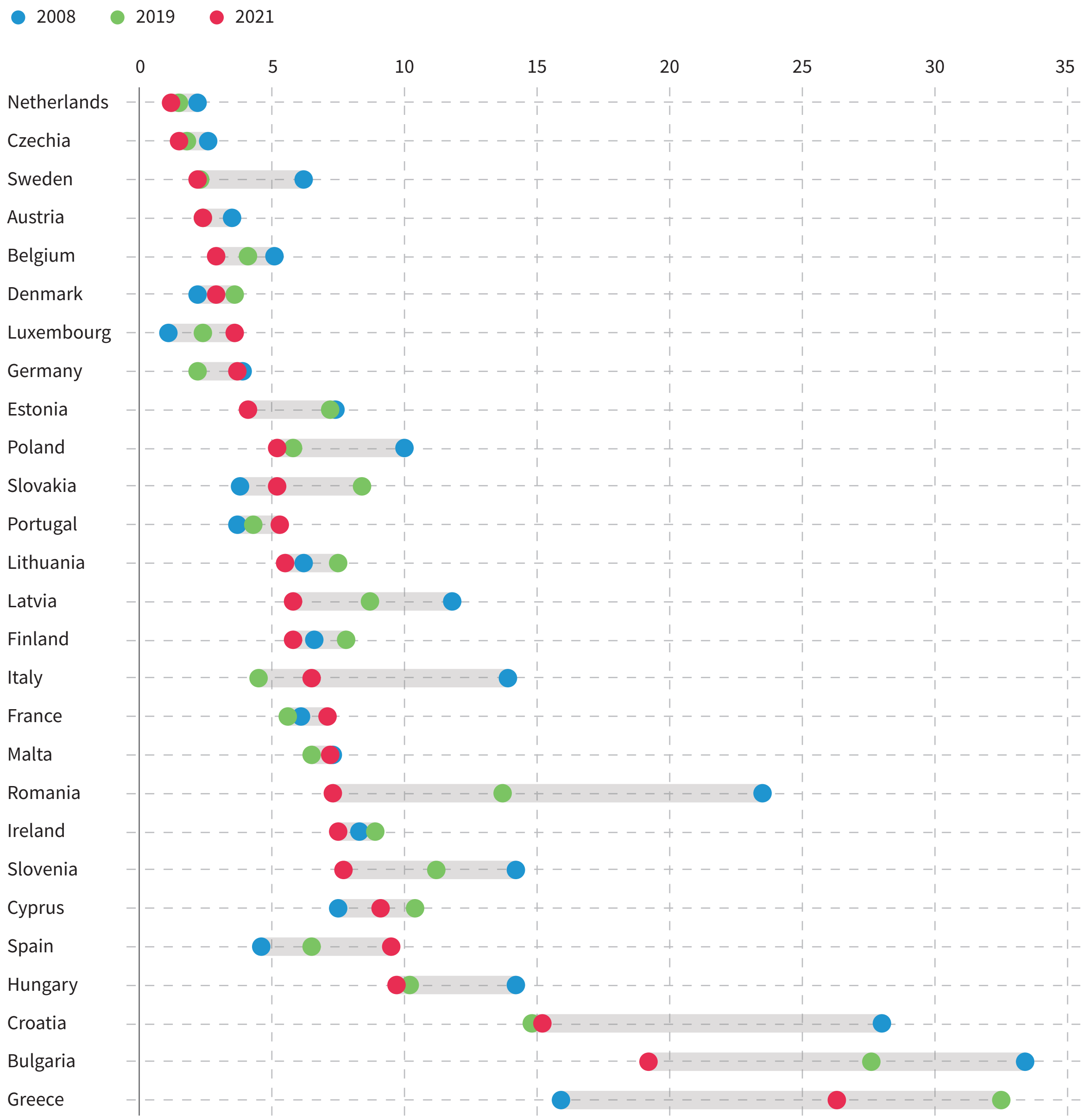
When disparities fell, it was due to improving performance by the countries that were initially the poorest performers (Bulgaria, Greece and Hungary) rather than declines in the performance of the best performers. The share of people reporting arrears in Bulgaria and Greece decreased, causing them to pull closer to better-performing countries, and Hungary in particular greatly reduced the share of its population in arrears on utility bills after 2013.

The reasons for changes in the share of the population in arrears are similar to those previously discussed earlier in the chapter in relation to energy poverty. Energy prices, weather patterns, household income, the energy efficiency of homes, and economic and political systems all interact to affect the incidence of arrears. In Bulgaria, an energy crisis coupled with a high dependency on Russian gas resulted in energy price spikes during the economic crisis, making energy unaffordable to many (Euractiv, 2013). Greece was one of the states most heavily hit by the economic crisis, and reduced incomes coupled with increased energy taxes resulted in an increase in defaults on bills. Since the end of the crisis, numerous interventions promoting clean and affordable energy have been put in place. Hungary was highly dependent on gas imports during the economic crisis. Prices spiked while wages decreased, increasing the share of the population in arrears on bills, especially for Hungarians not connected to gas lines and reliant on bottled gas.

Another explanatory factor could be, in contrast to EU-wide trends, a decrease in energy efficiency in countries such as Romania. One of the goals of the Romanian Energy Strategy 2016–2030 is to reduce energy poverty and protect vulnerable people. Achieving this goal is hindered by poor quality residential housing built before 1989, with no incentive to provide energy-efficient features such as good insulation. As a result, many Romanian homes today are energy-inefficient, and households try to save money by reducing their energy consumption.

Throughout the entire period, for both the total population and those with low incomes, the best performers were Austria, Denmark, Luxembourg, the Netherlands and Sweden. Figure 29 depicts the prevalence of energy poverty in the Member States in 2008, 2019 and 2021. In most countries, energy poverty decreased between 2008 and 2021. Exceptions include Greece, Spain, Cyprus, Portugal and Slovakia. In Bulgaria, Croatia and Romania, the share of households reporting arrears on utility bills decreased the most.

Figure 29: Share of population in arrears on utility bills, EU Member States, 2008, 2019 and 2021 (%)



Source: *Eurostat, authors' calculations*

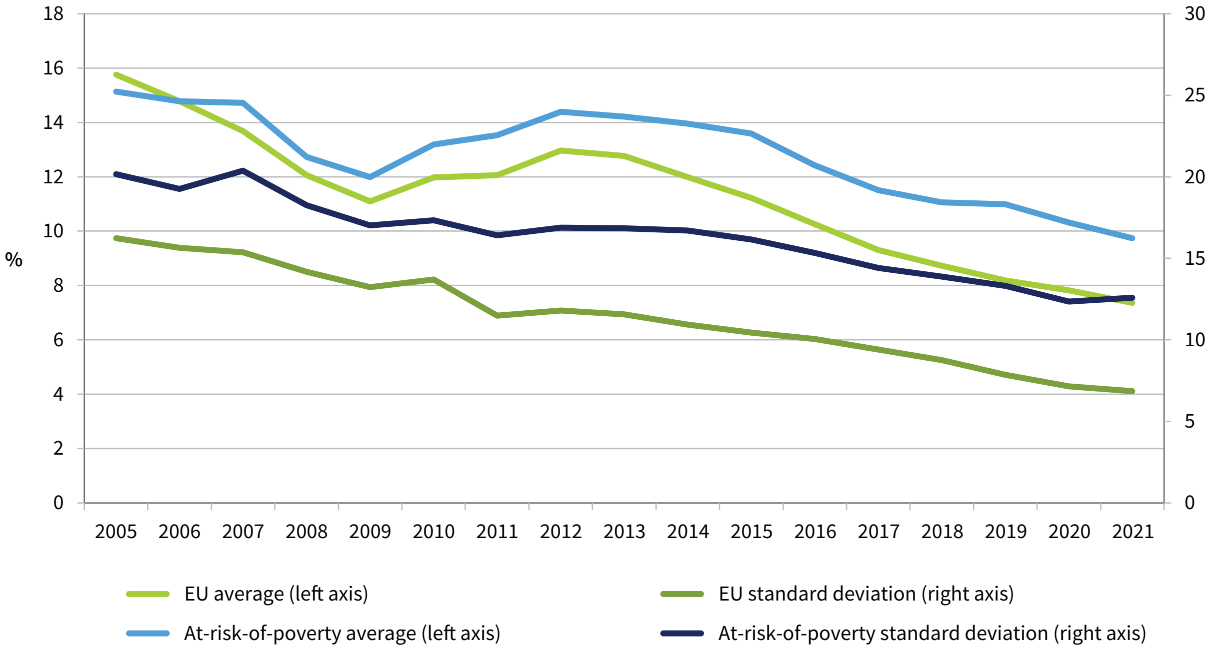
Population unable to keep home adequately warm, by poverty status

This indicator measures the share of the population who are unable to afford to keep their home adequately warm. Like the other indicators analysed in this chapter, this indicator is included in EU-SILC to monitor the development of poverty and social inclusion in the EU. The indicator is used to monitor progress towards SDG 7, on affordable and clean energy. The European Pillar of Social Rights lists energy among the essential services that everyone should have access to. The European Commission's EU Energy Poverty Observatory and, more recently, its Energy Poverty Advisory Hub seek to help Member States in their efforts to decrease energy poverty and ensure access to affordable energy.

