Designing the EU 2040 climate target

Political context, level of ambition, implications for Member States and sectors

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Contents

1 Introduction 10

2 European Sovereignty: The case for a strong 2040 target 11

2.1 Energy security and energy costs 12

2.2 Circular economy, climate policies and dependency on critical raw materials 13

2.3 Fossil fuels fund authoritarian regimes and war 13

2.4 Security of food supply 13

2.5 Migration and climate change 14

2.6 Energy poverty and demographic change 14

3 The EU's fair share: remaining emission budgets 15

3.1 Remaining global emission budget 15

3.2 Criteria for distributing global emission budgets 16

3.3 Estimated EU emission budgets 18

4 2040 target: The level of ambition 20

4.1 Emission levels in 2040 in different EU-wide scenarios 20

4.2 Member State contributions to the 2040 target as already existing in national law and policies 22

4.3 The gap between 2040 target scenarios and existing national commitments 23

5 Sector contributions to the 2040 climate target 24

5.1 Energy 25

5.2 Industry 27

5.3 Transport 28

5.4 Buildings 29

5.5 Agriculture 30

5.6 Waste 31

5.7 LULUCF 32

5.8 Technological removals 33

References 34

Annexes 37

Annex A: Estimated EU emission budgets 37

Annex B: Scenarios for 2040 GHG emission reductions 38

List of Figures

Figure 1: Estimates of historical CO2 emissions and remaining carbon budgets. 16
Figure 2: Possible criteria for emission budget estimation. 17
Figure 3: Implied EU greenhouse gas emission budgets for 2030-2050 and 2040 emission reductions for different ranges of scenarios. 18
Figure 4: Scenarios for GHG emissions in 2040. 20
Figure 5: Scenarios for GHG emissions and removals in 2040. 22
Figure 6: 2040 GHG emission reductions targets and scenario outcomes of EU Member States, compared to the average scenario assumptions for 2040. 24
Figure 7: Summary of sector contributions to the 2040 climate target. 25
Figure 8: Total amount of GHG and CO2 emissions and removals under current EU targets and policies. 37
Figure 9: Total amounts of GHG and CO2 emissions and removals under CAN Europe's proposed policy. 37
Figure 10: Maximum CO2 budgets for Germany and the EU. 38
Figure 11: -95% net by 2040 scenario. 38
Figure 12: -90% net by 2040 scenario. 39
Figure 13: -85% net by 2040 scenario. 39
Figure 14: EU Gas Exit Pathway. 40
Figure 15: 1.5°C compatible range. 40
Figure 16: EU 2030 Climate Target Plan. 41

List of Tables

Table 1: Emissions and sectors in the EU with an outlook to 2040. 8
Table 2: Summary of emission budgets' assumptions for EU27. 19
Table 3: Scenarios for 2040 GHG emissions. 20
Table 4: Assumptions for sectoral emissions (in Mt CO_2eq) according to 2040 scenarios. 24
Table 5: Scenarios' assumptions for emissions from *energy* in 2040. 26
Table 6: Scenarios' assumptions for emissions from *industry* in 2040. 27
Table 7: Scenarios' assumptions for emissions from *transport* in 2040. 28
Table 8: Scenarios' assumptions for emissions from *buildings* in 2040. 29
Table 9: Scenarios' assumptions for emissions from *agriculture* in 2040. 30
Table 10: Scenarios' assumptions for emissions from *waste* in 2040. 31
Table 11: Scenarios' assumptions for emissions from *LULUCF* in 2040. 32
Table 12: Scenarios' assumptions for *technological removals* in 2040. 33

Abbreviations

BECCS	Bioenergy with carbon capture and storage
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
DACCS	Direct air carbon capture and storage
ECL	European Climate Law

EEA	European Environment Agency
ESABCC	European Scientific Advisory Body on Climate Change
FAO	Food and Agriculture Organization of the United Nations
GHG	Greenhouse gas
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LTS	Long-Term Strategy
PAC	Paris Agreement Compatible
UNHCR	United Nations High Commissioner for Refugees

Executive summary

The EU climate target for 2040 is not solely about climate policies. It **is at the core of solving many of the EU's strategic challenges**: preserving its standard of living and prosperity, fostering peace and stability, reducing the influence of authoritarian regimes, and ensuring the competitiveness of its economy and energy security. The 2040 target is also about the restoration of ecosystems, protection of biodiversity, enhancement of food security, the fight against energy poverty, and the promotion of public health – other critical strategic challenges for the EU. And, obviously, the target is central to achieving the EU's 2050 climate neutrality target and to addressing the climate crisis itself – one of Europe's greatest strategic challenges.

It is imperative that there is a **broad public consensus** that an ambitious 2040 climate target is critical for the **well-being of all Europeans**, and that profound change is necessary to avert disruptive changes to the European way of life. To establish and expand this consensus, social aspects of decarbonisation should take centre stage in the discussion on the 2040 target. In addition, the discussion should be as concrete as possible. It should focus on the tangible implications of the 2040 target for Europe's economy and the daily life of Europeans – rather than an abstract emphasis on targets.

EU climate target for 2040: Level of ambition

The European Scientific Advisory Board on Climate Change (ESABCC) concluded that the EU's 2040 climate target should require **reductions of -90 to -95% (compared to 1990)**. Other scenarios compatible with climate neutrality by 2050 suggest GHG emission reductions in 2040 **between - 85% to - 95% (compared to 1990**). 2040 pathways indicate that net GHG emissions vary between 210 and 691 Mt CO_2eq, with natural removals ranging from 313 to 601 Mt CO_2eq and technological removals ranging from 46 to 160 Mt CO_2eq.

The **reduction pace accelerates** drastically in all scenarios and sectors. Annual average reductions between 1990 and 2020 were about 55 Mt CO_2eq or 1.1% of 1990 emissions. To achieve the EU's current 2030 climate target of at least net -55% compared to 1990, the EEA projects that this reduction rate will have to increase to 134 Mt CO_2eq or 2.9% of 1990 emissions. Meeting a new 2040 target of about 90% reduction will require an even more accelerated annual reduction rate: In absolute terms, emissions need to decrease every year by **164 Mt CO_2eq or 3.5% of 1990 emissions**.

Implementing the EU's 2040 climate target: Implications for Member States

10 Member States already have a 2040 climate target. While Finland, Germany, Greece, Portugal, and Sweden have legally binding 2040 targets in law, Estonia, Latvia, Lithuania, Malta, and Romania have indicative targets in their national long-term climate strategies (LTSs). The LTSs of Bulgaria, Croatia, Czechia, Hungary, Slovakia, and Slovenia feature outcomes of scenarios that only describe possible reduction pathways but do not commit to one. Laws and LTSs of the other **12 Member States are silent on a 2040 climate target**.

While Germany, Sweden, Finland, and Romania have national targets for 2040 that are in line with most 2040 emission reductions scenarios, commitments of other Member States are far behind the targets put forth in these scenarios. As meeting the EU climate target is a **collective**

effort of the EU, even Member States with targets compatible with most 2040 emission reduction scenarios might have to increase their contributions.

The 2040 EU climate target: Implications for sectors

Emission reductions of -85% to -95% by 2040 will have **profound implications for all economic sectors**. According to scenarios, emissions from **energy production** would fall between 94% and 98%, while emissions from **industry** would decrease between 78% and 91% by 2040 (all compared to 1990 levels). **Transport** emissions are estimated to fall between 53% and 78%, and emissions from **buildings** between 90% and 99% by 2040. In the **agriculture** sector, emissions are expected to decline between 40% and 64% by 2040. **LULUCF** removals increase between 50% and 125%.

In other words, the **reduction pace accelerates drastically in all sectors (Table 1)**. These reduction requirements leave **no room for trade-offs** between sectors. If historic reduction rates would continue until 2040, the reductions would not be sufficient to achieve the required emission levels in any of the 2040 scenarios (second column in Table 1). For example, the energy sector would only achieve a reduction of 70% below 1990, well short of the required 94% to 98%. The last column of Table 1 shows annual reductions required from 2021 on to achieve the higher ambition of sectoral reductions in scenarios.

Table 1: Emissions and sectors in the EU with an outlook to 2040.

Sector	Emissions' share of sector in the EU27 in % (2021)	Emissions compared to 1990 (2021)	Estimated emissions in 2040 compared to 1990 (scenarios)	Average annual change in emissions in % (1990-2021)	Emissions in 2040 compared to 1990 with linear reductions until 2040	Necessary annual reductions to reach max. contribution in 2040 scenarios in %
Energy	26%	-44%	- 94% to - 98%	-1.4%	-70%	-2.9%
Industry	21%	-35%	- 78% to -91%	-1.2%	-59%	-2.9%
Transport	22%	+16%	-53% to -78%	+0.5%	+25%	-4.9%
Buildings	15%	-27%	-90% to -99%	-0,9%	-44%	-3.8%
Agriculture	11%	-22%	-40% to -64%	-0,7%	-34%	-2.3%
Waste	3%	-41%	-50% to -78%	-1,2%	-58%	-2.2%
LULUCF	7%	+10%	Increase of removals by 50% to 125%	+0.3%	+16%	+6.1%

Do these reductions make up for the EU's fair share of global emissions?

As CO_2 stays in the atmosphere for millennia and accumulates, it is the overall amount of emissions over time that determines the atmospheric concentration of GHG and drives temperature increases. In other words: **What matters for the climate is the total amount of emissions and removals over time, less so specific reductions at a certain moment in time expressed in reduction targets.** Emission budgets recognise the fundamental importance of total emission volumes. The European Climate Law (ECL) requires the EU's 2040 climate target to be informed by an indicative EU greenhouse gas emission budget.

The quantification of emission budgets is primarily a political choice that involves many different criteria. Depending on the choice of criteria, **emission budgets vary greatly**. Estimated emission budgets for the EU are either already exhausted or range between 17 Gt CO_2eq and 39 Gt CO_2eq for 2020-2050. The ESABCC recommends a GHG budget of under 14 Gt CO_2eq for 2030-2050. In 2022, EU emissions were about 3.2 Gt CO_2eq.

These great ranges make emission budgets a **difficult basis for policy making**. The ESABCC concluded that even the lowest feasible budget estimates are still higher than the equal per capita emissions' allocations and other fair share estimates based on principles such as 'polluter pays' and 'ability to pay'.

The way forward

For good reasons, the ambition level of the 2040 target and emission budgets will play an important role in the discussion of the 2040 target, but target implementation is also central – even though the details of target implementation will probably only be discussed in 2025. It is very likely that the EU will adopt a **comprehensive package** to implement the new 2040 target. An important element of this package will be the adoption of consistent energy targets as a balance between the reduction of energy consumption and the further increase of the use of renewable energy. This package could be called a "European Green Deal 2.0" or a "European Deal for Sovereignty, Innovation and Prosperity".

Investment, innovation, and deployment will remain essential elements of the 2040 package. After the recent increases in public spending to address the consequences of the COVID-19 pandemic and Russia's war of aggression against Ukraine, however, it is possible that there will be a **period of austerity** in the EU. Public spending could decrease, requiring other sources to finance the required investments for the transition towards climate neutrality.

The upcoming discussion on the 2040 target also needs to clarify **whether an investment package alone can effectively achieve the necessary emissions reductions**. The discussion will have to find honest answers to whether a successful implementation package also includes policies that **scale down economic activities** that cannot deliver the required reductions in time with investment and technological advancement alone. Considering the technological constraints to reduce emissions from sectors such as aviation, agriculture, road transport, and the use of emission-intensive materials, the discussion should also address how to support these sectors when they enter a phase of reduced economic output.

1 Introduction

The European Climate Law (ECL) obliges the EU to adopt a **legally binding climate target for 2040**. To this end, the ECL states that the Commission presents a proposal by May 2024 - i.e., within six months of the first global stocktake. The ECL establishes many criteria that the Commission must take into account in its proposal, such as environmental impacts, cost effectiveness, fairness between Member States and international development. The proposal will be based on a detailed impact assessment in which the Commission must also consider progress made in Member States and the results of the global stocktake.

Moreover, the Commission's proposal must consider an **indicative EU greenhouse gas (GHG) emission budget for the period 2030-2050**. The ECL defines this emission budget as the indicative total volume of net GHG emissions "likely to be emitted during this period without jeopardizing the Union's commitments under the Paris Agreement"[1]. This emission budget takes into account the advice that the European Scientific Advisory Board on Climate Change (ESABCC) published on 15 June 2023[2]. The Commission must present this emission budget at the same time as its proposal for the 2040 target. In accordance with the EU's obligations under the Paris Agreement, the EU should communicate its next nationally determined contribution (NDC) with commitments going beyond 2030 nine to twelve months before the 30th UN Conference of the Parties (COP 30) in November 2025.

The 2040 target is an **essential milestone for the EU's journey towards climate neutrality** by 2050 and net negative emission thereafter. To maintain a realistic chance of reaching these targets, it is indispensable that the 2040 target establishes steep net reduction obligations. Such a steep reduction will have far-reaching consequences for Europe's economies and societies. It will have profound implications for all economic sectors, notably transport, agriculture, industry, and buildings. This will accelerate innovation and will require significant investments. It will improve overall efficiency.

Because of the profound changes, the **political discussion on the target is currently gaining momentum, though only slowly**. The Commission started public consultations on the target which closed in June 2023. Until now, the broader public has hardly taken notice of this discussion. There is barely a public discourse on the 2040 target and its ambition, let alone on its implementation. Unless the public debate gains momentum quickly, this will become a problem. The necessary 2040 framework requires a broad public discussion – a prerequisite for high public acceptance and legitimacy. It cannot be the result of a technical discussion between the Commission, Council, Parliament and a few interest groups and scientists.

For the **further political process**, it is expected that the current Commission will publish a communication outlining the options and ranges of the 2040 target. An impact assessment is set to accompany this communication. This communication will be presented shortly before the next European Parliament **elections in May 2024** and at the end of the term of the current Commission. This temporal constellation has important implications for the further political process.

[1] European Parliament and Council of the European Union, 2021
[2] European Scientific Advisory Board on Climate Change, 2023

In light of this communication, it will probably be the next Commission's responsibility to present the legislative proposal for the 2040 target for consideration and decision by the European Parliament and the Council. It will also be the next Commission that will propose the measures required to achieve the target for 2040. Since the next Commission is only expected to take office at the end of 2024, these measures could be proposed in late 2025 or early 2026, perhaps as a comprehensive package, possibly dubbed **a "European Green Deal 2.0" or a "European Deal for Sovereignty, Innovation and Prosperity"**.