Convergence analysis

For both the total population and those at risk of poverty, the share of households unable to heat their homes increased during the crisis. However, disparities between Member States did not increase as much as for arrears on utility bills. After the crisis, Member States surpassed their pre-crisis performance and became more alike in all measures of convergence. The COVID-19 pandemic does not seem to have adversely affected performance or cohesion. The effect of the war on Ukraine and increased energy prices on this indicator remains to be seen.

Figure 30: Sigma-convergence in the share of the population unable to keep home adequately warm, by total population and population at risk of poverty, EU27, 2005–2021



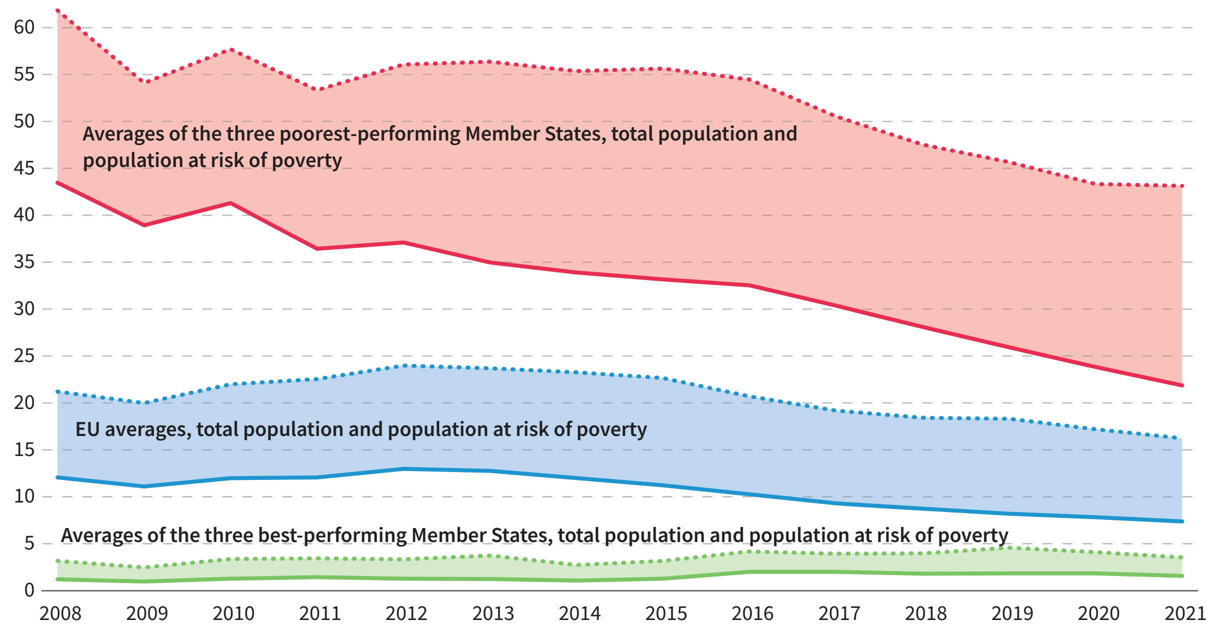
Source: *Eurostat, authors' calculations*

Like the previous indicator, this indicator is examined in three subperiods: before the economic crisis, during the crisis and post-crisis. From 2004 to 2008, for both the total population and those with low incomes, there was upward sigma-convergence, delta-convergence and no statistically significant beta-convergence. During the economic crisis, there was downward sigma-convergence, delta-divergence and no statistically significant beta-convergence. After the crisis, upward sigma-convergence resumed while delta-convergence re-emerged, and there was also evidence of beta-convergence.

Notwithstanding, the population at risk of poverty struggled more than the total population throughout the period and especially in the poorest-performing countries. In those countries, the indicator peaked among the population at risk of poverty during the economic crisis, but the recovery was not as promising as for the same population in the best-performing countries (Figure 31). Moreover, the poorest-performing countries recorded a larger divide between the total population and the population at risk of poverty in 2021 (Figure 32).

Interestingly, during the years of the economic crisis, when the unweighted EU average increased, disparities between Member States continued to decrease; that is, countries became more alike.

Figure 31: Share of the population unable to keep home adequately warm, by total population and population at risk of poverty, EU27, 2008–2021 (%)



Note: *A solid line represents the total population, whereas a dotted line represents the population at risk of poverty.*
Source: *Eurostat, authors' calculations*

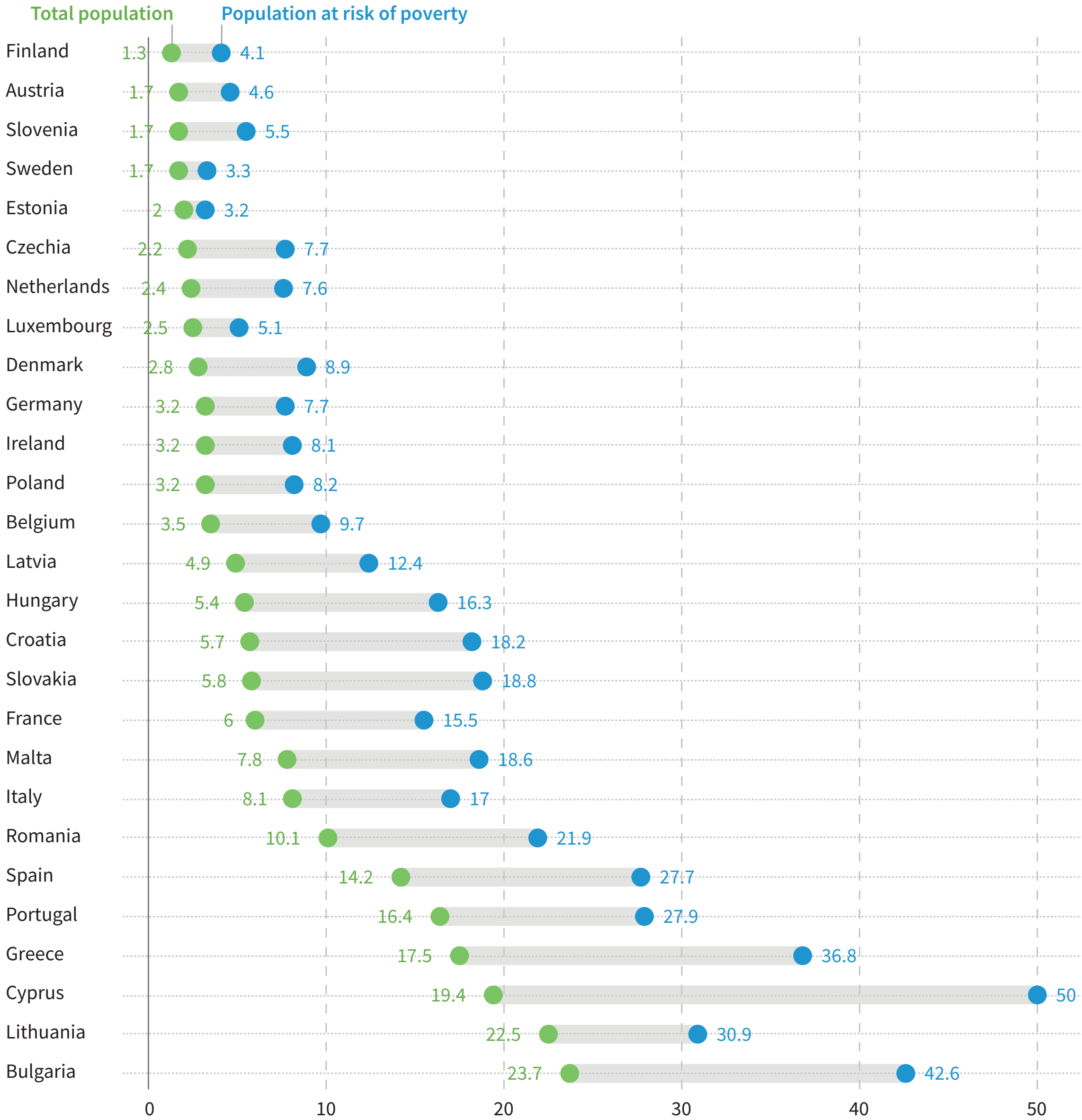
Throughout the entire time frame of the analysis (2005–2021), Bulgaria had the largest share of the population reporting that they could not keep their home adequately warm (in 2010, this included 82% of people with low incomes). An energy crisis involving disruptions to gas supplies in 2010–2011 affected most of its population. The closure of supply pipelines and spikes in energy prices were especially harsh on the poorest. Bulgaria steadily improved and caught up with the other Member States, which mostly saw decreases in the percentage of their low-income population reporting that they could not heat their homes.