To contribute to the political debate, **this paper provides an overview of key elements relevant for the discussion of the 2040 target**. In its second chapter, the paper discusses the relevance of the 2040 target for the EU's broader strategic discussion on its future, prosperity, and sovereignty. Chapter 3 discusses emission budgets, while chapter 4 focusses on possible levels of ambition of the 2040 target and target design options. The subsequent chapters discuss Member State contributions to the 2040 target (chapter 5) and sector contributions to this target (chapter 6). Although the 2040 climate target will need to be supported by a set of energy 2040 targets, e.g. for the use of renewable energy and energy consumption, this paper only focusses on climate aspects. The discussion of consistent energy targets requires a deep reflection of options and correlations which exceed the scope of this document.

2 European Sovereignty: The case for a strong 2040 target

Clearly, the **discussion of the EU's 2040 energy and climate targets is not solely about EU climate policies**. It holds significant implications for many other policy fields. Nearly all of the **EU's strategic challenges are related to the 2040 target and its implementation.** The target will have significant effects on energy security, as well as critical raw materials and food supply import dependencies. It will also have implications for other issues central to the well-being of the EU, such as migration, social cohesion, demographic change, and biodiversity. Additionally, the 2040 target can impact the EU's standing in the world, and its relationship with authoritarian regimes. It can affect important sources of revenues of authoritarian regimes and – hence – their capabilities to destabilise democracies. Last but not least, the target is central for addressing the climate crisis itself – one of Europe's greatest strategic challenges.

In essence, the discussion on the 2040 target is at the core of the **discussion on European sovereignty and the EU's strategic autonomy**, i.e., the EU's ability to act independently in global affairs and to promote its own values and interests in a new international context that is marked by new challenges to democracy, competition between the great powers resulting in trade tensions and geopolitical instability. This discussion has grown ever more important with Russia's war of aggression against Ukraine and an increasingly authoritarian and assertive China. The US Inflation Reduction Act and its boosting effects for the competitiveness of the United States has added to the challenge.

At its informal meeting in Versailles in 2022, the **European Council** decided to take "decisive steps towards building our European sovereignty, reducing dependencies and

designing a new growth and investment model for 2030[3]." To this end, the European Council decided to, inter alia, reduce energy dependencies and to make Europe's "economic base more resilient, competitive and fit for the green and digital transitions". Strategic dependencies should be reduced, particularly in the most sensitive areas such as critical raw materials or semi-conductors.

2.1 Energy security and energy costs

The EU is heavily dependent on energy imports. In 2019, for example, the EU imported 60.6% of the energy it consumed - the highest level in 30 years[4]. In 2022, international prices for coal reached **record levels.** Prices for spot purchases of natural gas reached levels never seen before, regularly exceeding the equivalent of USD 250 for a barrel of oil[5]. These record high energy prices dealt a significant blow to the EU's economy and public finance. EU governments spent €634 billion supporting customers through the energy crisis[6]. It is not clear to what extent energy prices will remain at similarly high levels as projections of future energy costs differ considerably[7].

However, while the forecast of future energy prices is uncertain, one issue is not: **prices for fossil fuels will remain very volatile**. They heavily depend on geopolitical tensions, supply chain disruptions, changes in government policies, advancements in technology, and unexpected events such as pandemics, wars, or natural disasters. It is very likely that the next crisis will send energy costs skyrocketing again – with significant implications for all countries, particularly the ones with limited economic resources. The extreme volatility of prices of fossil fuels is exacerbated by the fact that large shares of fossil fuel imports come from authoritarian countries and unstable regions – with Saudi Arabia, Iran, Qatar, Venezuela, and Nigeria still being important providers of energy.

Although the EU has increased the share of fossil fuel **imports** from Norway, the US and other **stable countries**, purchases from these new sources will remain costly and not necessarily address the problem of price fluctuation.

In contrast, prices for **renewable energy technologies** have only gone downwards. Between 2010 and 2019, the cost of photovoltaics dropped by 82% and of onshore wind by 29%, and their costs are expected to continue to decline[8]. It is noteworthy that the IEA has often underestimated the pace of projected cost declines for renewable energy technologies in the past[9].

It should be noted that the ESABCC stated that primary fossil energy imports are projected to **decrease by 65-93% below 2019 levels by 2040**, with imports of fossil gas largely eliminated, and imports of fossil oil reduced by 60-80% compared to 2019 levels[10]. The reduction of energy demand and improved energy efficiency, as well as the increased use of renewable energy, will further boost EU energy security.

[3] Versailles Declaration: https://www.consilium.europa.eu/media/54773/20220311-versailles-declaration-en.pdf
[4] European Commission, 2021a
[5] IEA, 2022
[6] Sgaravatti, 2023
[7] IEA, 2022
[8] IRENA, 2020
[9] Garfield, 2017
[10] ESABCC, 2023

2.2 Circular economy, climate policies and dependency on critical raw materials

The EU is not only heavily dependent on imports of fossil fuels, but also of critical raw materials such as nickel, copper, lithium, and rare earth elements. These are essential for high-tech and strategic industries such as energy, electric mobility, machinery, and IT. Without them, it is inconceivable that Europe's economy remains competitive and prosperous. More than **90% of the EU's supply** often comes from a single third country – e.g., 100% of heavy rare earth elements originate from China.[11]

In tandem, **circular economy and climate policies can help reduce this dependency**. The EU´s 2040 climate target can be a strong driver to realise the circular economy, decreasing dependency on critical raw materials. Implementing circular economy strategies in the mobility, food and built environment sectors, for example, could reduce CO_2 emission by 48% by 2030 and 83% by 2050[12]. Reducing demand for primary materials through various circularity measures has the potential to reduce GHG emissions from industry in the EU by almost 300 Mt/year by 2050[13]. Globally, implementing circular economy strategies could reduce GHG emissions by 3.6 Gt CO_2eq per year.[14]

2.3 Fossil fuels fund authoritarian regimes and war

The authoritarian challenge is another strategic test that the EU – as well as other democracies – face. This challenge could define the next decades as China and other authoritarian regimes are expected to gain influence – globally or regionally. Many factors fuel the gain of strength of these countries. **Revenues from and dependence on fossil fuels and critical material exports are two particularly important factors.**

In **Russia**, for example, revenues from oil and gas accounted for 45% of the country's federal budget in 2021 and around 17% of its GDP[15]. In **Saudi Arabia**, oil accounts for over 40% of the country's GDP and over 80% of its export income[16]. **Iran** is another example, where oil exports account for around 80% of export revenues and around 30% of the country's GDP[17]. These three countries are, to very different extents, at the heart of major international armed conflicts – in the war of aggression against Ukraine and the civil wars in Yemen and Syria, or in funding international terrorism.

2.4 Security of food supply

The increasing occurrence of extreme weather and climate events **exposes millions of people to acute food insecurity and reduced water security, according to the IPCC**[18]. Roughly half of the world's population experiences severe water scarcity[19]. The most

[11] European Commission, n.d-a
[12] Ellen MacArthur Foundation, 2015
[13] Material Economics, 2018
[14] Material Economics, 2018
[15] IEA, 2022a
[16] Schaer, 2022
[17] US Energy Information Administration (EIA). (2021). Iran. https://www.eia.gov/international/analysis/country/IRN
[18] IPCC, 2023
[19] IPCC, 2023

adverse impacts occur particularly in poor regions in Africa, Asia, and Central and South America. The devastating 2022 floods in Pakistan, for example, destroyed nearly half its crops, at an estimated cost of $2.3 billion, and vegetable prices initially spiked by 500%[20]. The drought in the Horn of Africa has caused millions to move away from the stricken areas in search of food.

While most negative impacts occur in poor countries, **rich countries are also affected**. Climate impacts have led to poorer harvests and higher production costs in all parts of Europe, mostly in southern Europe[21]. The 2022 heatwaves in the UK, France, Italy, Spain, and Germany severely damaged summer crops such as maize, sunflower and soybeans[22].

The **forecast is even grimmer**. Yields of non-irrigated crops such as wheat, corn and sugar beet are projected to decrease in southern Europe by up to 50% by 2050, resulting in a substantial drop in farm income by 2050[23]. Farmland values could decrease in parts of this region by more than 80% by 2100, which could result in land abandonment. With large regional differences, climate change impacts on agriculture could decrease average GDP by up to 1% by 2050.

2.5 Migration and climate change

According to the United Nations High Commissioner for Refugees (UNHCR), the displacement of people due to floods, storms, wildfires, and extreme temperatures **averaged 21.5 million annually between 2008 and 2016**[24]. While many factors contribute to people leaving their homelands, it is highly certain that climate change will exacerbate displacement[25], including in neighbouring regions of Europe. The impact of climate change is expected to intensify migration pressures in Northern Africa, the Middle East, and the western Sahel.[26] In the coming decades, heatwaves in these regions, for example, could surpass human physiological and social thresholds[27], leading to mass migration and immense human suffering.

Considering that migration still stands as one of the most contentious political issues within the EU, it remains uncertain how the EU and its **Member States will address an additional surge in refugee numbers**. Although Member States theoretically possess the capacity and resources to accommodate a significantly larger refugee population, the political consequences of such an influx are unpredictable but are likely to destabilise both the EU and its Member States.

2.6 Energy poverty and demographic change

In 2020, approximately **36 million people** in the EU – or 8% of the population – faced challenges in adequately heating their homes. Utility bill arrears affected around 6% of the EU population, and nearly 13% of the population resided in dwellings with leaks, dampness,

[20] Carbon Brief, 2022
[21] EEA, 2019
[22] Barclays, 2023
[23] EEA, 2019
[24] UNHCR, 2016
[25] McAllister, 2023
[26] European Parliament, 2022
[27] IRFC, UN OCHA, Climate Centre, 2022

or rot in 2019. In 2018, the lowest 10% income bracket spent 8.3% of their expenditure towards energy costs[28]. While energy costs were already a significant burden in recent years, the excessive price increases in 2022 disproportionately affected the poor.

Energy poverty is exacerbated by the fact that the **EU's population is projected to continue ageing and shrinking in the coming decades**. By 2050, the EU's population is expected to be at 448 million - or 7 million less than in 2020. At the same time, the proportion of people aged 65 or over is projected to increase from 20,8% in 2021 to 29,5% in 2050, while the proportion of people aged 15-64 is expected to decline from 63,8% in 2022 to 56,8% in 2050[29].

This demographic change can have a **significant impact on energy poverty** as older people are particularly affected by it. They often have lower incomes, live in poorly insulated homes and are more susceptible to health problems associated with cold homes. Energy poverty can exacerbate social exclusion[30]. It should also be noted that climate change affects the poor at a disproportionately higher rate as they frequently suffer from poor health conditions and work outside more often.

The **energy transition can help mitigate these challenges**. Improving the energy efficiency of buildings alone could lift millions of people out of energy poverty in the EU. For every 1% increase in the energy efficiency targets, 7 million people can be lifted out of energy poverty[31].

3 The EU's fair share: remaining emission budgets

3.1 Remaining global emission budget

The IPCC estimates that the remaining global carbon budget from the beginning of 2020 is between 500 Gt CO_2 (50% likelihood of 1.5°C) and 1150 Gt CO_2 (67% likelihood of 2°C) (Figure 1). These estimates consider the transient climate response to cumulative carbon emissions (TCRE, or the global temperature change per tonne of emitted CO_2) and its uncertainty, as well as historical warming, climate system feedbacks, the global temperature change after net zero, and non-CO_2 emissions. According to one recent report, the remaining budget has nearly been halved, as all parameters worsen faster than anticipated.[32]

[28] Widuto, 2022
[29] Eurostat, 2021
[30] Widuto, 2022
[31] https://friendsoftheearth.eu/wp-content/uploads/2021/05/Towards-a-healthy-renovated-Europe.pdf
[32] https://www.igcc.earth/

Figure 1: Estimates of historical CO2 emissions and remaining carbon budgets.

Global Warming Between 1850–1900 and 2010–2019 (°C)		Historical Cumulative CO_2 Emissions from 1850 to 2019 ($GtCO_2$)					
1.07 (0.8–1.3; likely range)		2390 (± 240; likely range)					
Approximate global warming relative to 1850–1900 until temperature limit (°C)[a]	Additional global warming relative to 2010–2019 until temperature limit (°C)	Estimated remaining carbon budgets from the beginning of 2020 ($GtCO_2$) *Likelihood of limiting global warming to temperature limit*[b]					Variations in reductions in non-CO_2 emissions[c]
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