Similar trends can be seen for Greece, which managed to curb the increase with dedicated interventions to improve energy efficiency. However, decreases in energy use were also due to residents heating their homes less in order to save on utility bills, which lowered their quality of life (Papada and Kaliampakos, 2016).

Cyprus, Lithuania, Portugal, Romania and Spain also had notably high shares of people unable to heat their homes. The best performers were Finland, Luxembourg and Sweden. The findings confirm those in the literature on energy poverty, which documents especially high rates of energy poverty in the southern and eastern EU Member States (Papada and Kaliampakos, 2016; Bouzarovski and Tirado Herrero, 2017; Papada and Kaliampakos, 2018; Karpinska and Śmiech, 2021).

High rates in this indicator are worrying because, as already discussed, living in energy poverty is detrimental to physical, financial and emotional well-being. In addition, cold temperatures suppress the immune system, making people more vulnerable to colds and minor illnesses, and are associated with cardiovascular and respiratory diseases (Oliveras et al, 2021). As energy prices rise, it is imperative that the most vulnerable are not left to deal with freezing or sweltering temperatures in energy-inefficient housing with insufficient incomes.

Figure 32: Inequalities in the population unable to keep home adequately warm in 2021, by total population and population at risk of poverty, EU Member States (%)



Source: *Eurostat, authors' calculations*

Policy takeaways for micro-level indicators

Energy poverty entered the policy debate only 15 years ago, but its importance quickly became apparent. Soon packages and directives, such as the Third Energy Package[27] from 2009 and the 2019 Clean Energy for All Europeans package,[28] addressed the issue of energy vulnerability. Other measures included the publication of the Commission recommendation on energy poverty (European Commission, 2020b), the creation of the Energy Poverty Advisory Hub,[29] and the setup of the Commission's Energy Poverty and Vulnerable Consumers Coordination Group (European Commission, 2022a).

Energy poverty has become a firm priority over the past two years. Hikes in energy prices in 2021 in the aftermath of the COVID-19 pandemic and the following increase in global energy demand revived concern about the affordability of energy for low-income groups.

27 See https://energy.ec.europa.eu/topics/markets-and-consumers/market-legislation/third-energy-package_en

28 See https://energy.ec.europa.eu/topics/energy-strategy/clean-energy-all-europeans-package_en

29 See https://energy-poverty.ec.europa.eu/index_en

The Russian invasion of Ukraine in 2022 and the subsequent weaponisation of energy pushed wholesale prices for oil and gas considerably higher, which had a massive impact on consumer prices. Dealing with it requires a set of policies and instruments distinguishing between short-term compensation measures and long-term policy actions.

- To alleviate the worst impacts of energy price rises, the Commission published a toolbox of measures as an immediate response, to be implemented by Member States. These included time-limited compensation measures and direct support to energy-poor end-users, including groups at risk, for example through vouchers or by subsidising energy bills. Another measure was the reduction of taxation rates for vulnerable populations in a time-limited and targeted way (European Commission, 2021f).
- Other policy measures have a longer time horizon. These include the Renovation Wave strategy of the European Commission (2020e), which aims to make buildings more energy-efficient by promoting renovation and to reduce people's vulnerability to energy price fluctuations. In addition, high rates of energy poverty are reported in the Member States with high rates of low-quality dwellings (CEB, 2019), making investments in energy efficiency even more important.
- It is crucial to share knowledge of measures implemented at national and local levels with the clearly defined objective of tackling energy poverty. This type of information can be disseminated through reports, such as those published by the EU Energy Poverty Observatory (European Commission, 2020f), the Energy Poverty Advisory Hub (European Commission, 2021g) and Interreg Europe (Interreg Europe, 2022).
- Eliminating energy poverty requires EU-wide as well as national policies. It is essential to tackle the underlying drivers, such as demographic, technical, financial and socioeconomic factors. This is a lengthy process and cannot be done in the short term.

6 Interplay between socioeconomic and environmental factors

Previous research has shown the interplay between socioeconomic factors and various environmental factors. Several societal hazards related to poor environmental quality of life have been identified for citizens, as well as for workers more specifically. Some citizens may be forced to live in inadequate dwellings or close to factories and industrial areas, places with environmental hazards. Social vulnerability is determined not only by working and living conditions but also by access to healthcare and services that improve quality of life (WHO Regional Office for Europe, 2012). An inverse relationship between environmental hazards and socioeconomic status has been shown in a recent EEA publication (EEA, 2018). Low-income citizens are more likely to have low-paid jobs in sectors with more environmental hazards. Moreover, they can afford to live only in residential areas with poor environmental standards, which are usually close to industrial areas; hence, they suffer more from air, water and noise pollution. Another aspect to be considered is the affordability of adequate housing. Due to market prices, low-income groups are more likely to struggle to buy or rent houses that are energy-efficient. This leads them to rent poorer quality accommodation, which increases their exposure to health risks (EEA, 2018).

According to the literature, improvements in socioeconomic factors are associated with improvements in environmental indicators. Better results in socioeconomic indicators such as those related to income and education reduce the likelihood of exposure to environmental hazards (Evans and Kantrowitz, 2002; Mazzanti et al, 2008; EEA, 2018). A similar trend could be assumed to exist if the aggregate results of Member States are analysed at EU level. As previous literature suggests, people living in richer countries enjoy better living conditions (Eurofound, 2021b). Therefore, improvements in socioeconomic indicators could be associated with improvements in environmental indicators over time, and vice versa.

Against this backdrop, this chapter analyses the main socioeconomic factors that are at play in determining European environmental quality of life. The analysis looks at the Member States' performance in relation to socioeconomic and environmental factors over time and aims to find a relationship between them.
It examines the following environmental indicators:

- air pollution
- noise pollution
- waste generation and management
- inadequate housing
- energy poverty

And it looks at the relationship between each of these and the following socioeconomic factors:

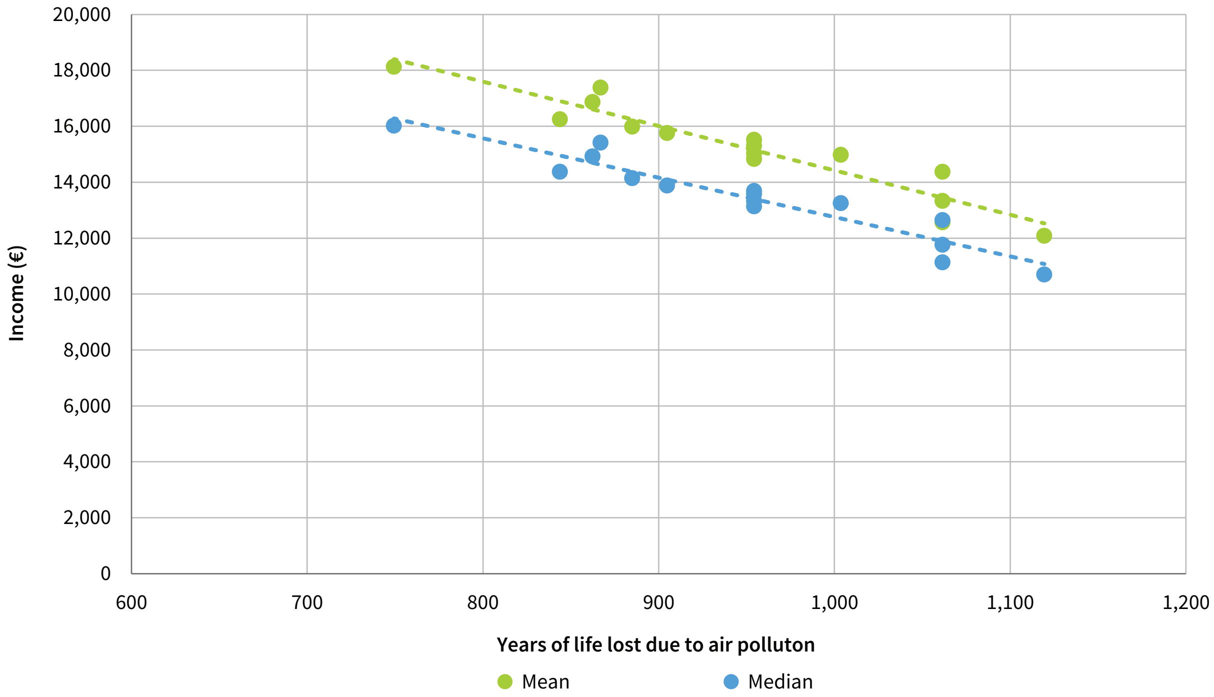
- mean and median income
- disposable income
- GDP per capita
- share of the population at risk of poverty or social exclusion (AROPE)
- employment and unemployment rates
- education, expressed as the early school-leavers rate and the tertiary education completion rate

Table 8 at the end of this chapter provides the results of the analysis, showing the correlation between environmental and socioeconomic variables. The sections that follow highlight some of the findings.

Air pollution

Concerning air pollution, Evans and Kantrowitz (2002) reported findings from the United Kingdom, the United States and the EU, where exposure to air pollutants was inversely related to income levels. In other words, people with lower incomes experienced higher levels of air pollution. More specifically, living close to factories and industrial areas at the periphery of cities is a crucial factor in health deterioration (Ash and Boyce, 2018). Moreover, minorities and low-income populations are more likely to work at polluting facilities, increasing the number of health hazards they are exposed to (WHO, 2011; EEA, 2018). Similar results were found for water pollution, although to a lesser extent (World Bank, 2015).

Figure 33: Correlation between years of life lost due to air pollution and mean and median income, EU27, 2005–2019



Source: *Eurostat, authors' calculations*

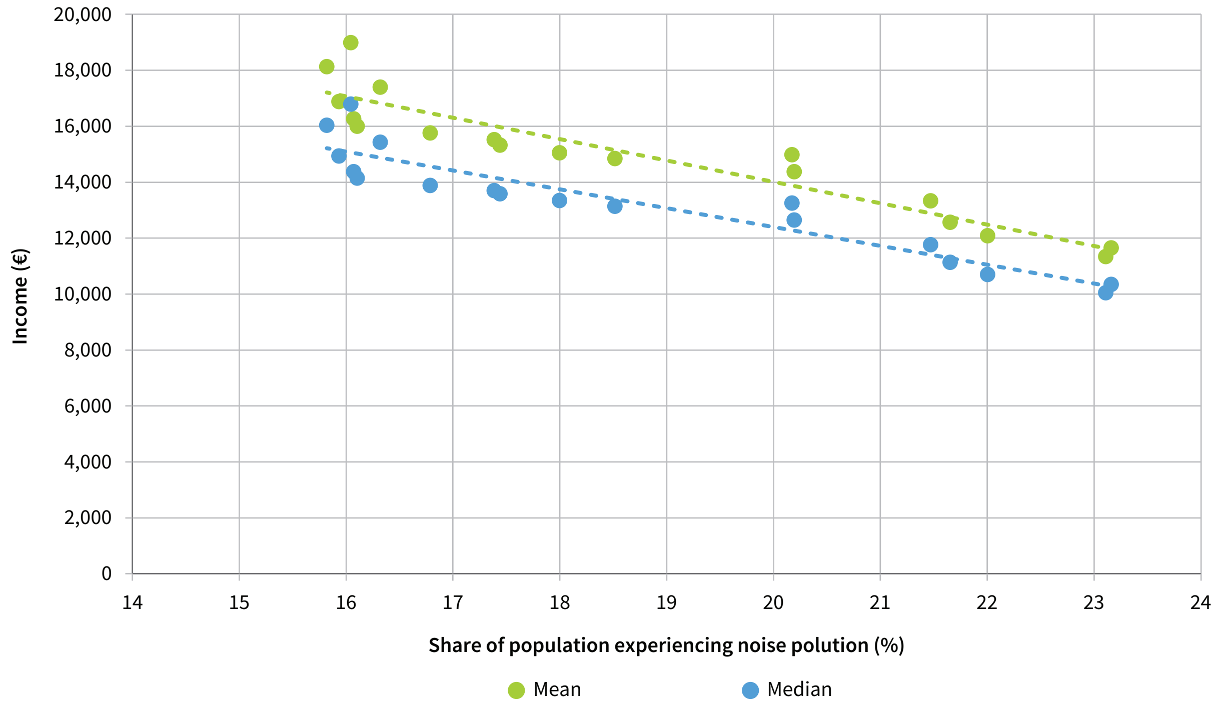
The results of the analysis confirm the findings of previous studies. When looking at the relationship between the effect of air pollution on lifespan and several socioeconomic factors at country level, a strong negative correlation can be seen: increasing income is related to a decrease in years of life lost due to air pollution (Figure 33). This relationship was found to be significant for several measures of income: mean income, median income and real gross disposable income per capita. Similarly, a reduction at EU level in the unemployment rate is associated with a reduction in air pollution over time. These findings point to a significant negative correlation between the wealth of the EU overall and air pollution.

Noise pollution

Low-income neighbourhoods report twice as much noise as affluent ones (Evans and Kantrowitz, 2002). The extent of noise exposure is especially acute in metropolitan and industrial areas and close to airports, as reported for neighbourhoods living in close proximity to Heathrow Airport (Heathrow Airport Limited, 2013). Similarly, low-income populations are more likely to live next to busy roads, as observed in Germany and the Netherlands (Kruize and Bouwman, 2004; Laußmann et al, 2013).

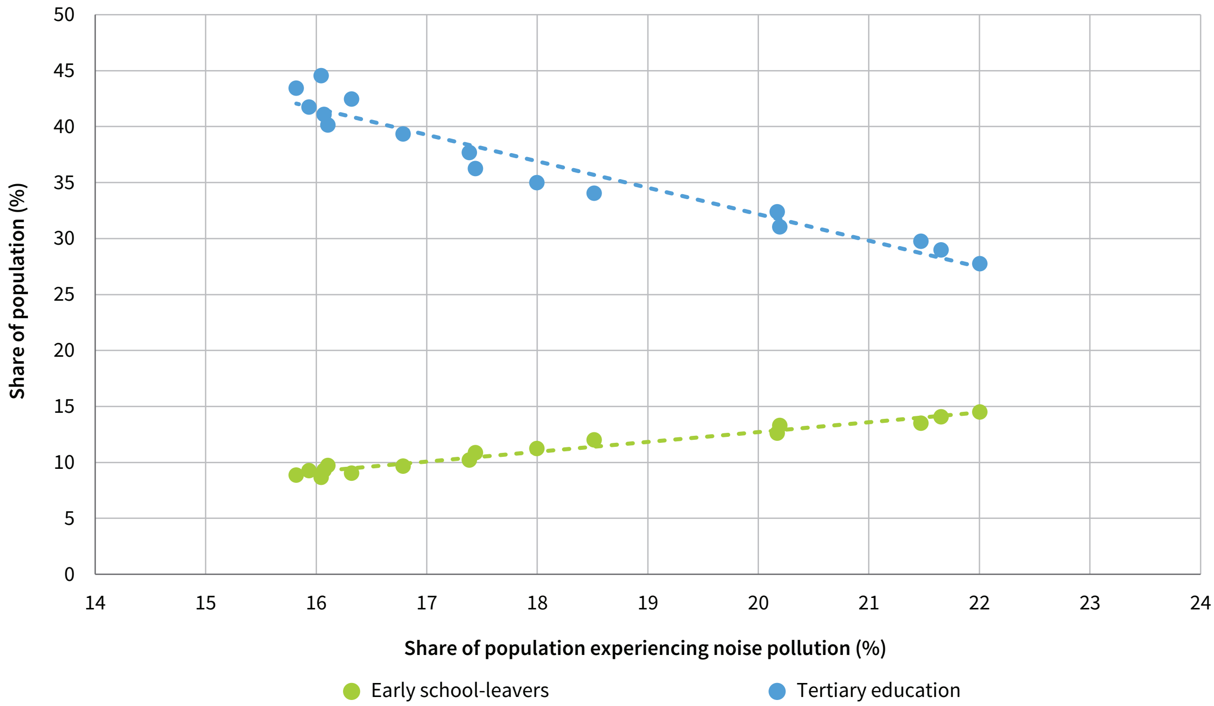
The analysis confirms an inverse relationship between Member States' performance with regard to noise pollution and two socioeconomic factors examined, income and level of education (Figures 34 and 35). An income increase is associated with a decline in noise pollution. Similarly, an increase in the share of the population who have completed tertiary education is associated with a decline in noise pollution. On the other hand, an increase in the share of the population who are early school-leavers is associated with an increase in noise pollution.