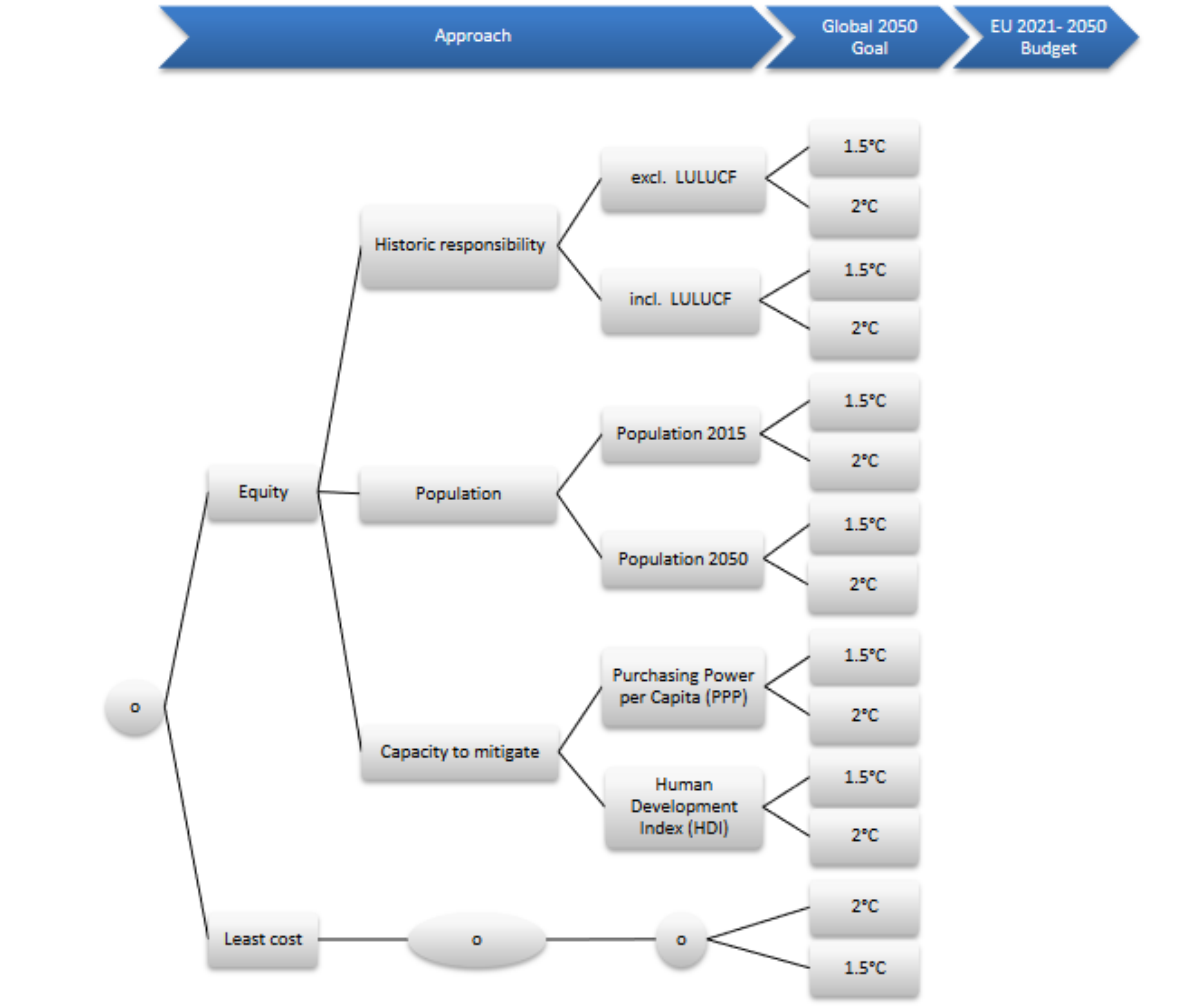
Source: IPCC, 2021.

3.2 Criteria for distributing global emission budgets

The distribution of the global emission budgets to countries is a **political choice or – according to the ESABCC – a value judgement**. This political choice involves a range of different criteria, including least-cost considerations or equity considerations, such as historical emission, per capita emissions, or polluter-pays principle.

The following graphic provides an overview of possible criteria and their combination – as depicted in Figure 2.

Figure 2: Possible criteria for emission budget estimation.



Source: Meyer-Ohlendorf et al., 2018.

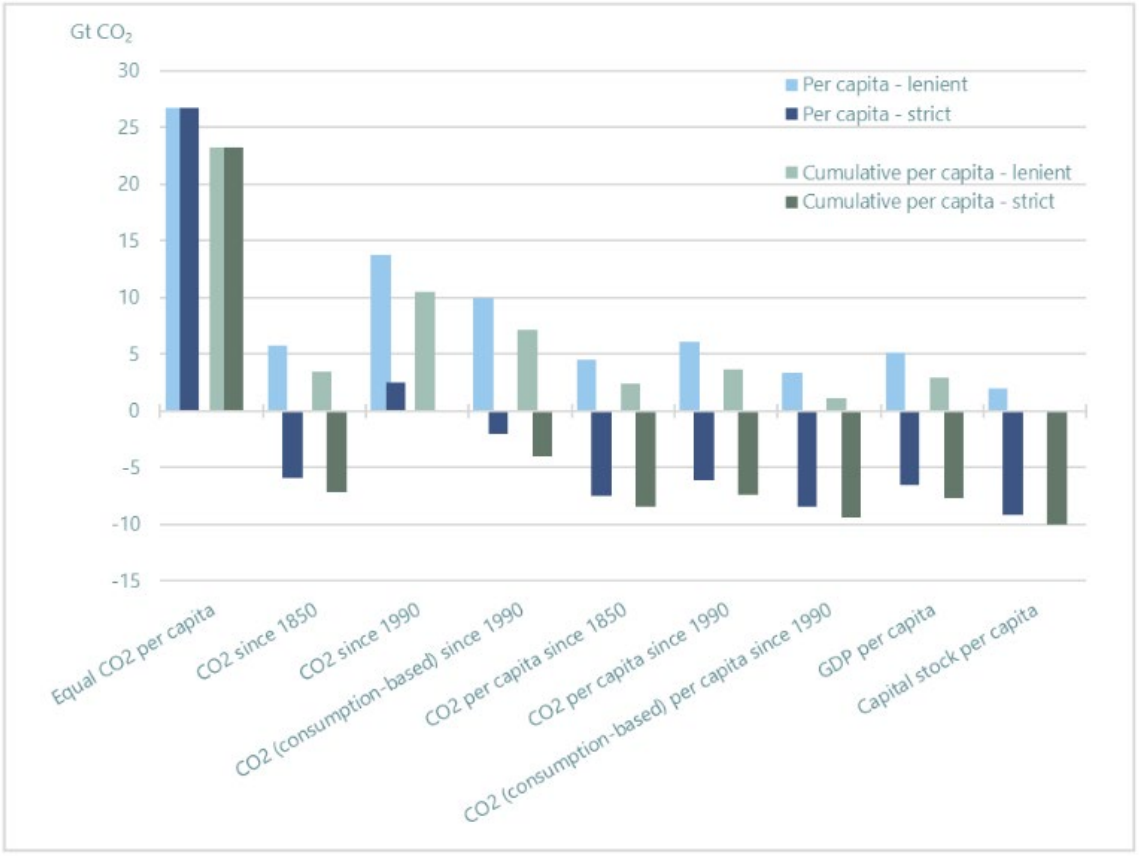
Depending on the political choice of criteria, or their weighting and combination, emission **budgets for countries differ hugely**[33]. Effort-sharing proposals largely based on equity considerations distribute the remaining emission budget in a completely different manner than proposals based primarily on least-cost considerations. Emission budgets also differ drastically depending on whether they are intended to contribute to 1,5°C or 2°C goals or whether they assume high or low probabilities of achieving these goals. There are also great differences if emission budgets include all GHG or only CO_2. Due to scientific advancements, budget estimates change constantly.

According to the **ESABCC**, the highest EU emission budgets are associated with equal per capita allocation of emissions, while approaches based on historical emissions result in much lower or even negative emission budgets for the EU. In cases of negative emission budgets, the EU's fair share would already be exhausted.

Figure 3 contains an overview of EU fair share carbon budget estimates from 2020, according to different principles and allocation methods[34].

[33] Meyer-Ohlendorf et al., 2018
[34] ESABCC

Figure 3: Implied EU greenhouse gas emission budgets for 2030-2050 and 2040 emission reductions for different ranges of scenarios.



Source: ESABCC, 2023.

3.3 Estimated EU emission budgets

The European Scientific Advisory Board on Climate Change recommends a GHG emission budget between **11 and 14 Gt CO_2eq** between 2030 and 2050.

For the same period, Agora Energiewende's EU Gas Exit Pathway achieves an EU emission budget of **14.3 Gt CO_2eq GHG emissions**.