Figure 34: Correlation between the share of the population experiencing noise pollution and mean and median income, EU27, 2003–2020



Source: *Eurostat, authors' calculations*

Figure 35: Correlation between the share of the population experiencing noise pollution and educational attainment, EU27, 2003–2020



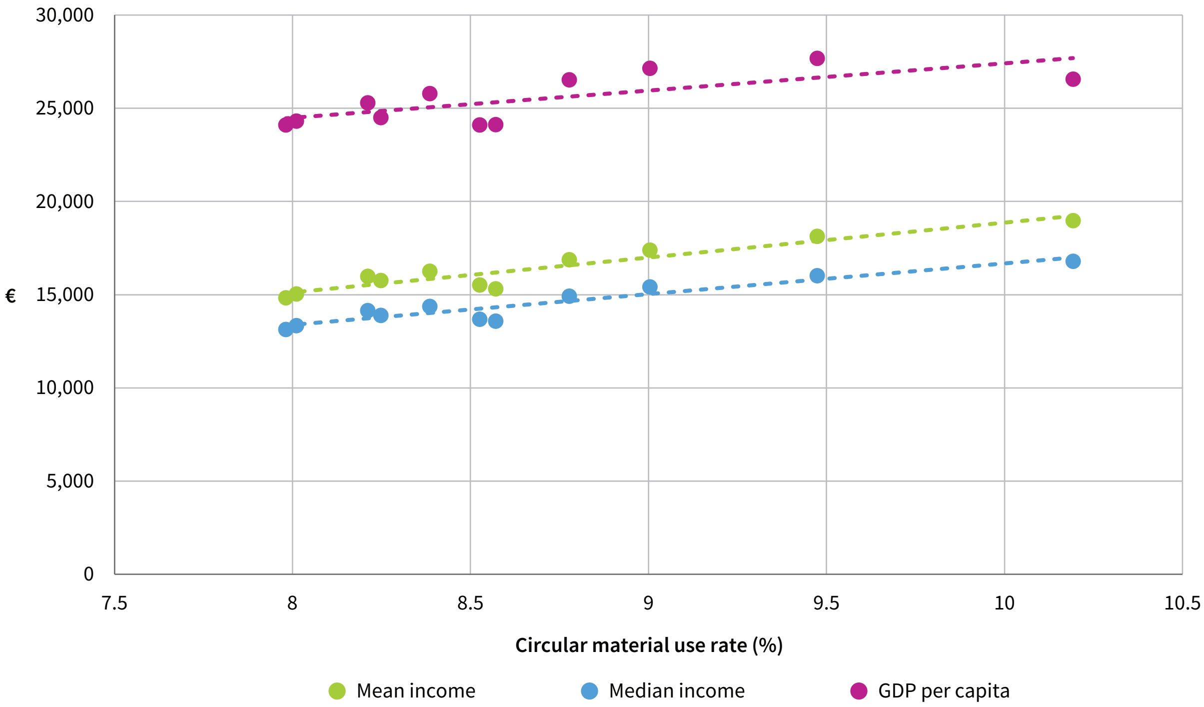
Source: *Eurostat, authors' calculations*

Waste generation and management

Waste generation and waste management pose serious risks for those with low incomes. Exposure to hazardous waste landfill is widespread among low-income populations (Evans and Kantrowitz, 2002). An Italian study analysed the differences between the country's more affluent northern provinces and the less affluent southern provinces in waste generation and waste management. The results showed that, despite higher generation of waste in the north, northern provinces had a stronger commitment to environmental policy through better waste management initiatives (Mazzanti et al, 2008). Southern regions, despite generating less waste, did not have waste management mechanisms to decrease their environmental impact. The geographical and financial divide in waste management and the circular economy at EU level was also highlighted by a recent publication from the Joint Research Centre (JRC, 2018). The circular economy could help deal with the recycling of hazardous waste, preventing it from ending up in landfill and damaging the quality of life of communities living in close proximity to landfill sites.

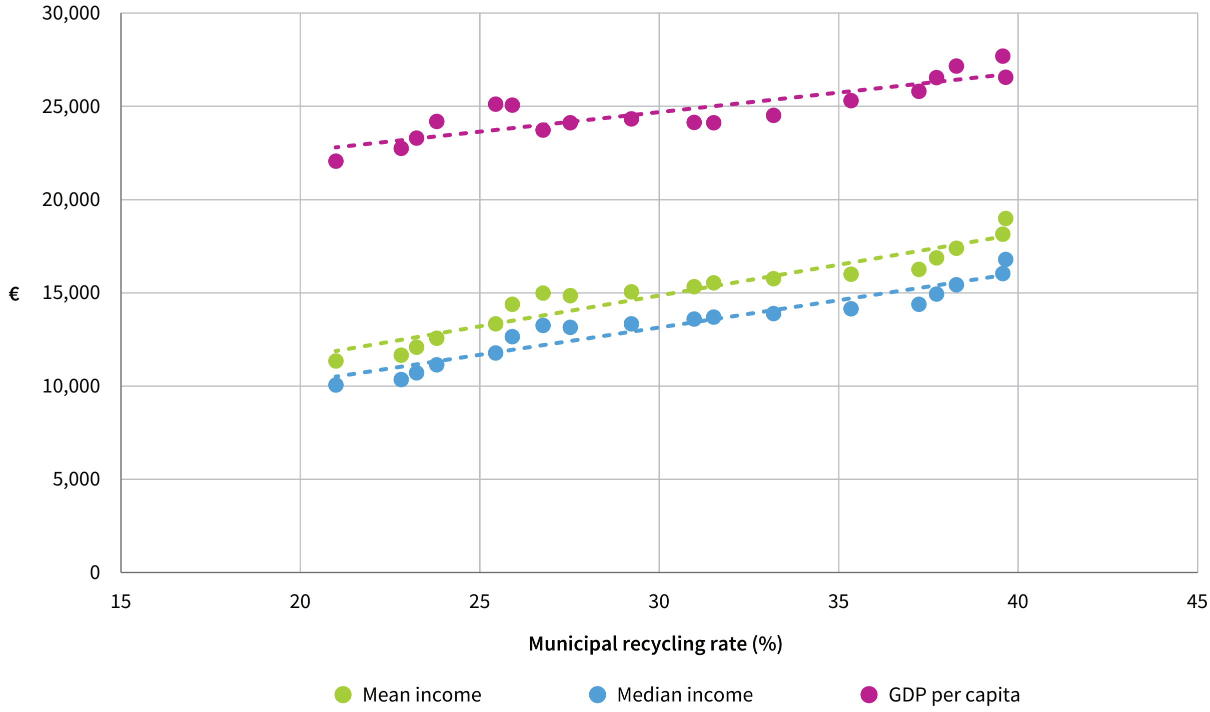
In line with previous literature, the analysis for this study found strong positive correlations between socioeconomic factors – income, GDP per capita, education and the employment rate – and circular material use rates and recycling rates at municipal level. The analysis confirms the results of previous research, finding that higher wealth at EU level is associated with a better-developed circular economy (Figure 36) and higher rates of recycling (Figure 37) over time. The same trend was found when education was considered, showing how higher educational attainment is associated with better waste management.

Figure 36: Correlation between circular material use rate and income and GDP, EU27, 2008–2019



Source: *Eurostat, authors' calculations*

Figure 37: Correlation between municipal recycling rate and income and GDP, EU27, 2004–2020



Source: *Eurostat, authors' calculations*

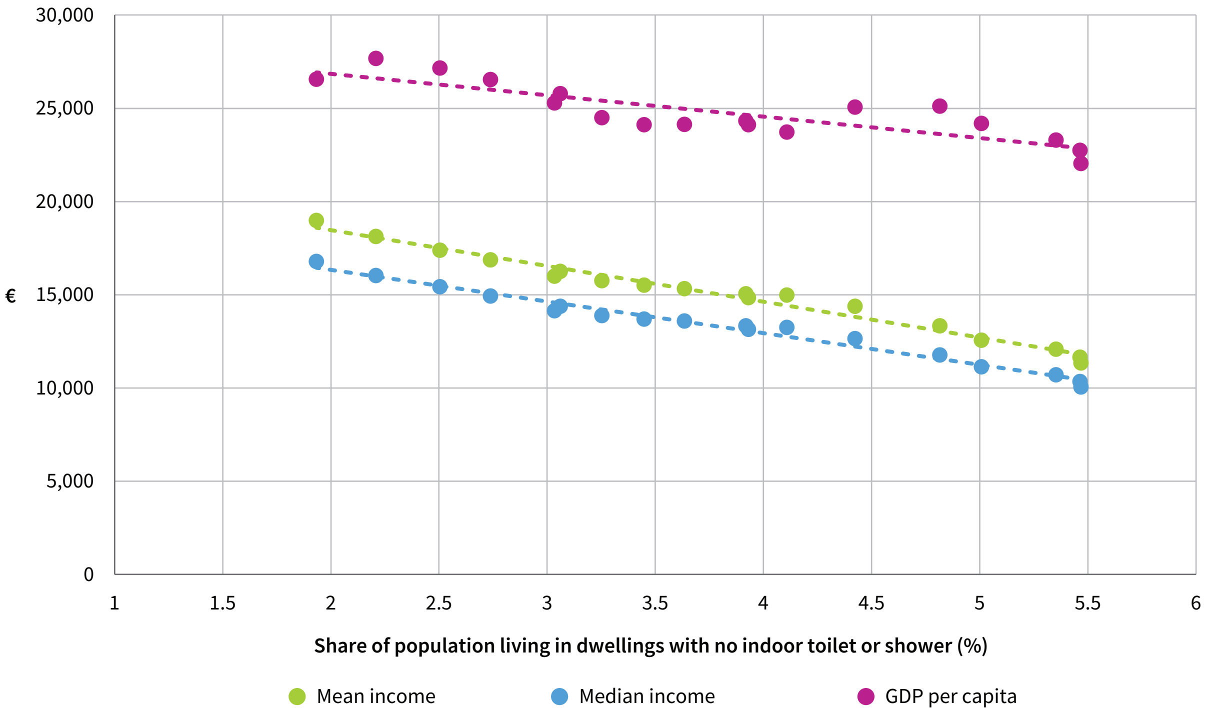
Inadequate housing

Housing itself may constitute an environmental hazard for the people living in it. Low-income populations are less likely to own the houses they live in and more likely to live in publicly or privately rented homes. Privately rented homes have the worst energy efficiency standards when compared with owned homes or publicly rented homes (Eurostat, 2020; Eurofound, 2023b). Reports focusing on Belgium, France and Spain show that rented houses have poor energy performance and are mostly inhabited by people with low incomes (Aristondo and Onaindia, 2018; Meyer et al, 2018). Indoor air quality is an important factor in the health of renters. Indoor smoking and inefficient heating systems, such as unvented gas heating and hot air units without ducts, are the primary causes of health problems (Evans and Kantrowitz, 2002).

Similarly, studies from Belgium, Germany and some regions of other Member States have found that poor insulation and dampness are linked to the presence of more dust mites and mould, both increasing the likelihood of respiratory disorders (EEA, 2018). Similarly, in the Netherlands, housing deficiency (a lack of home appliances and overcrowding) was recorded more frequently among the low-income population than among more affluent citizens (Carliner and Marya, 2016).

The analysis shows strong negative correlations between Member States' performance with regard to income and two indicators of inadequate housing examined: the share of the population living in households with damp, leaks or rot and the share of the population living in dwellings lacking indoor toilets, baths or showers. As Figure 38 clearly illustrates, higher income and GDP per capita at EU level are associated with a lower share of the population living in houses with inadequate indoor sanitary facilities.

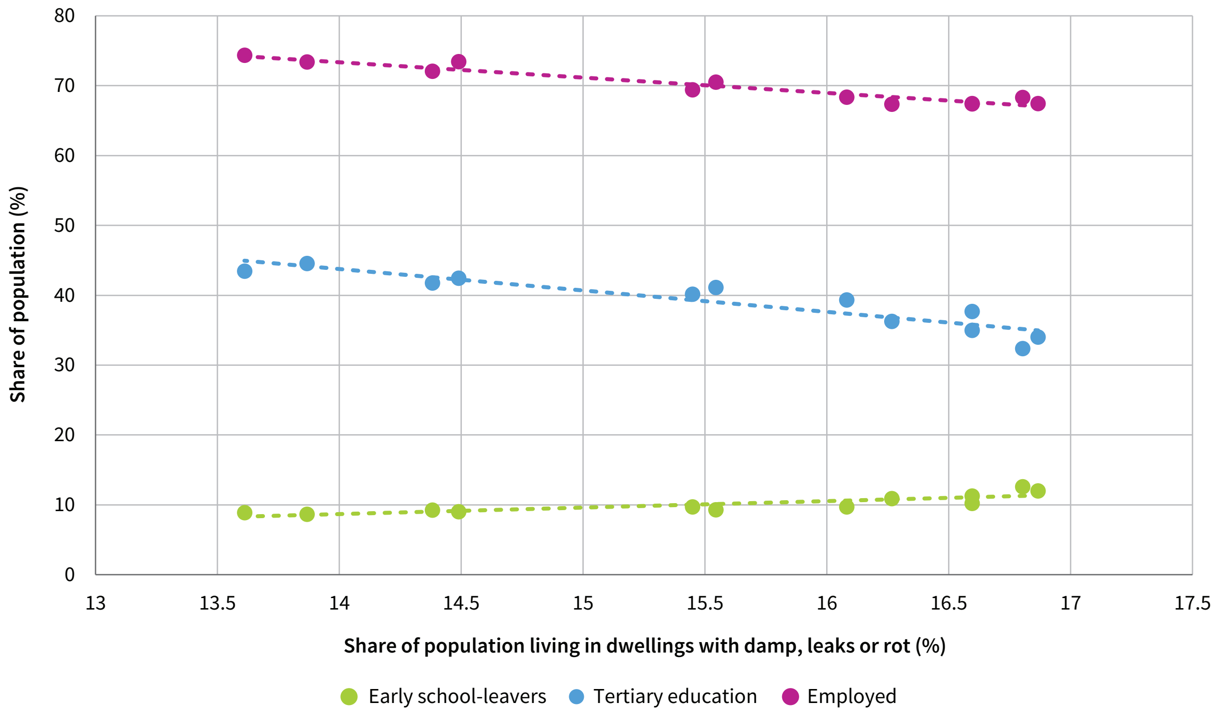
Figure 38: Correlation between the share of the population living in dwellings with no indoor toilet or shower and mean and median income and GDP per capita, 2009–2020, EU27



Source: *Eurostat, authors' calculations*

Similarly, Figure 39 shows that Member States with higher employment rates have lower rates of inadequate housing conditions. It also shows, as seen before, that Member States with higher rates of completion of tertiary education and a lower share of early school-leavers have better housing conditions.