For 2020-2050, the Air Pollution & Climate Secretariat (AirClim) estimates the EU emission budget under current EU targets and policies to be **39 Gt CO_2eq**. AirClim also calculates what the remaining budget would be based on policy proposals by CAN Europe and concludes that the total CO_2 budget for the EU would be around **19 Gt CO_2eq** for the period 2020-2050.

Considering CO_2 emissions only, the German Advisory Council on the Environment calculates EU emissions budgets for the period 2020 to 2050 of **17.1 Gt CO_2** (67% likelihood of 1.5°C), **23.1 Gt CO_2** (50% likelihood of 1.5°C) and **39.5 Gt CO_2** (67% likelihood of 1.75°C).

Table 2 provides a summary of budget assumptions. Additional information is included in figures in Annex A.

Table 2: Summary of emission budgets' assumptions for EU27.

	Emission budget (in Gt CO_2eq)	Emission type	Timeframe	Scope	Assumptions
European Scientific Advisory Board on Climate Change (2023)	11.1	GHG	2030-2050	Includes LULUCF and technical removals	'Mixed options' pathway (-90.8% GHG emission reductions in 2040)
	11.7				'Demand-side focus' pathway (-91.2% GHG emission reductions in 2040)
	13.8				'Renewable energy' pathway (-90.9% GHG emission reductions in 2040)
Agora Energiewende (2023)	14.3	GHG	2030-2050	Includes LULUCF	
AirClim (Trio, 2022)	19	GHG	2020-2050	Include LULUCF	Based on CAN Europe policy proposals. Calculated assuming that from 2030 onwards total removals from LULUCF would remain stable at 600 Mt CO_2/year.
	39				Value under current EU targets and policies
German Advisory Council on the Environment (2022)	17.1	CO_2	2020-2050	Include LULUCF. Do not include aviation and shipping, imports/exports, negative emissions or international budget trade.	67% likelihood of 1.5°C
	23.1				50% likelihood of 1.5°C
	39.5				67% likelihood of 1.75°C

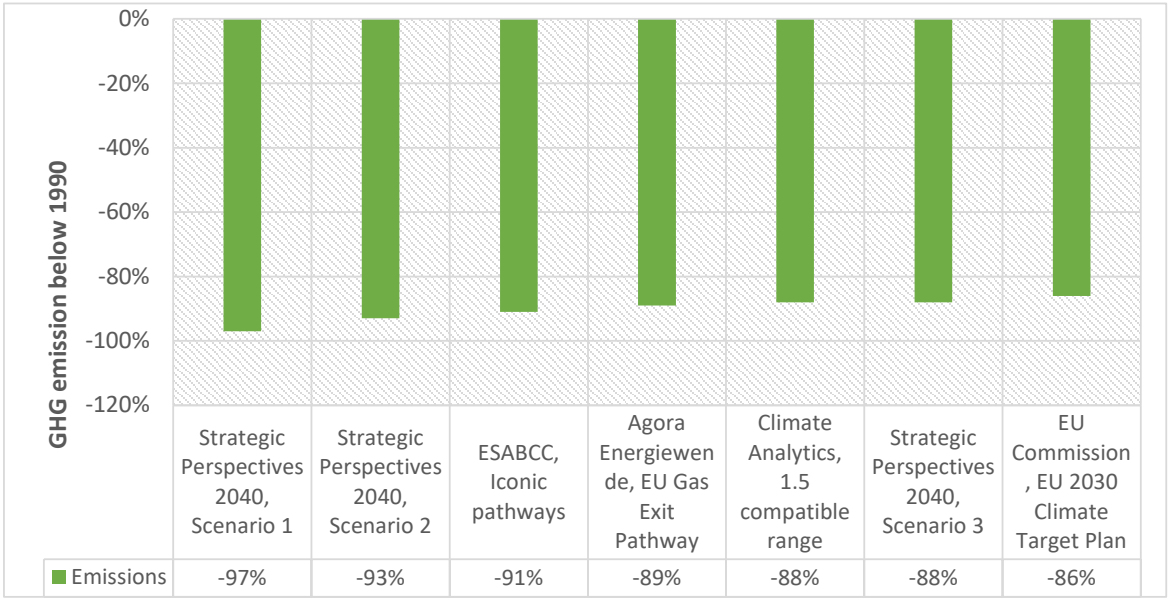
4 2040 target: The level of ambition

This chapter provides an overview of the scenarios available for the 2040 emission reductions targets. Starting from this, it discusses Member State contributions to the 2040 climate target scenarios. For this purpose, in a first step, it explores the **existing national targets** for **2040**, as enshrined in national climate laws or in national climate strategies[35]. In a second step, it discusses whether there is a **gap between existing national commitments and EU climate target options**.

4.1 Emission levels in 2040 in different EU-wide scenarios

An analysis of seven scenarios compatible with climate neutrality by 2050 revealed a range of options for GHG emissions in 2040, spanning from **-86% to -97%** (Figure 4) – or an average of -90%.

Figure 4: Scenarios for GHG emissions in 2040.



Note: All scenarios include LULUCF and exclude emissions from international transport.

The following table summarises scenarios' assumptions, data sources and key elements.

Table 3: Scenarios for 2040 GHG emissions.

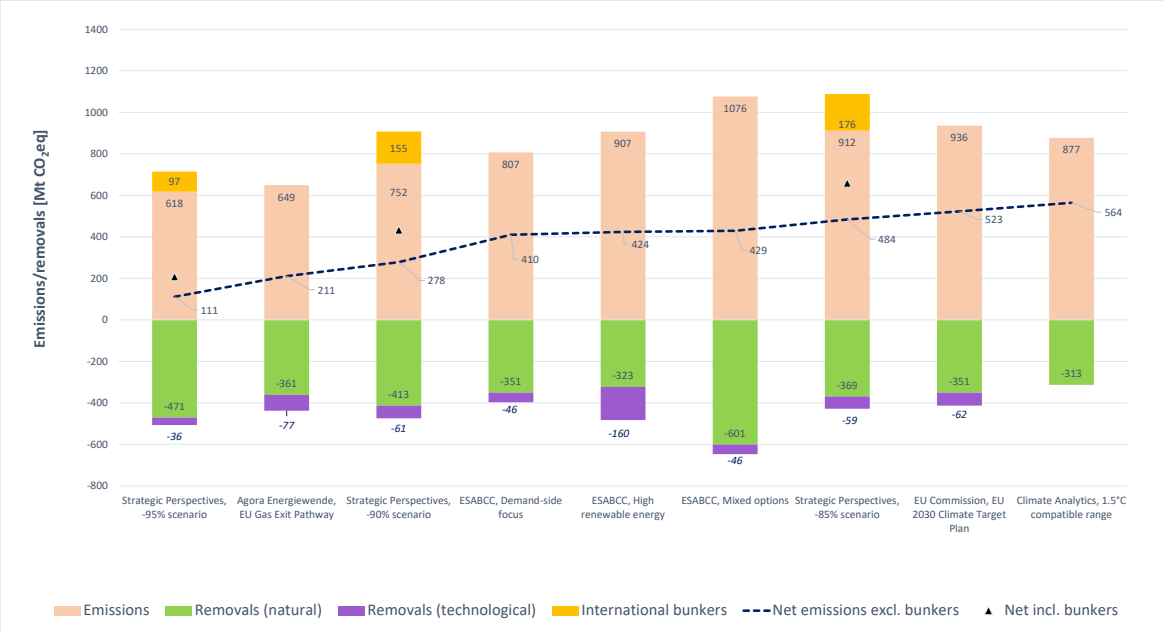
Scenario	GHG emissions	Data source
Strategic Perspectives 2040, -95% net scenario: Based on the -90% net scenario, with more ambition for societal changes and some technological breakthrough.	**-95% incl. int. transport, 97% without.**	Kalcher et al. (2023)

[35] National climate laws and their targets were considered due to their legally binding nature. National long-term climate strategies (LTSs) were chosen over national energy and climate plans (NECPs), due to LTSs presenting a longer-term outlook and generally being more current than NECPs. The latter are pending revision in 2024. No other national documents and potential language on a 2040 target that they may include were examined.