Figure 39: Correlation between the share of the population living in dwellings with damp, leaks or rot and educational attainment and employment rate, EU27, 2009–2020



Source: *Eurostat, authors' calculations*

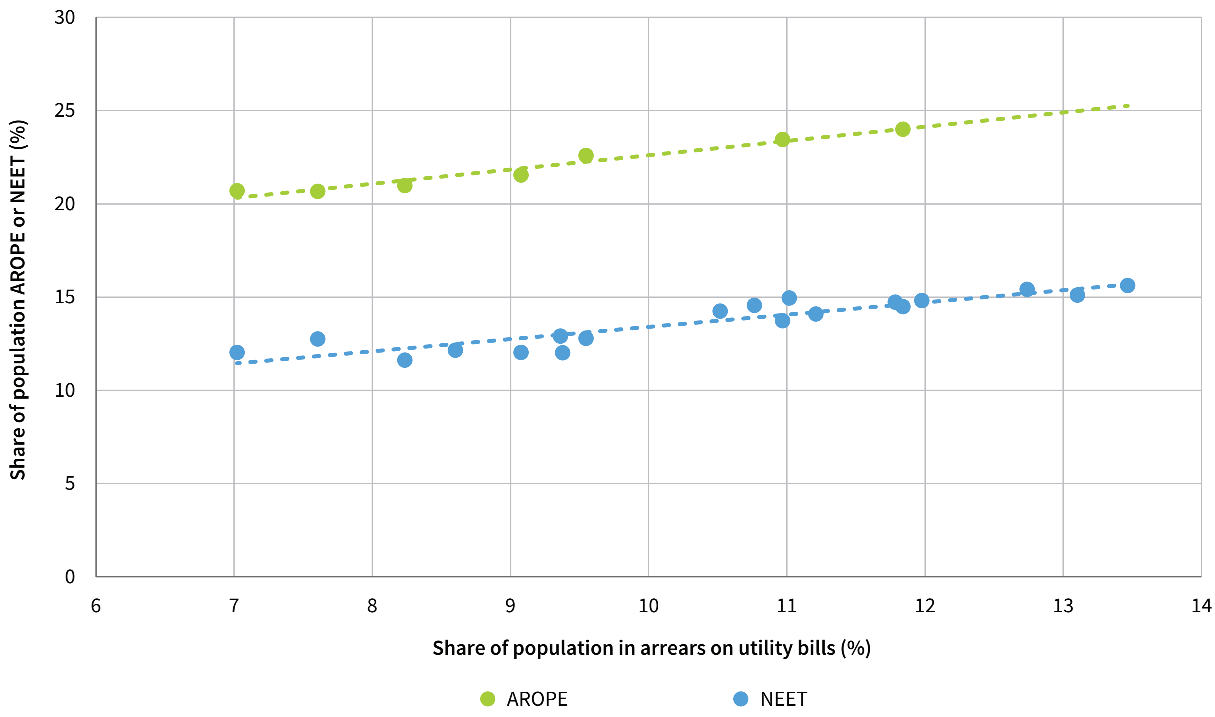
Energy poverty

The concept of energy justice (which deals with the availability, affordability and sustainability of energy) is a keystone in the debate around environmental quality of life (Sovacool and Dworkin, 2015). When these mechanisms are unbalanced, energy poverty rises (Heyen et al, 2020). Energy poverty became a central issue with the development of decarbonisation policies. Renewable energies, despite their lower environmental and health impacts, are still relatively expensive, leading people with lower incomes to continue to resort to carbon fuels. Simultaneously, carbon fuels are slowly being phased out by increasing taxes and cutting subsidies. Hence, low-income populations are trapped, because both renewables and carbon fuels are very expensive sources of energy, which some families cannot pay for any more (Heyen et al, 2020). Energy poverty not only affects the accessibility of energy but also the closely related issues of health, wealth and social inclusion. Moreover, it affects people differently. Households with children, extended families and single parents are more vulnerable to the wider social impacts of energy poverty, such as social isolation and social stigma (Eurofound, 2023a).

Another factor to take into account is that the quality of housing affects household bills. Energy-inefficient housing leads either to higher energy consumption, meaning higher energy bills, or to uncomfortably cold or warm houses. Low-income households are more likely to live in inadequate dwellings, and, across the EU, they have reported spending more than a third of their disposable income on energy bills (CEB, 2017). Studies from Belgium, Spain and the United Kingdom have documented how low-income populations renting private houses struggle to pay bills due to energy-inefficient housing. Experts have also ranked people with low incomes as those hardest hit by energy poverty (Papantonis et al, 2022), followed by displaced people and ethnic minorities.

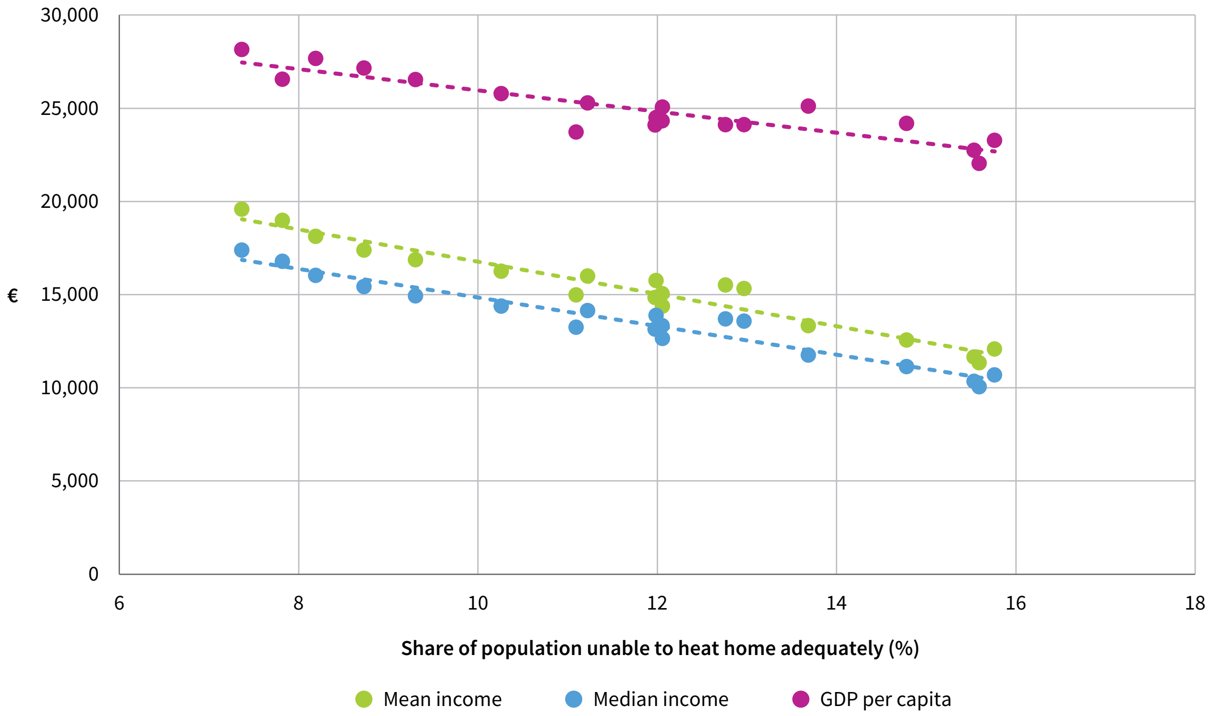
The analysis of this study produced similar findings, showing correlations between socioeconomic and energy poverty trends. A decrease in the share of the population in arrears on their utility bills is associated with a decrease in the share of the population at risk of poverty and the NEET rate (Figure 40).

Figure 40: Correlation between the share of population in arrears on utility bills and the AROPE or NEET share of the population, EU27, 2015–2021



Source: *Eurostat, authors' calculations*

Figure 41: Correlation between the share of the population unable to heat their home adequately and mean and median income and GDP per capita, EU27, 2005–2021



Source: *Eurostat, authors' calculations*

Similar results were found for EU-level trends in the share of the population unable to heat their dwellings adequately (Figure 41). Increases in mean and median incomes and GDP per capita are associated with a reduction in the share of the population unable to keep their homes adequately warm.

Summary

The findings of this chapter can be summed up as follows: wealthier countries tackle environmental problems more effectively and are better equipped to address the challenges of the green transition. Table 8 summarises the findings of the analysis, showing the correlation between environmental and socioeconomic variables.