European Scientific Advisory Board on Climate Change (ESABCC), Iconic pathways: a set of three pathways, chosen to demonstrate the different societal choices and mitigation approaches that the EU may follow on its path to climate neutrality.	**-91%**	European Scientific Advisory Board on Climate Change (2023)
Strategic Perspectives 2040, -90% net scenario: Requires the EU to maintain the same pace of decarbonisation after 2030, maximises the electrification potential across sectors, sets clear phase-out milestones for gas consumption, endorses circularity, relies on technological innovation driven through policies and keeps a conservative approach on societal choices.	**-90% incl. int. transport, 93% without.**	Kalcher et al. (2023)
Agora Energiewende, EU Gas Exit Pathway: Long-lasting demand reductions, increased climate investments and a phase-out of fossil fuels.	**-89%**	Graf, A., Gagnebin, M. & Buck, M. (2023)
Climate Analytics, 1.5°C compatible range: Middle of a 1.5°C compatible range, which demonstrates the highest plausible ambition for Europe.	**-88% excl. LULUCF**	Climate Analytics (2022)
EU Commission, EU 2030 Climate Target Plan: Included in the proposal to raise the EU's ambition on reducing GHG emissions to at least 55% by 2030 and provides projections for 2040.	**-86%**	European Commission (2020)
Strategic Perspectives 2040, -85% net scenario: Based on the -90% net scenario, with lower ambition for societal changes and some technological breakthrough.	**-85% incl. int. transport, 88% without.**	Kalcher et al. (2023)

The scenarios offer further insights into the expected GHG emissions and removals in 2040 (Figure 5). These pathways indicate that **net GHG emissions** range from 111 Mt CO_2eq (-95% net scenario excl. international transport) to 564 Mt CO_2eq (Climate Analytics, 1.5°C compatible range), with **natural removals** ranging from 313 Mt CO_2eq (Climate Analytics, 1.5°C compatible range) to 601 Mt CO_2eq (ESABCC, Mixed options) and **technical removals** ranging from approximately 36 (-95% net scenario) to 160 Mt CO_2 (High renewable energy). The three Strategic Perspectives scenarios also provide values for GHG emissions from international bunkers – 97 Mt CO_2eq for the -95% net scenario, 155 Mt CO_2eq for the -90% net scenario and 176 Mt CO_2eq for the -85% net scenario.

Figure 5: Scenarios for GHG emissions and removals in 2040.



Own depiction based on data from 2040 scenarios.

The reduction pace in all scenarios and sectors **accelerate drastically** compared to historic rates. Annual average reductions between 1990 and 2020 were about 55 Mt CO_2eq or 1.1% of 1990 emissions[36]. The EEA anticipates that this reduction rate needs to increase to 134 Mt CO_2eq or 2.9% of 1990 emissions to achieve the 2030 target of net -55% compared to 1990[37]. Meeting a new 2040 target entailing a reduction of 90% will require an even more accelerated annual reduction rate: In absolute terms, emissions need to decrease by 164 Mt CO_2eq, or 3.5% of 1990 emissions.

4.2 Member State contributions to the 2040 target as already existing in national law and policies

Most Member States have targets for 2050[38] but only 16 Member States have commitments for 2040. Out of these 16 Member States, **five** have a quantified and legally binding GHG emissions **reduction target for 2040 in place**. These countries are Finland, Germany, Greece, Portugal, and Sweden.

Another five Member States – Estonia, Latvia, Lithuania, Malta, and Romania - provide **indicative targets for 2040 in their LTSs**. Unlike targets set in law, indicative targets in LTSs are legally non-binding and only carry political weight.

The LTSs of Bulgaria, Croatia, Czechia, Hungary, Slovakia, and Slovenia **do not feature indicative targets, but only outcomes of scenarios** describing possible reduction

[36] These numbers refer to a target scope of net GHG emissions including international aviation.
[37] EEA, 2022
[38] Bulgaria and Croatia do not have a 2050 target in either their climate laws or LTSs, while Poland does not have a law and has yet to submit an LTS, meaning it does not have a 2050 climate target.

pathways[39]. However, these scenario outcomes do not politically commit the countries to a 2040 pathway.

The other 11 Member States make no mention of 2040 reduction commitments, neither in law nor in LTS. Additionally, Austria has set a 2040 climate neutrality target in its 2020-2024 government programme – however, this target has not been quantified and its status at present is not legally binding.

Targets and milestones for 2040 **differ significantly** – from Germany's 88%, stipulated in its climate law, to Malta's 60% "indicative milestone" and Croatia's LTS scenarios, where reductions range between 44.8% and 50.9%. Romania's LTS features the most ambitious 2040 milestone: 91% emission reductions compared to 1990.

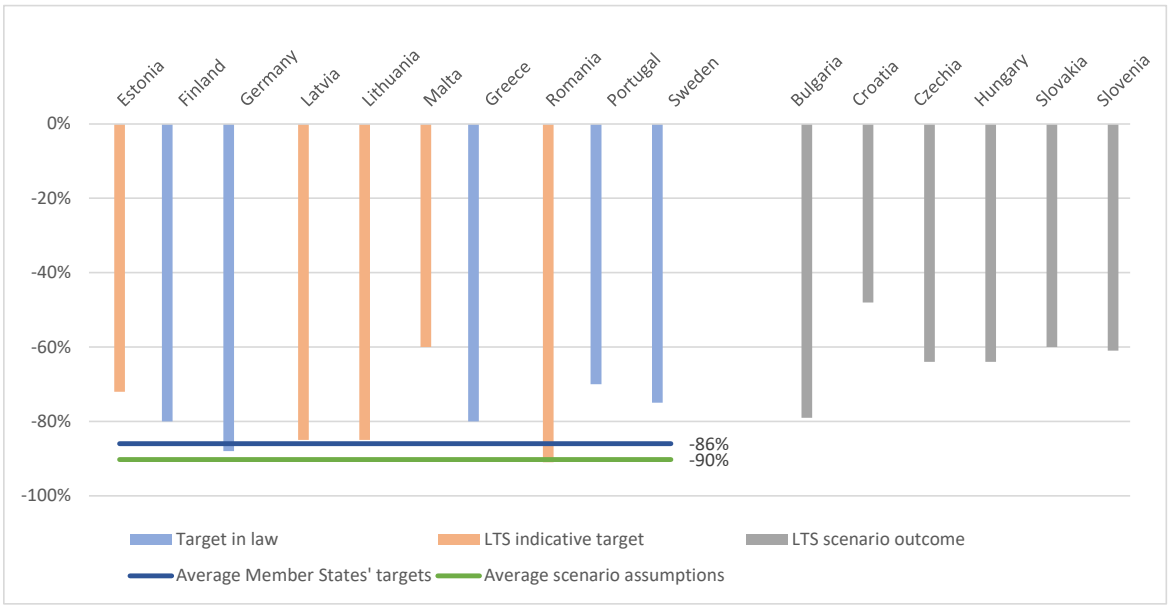
4.3 The gap between 2040 target scenarios and existing national commitments

There are **significant caveats to estimating a gap** between 2040 target scenarios and existing national commitments. 11 Member States make no mention of a 2040 target – neither in a climate law nor in an LTS. In addition, the LTSs of six Member States do not commit to any reduction pathways as they only feature descriptive scenarios on the 2040 target.