Table 8: Correlation matrix of environmental and socioeconomic variables, EU27

	Mean income	Median income	GDP per capita	Disposable income	AROPE rate	Employment rate	Unemployment rate	NEET rate	Early school-leavers	Tertiary education
Air pollution										
Years of life lost due to PM2.5 pollution	-0.96	-0.96	-0.89	-0.89	0.68 (ns)	-0.76	0.5 (ns)	0.58 (ns)	0.95	-0.96
Noise pollution										
Population suffering from noise	-0.94	-0.94	-0.77	-0.71	0.17 (ns)	-0.58	0.24 (ns)	0.12 (ns)	0.99	-0.97
Waste generation and management										
Circular material use rate	0.83	0.83	0.75	0.86	-0.94	0.83	-0.65	-0.38 (ns)	-0.72	0.79
Municipal recycling rate	0.97	0.97	0.92	0.87	-0.96	0.81	-0.52	-0.51	-0.98	0.99
Inadequate housing										
Population living in houses with damp or rot	-0.96	-0.96	-0.96	-0.95	0.93	-0.97	0.89	0.88	0.85	-0.92
Population without an indoor bathroom	-0.99	-0.99	-0.85	-0.88	0.97	-0.76	0.47 (ns)	0.28 (ns)	0.98	-0.99
Energy poverty										
Population in arrears on bills	-0.38 (ns)	-0.38 (ns)	-0.65	-0.68	0.98	-0.76	0.9	0.92	0.16 (ns)	-0.25 (ns)
Population unable to heat home	-0.97	-0.97	-0.91	-0.96	0.98	-0.86	0.72	0.54	0.89	-0.9

Notes: *ns, not significant. Green indicates a positive correlation, whereas red indicates a negative correlation.*

7 Conclusions

This report investigated the dynamics of the environmental performance of the EU Member States and disparities between them in relation to three types of outcomes: headline (macro-level), residential-level (meso-level) and household-level (micro-level) indicators. It also investigated the interplay of environmental and socioeconomic indicators to highlight the impact of factors such as income, education level and employment rates on environmental progress.

The report is the result of a collaboration between Eurofound and the EEA. The two agencies also carried out a foresight study to gauge what the next 10 years may hold for the European green transition. That report explores the various scenarios that Europe may face in the future (Eurofound and EEA, 2023).

Convergence in environmental performance was seen across thematic areas, suggesting that Member States are committed to becoming carbon neutral. Although progress was recorded for most of the indicators, some of the improvements were rather small or very recent. Therefore, environmental laws – such as regulations, directives and decisions – need to be regularly revised and strengthened in terms of reduction targets. These include the European Green Deal, which comprises a set of different policy initiatives, such as the Fit for 55 package, which aims to reduce net GHG emissions by 55% by 2030 (compared with 1990 levels); the REPowerEU plan, which commits to achieving a share of renewable energy in gross final energy consumption of 45% and a 13% reduction in energy consumption; the Zero Pollution Action Plan; and the Circular Economy Action Plan.

This study found improvements in all four headline (macro-level) indicators analysed, indicating progress on reaching policy targets. Convergence trends were less clear. There was a reduction in disparities between Member States in respect of GHG emissions and years of life lost due to air pollution, whereas disparities increased regarding the share of renewable energy in energy consumption and the circular material use rate. These increases were driven mostly by the best- performing Member States pulling further ahead. There was evidence of the poorest-performing Member States catching up with the best performers in respect of two indicators, namely GHG emissions and the share of renewable energy in energy consumption, whereas there was no such catch-up regarding years of life lost due to air pollution and circular material use rates. It should be borne in mind, however, that decreases in GHG emissions could be due not only to environmental policies but also to external factors such as deindustrialisation.

Most of the four residential-level (meso-level) indicators analysed showed promising trends. There was an improvement in three: pollution, grime or other environmental problems; recycling rate of municipal waste; and the share of the population living in households considering they suffer from noise. No improvement was found, however, in the fourth indicator: the share of trains and buses in total passenger transport. A reduction in disparities between the Member States and a catching-up of the poorest performers with the frontrunners were observed for all indicators other than noise pollution. Disparities increased mostly among populations at risk of poverty in poor-performing countries.

The analysis of two household-level (micro-level) indicators – arrears on utility bills and ability to keep the home adequately warm – highlighted different trends in three subperiods relating to the economic crisis of 2008–2013: pre-crisis, during the crisis and post-crisis. While the impact of the economic downturn was more or less absent at macro and meso levels, these micro-level indicators were clearly linked with socioeconomic outcomes, with poor performance peaking during the years of the economic crisis. Until 2008, the share of the population in arrears on utility bills and the share unable to keep their home adequately warm fell in Member States, both for the total population and the population at risk of poverty. Disparities reduced across the Member States among populations at risk of poverty regarding the inability to keep the home adequately warm but not so for the share in arrears on utility bills. A catching-up process was not found. The economic crisis undermined most of the progress made by Member States: performance dropped drastically, and inequalities surged for everyone, particularly among populations at risk of poverty in poor-performing countries. There was a swift change for the better during the recovery years, however, with rapid improvements in performance, reduced inequalities and speedy catching-up processes in poor-performing countries. Conversely, housing quality improved steadily over the years of the crisis, coupled with a reduction of disparities. The trend reversed during the COVID-19 pandemic, when performance dropped and disparities increased.

Finally, the report examined the correlation between socioeconomic and environmental indicators. The environmental indicators chosen were those most likely to be affected by socioeconomic performance, such as air and noise pollution, recycling and energy poverty. The analysis showed that high performance on socioeconomic indicators goes hand in hand with progress in environmental factors. Most noticeably, higher income is strongly associated with better performance on environmental factors. Similarly, better performance in social indicators (such as a reduction in the share of the population at risk of poverty or social exclusion) is linked with improved environmental performance.

Policy pointers

- For many indicators, the EU should stay the course, sticking with the greening objectives it has set out. In recent years, the EU has made progress on headline indicators such as reducing GHG emissions and increasing renewable energy use. The EU has maintained its commitment to climate action by devoting 30% of its current long-term budget (MFF) and 37% of NextGenerationEU funds to climate action.
- The EU should diversify its energy and material dependencies and increase its autonomy through measures promoting the use of renewable energy and the circular economy to increase energy resilience and cushion the effects of future energy and material crises. These measures would protect low-income citizens in particular. Energy crises were most severe in countries highly dependent on Russian gas and oil, such as Bulgaria and Romania.
- Residential- and household-level environmental goals may need more stringent or timely policy measures than those currently in place. Interventions should focus on three areas where this study detected divergence between Member States: housing, energy poverty and public transport.
- In line with the Renovation Wave strategy, urban design should provide adequate and affordable homes in areas free of environmental hazards for low-income populations, especially in densely populated areas. Financial support measures, such as subsidies, could incentivise people to improve their housing and should be better targeted at vulnerable consumers. National interventions to improve social housing should also be promoted. These measures would reduce the threat of energy poverty.
- More widespread and affordable public transport systems could increase mobility and reduce emissions simultaneously. The Zero Pollution Action Plan encompasses measures to reduce transport emissions, while the Sustainable and Smart Mobility Strategy aims to improve public transport systems. The two measures combined would address the problem of growing private transport emissions. People living in rural areas, senior citizens and people with underlying health conditions have the greatest need for connectivity, and transport policies should be designed with them in mind.
- Authorities pursuing greening could follow established practices suggested by Member States or the EU. High-level solutions as well as everyday fixes are needed. For example, Slovenia aligned its waste management policies with EU directives and saw rapid improvements. Similarly, several European cities (Gothenburg, Madrid, Milan, Munich and Stockholm) are adapting and implementing rules on congestion taxes and low-emission zones that are tailored to their needs.
- The EU and its Member States need to work closely together to improve the EU's environmental performance. Clear communication from the EU and national governments should help the public to adopt more sustainable behaviours. Cooperation between the Member States could foster the circular economy. Regulations concerning cross-country waste recycling need to be updated so that materials transported are not heavily taxed. For example, recycling out-of-use wind turbines is much more costly if during their transportation they are taxed as wind turbines instead of waste. However, stricter controls on cross-country waste disposal should be applied to avoid hazardous waste travelling to countries with poor environmental-protection laws.

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This report explores the dynamics of the environmental performance of the EU Member States and the extent to which the disparities in their performance have narrowed since the early 2000s. The report is a product of cooperation between Eurofound and the European Environment Agency, with the technical expertise in convergence of the former meeting the expertise in European environmental issues of the latter. It focuses on three levels of analysis: headline indicators, residential-level indicators and household-level indicators.

In order to explore the multifaceted issue of environmental quality of life in the EU, the report investigates environmental indicators through a convergence analysis. The results suggest that the EU is on the right track to becoming carbon neutral, although the speed of the greening process varies among the Member States. A fast and steady improvement in performance can be seen for most of the indicators. One noteworthy finding is that the economic downturns of the past two decades negatively affected the household-level indicators examined, which focused on energy poverty.

The European Foundation for the Improvement of Living and Working Conditions (Eurofound) is a tripartite European Union Agency established in 1975. Its role is to provide knowledge in the area of social, employment and work-related policies according to Regulation (EU) 2019/127.

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