Based on weighted average national commitments, the differences between average scenarios for a 2040 climate target and the existing commitments set by individual Member States is small. While the average emissions of the scenarios as presented in Figure 5 is -90%, Member States' commitments average at -86%, **entailing a gap of 4 percentage points** (Figure 6). The gap might, in fact, be smaller, because not all MS targets include removals from land-use activities in their (indicative) target. For example, the German 88% target only covers emissions; in addition, there is a separate removal target of 35 Mt CO_2 for natural removals and the option to include technical sinks in the future. Despite this, the ambition of some of the countries which have already committed to a target might not be sufficient in light of their economic position and historic responsibilities.

[39] Slovakia's 60% target for 2040 is taken from a scenario which does not meet the country's 2050 target.

Figure 6: 2040 GHG emission reductions targets and scenario outcomes of EU Member States, compared to the average scenario assumptions for 2040.



5 Sector contributions to the 2040 climate target

Various scenarios examine contributions of economic sectors to achieving an EU 2040 target. Table 4 presents an overview of six scenarios and their assumptions about sectoral GHG emissions in 2040. The emissions depicted here cover anthropogenic emissions from various sources, as accounted for in GHG inventories. One source, with a strong decreasing share of total emissions, is the use of energy for all types of activities in and across a large part of sectors displayed below. The development of energy consumption and the use of various types of energy sources on the supply side are the determining parameters for resulting emissions. A comparison of these aspects would exceed the scope of this paper. Therefore, the focus is on emissions which result from all modelling parameters and assumptions.

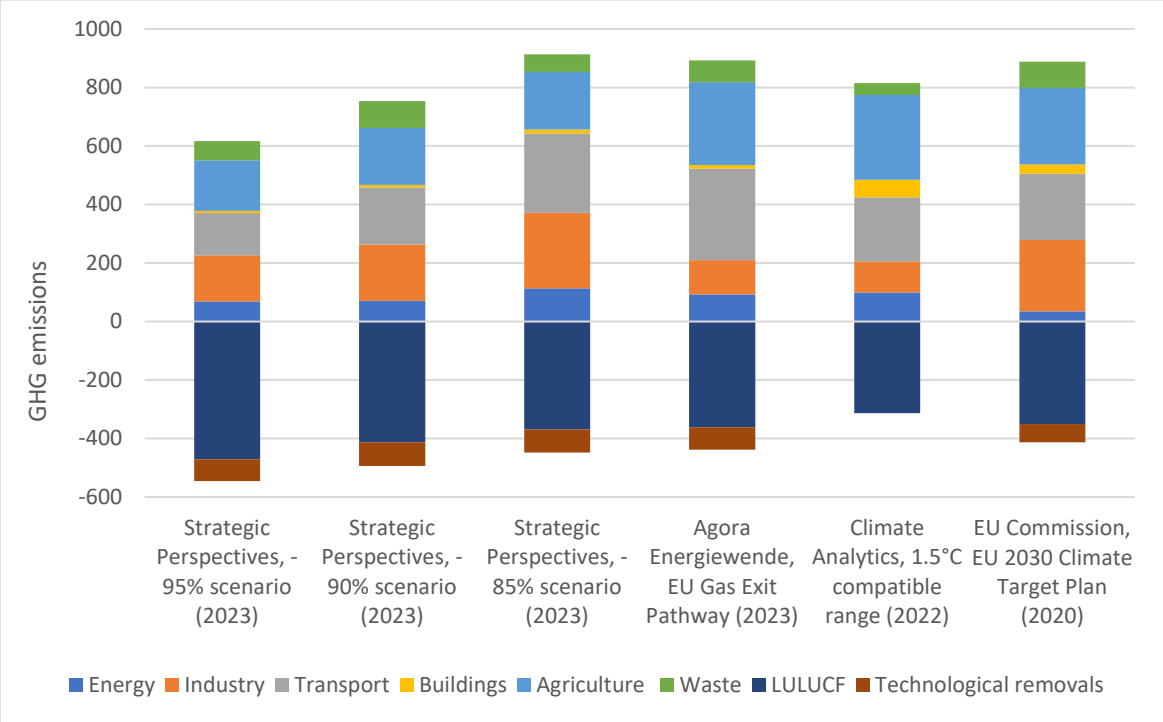
Table 4: Assumptions for sectoral emissions (in Mt CO_2eq) according to 2040 scenarios[40].

Sector	Strategic Perspectives, **-95% net scenario (2023)**	Strategic Perspectives, **-90% net scenario (2023)**	Strategic Perspectives, **-85% net scenario (2023)**	Agora Energiewende, **EU Gas Exit Pathway (2023)**	Climate Analytics, **1.5°C compatible range (2022)**	EU Commission, **EU 2030 Climate Target Plan (2020)**	Estimated reductions in 2040 compared to 1990
Energy	69	71	114	93	99	35	94% - 98%
Industry	157	192	258	117	106	244	78% - 91%
Transport	145	195	271	313	219	226	53% - 78%

[40] Values by sector are not always directly comparable because the different studies might define the scope of each differently. For example, district heating might be included under energy or the buildings sector.

Buildings	7	9	13	12	60	32	90% - 99%
Agricul-ture	173	195	197	283	290	261	40% - 64%
Waste	66	92	60	75	41	90[41]	50% - 78%
LULUCF	-471	-413	-369	-361	-313	-351	increase by 50% - 125%
Techno-logical re-movals	-36	-61	-59	-77	-	-62	n/a

Figure 7: Summary of sector contributions to the 2040 climate target.



Own depiction based on projections.

5.1 Energy

Power and heat production, oil and gas extraction and refining, and coal mining remain the **largest emitters** of GHG emissions in the EU (26% of emissions in 2021), despite significant reductions over the last decades[42]. According to EEA calculations, between 2005 and 2020, emissions in the sector decreased by 43% and in 2021 stood at 902 Mt CO_2eq.

Six scenarios envision energy production emissions between 35 Mt CO_2eq (EU Commission, EU 2030 Climate Target Plan) and 114 Mt CO_2eq (Strategic Perspectives, -85% net scenario) in 2040. To achieve these projections, the EU would have to cut emissions

[41] Includes "non-CO_2 other".
[42] European Environment Agency (2023)

between 94% (-85% net scenario) and 98% (EU 2030 Climate Target Plan) compared to 1990 levels.

Based on an analysis of 36 scenarios, the ESABCC expects reductions in final energy demand **between 21% and 42% by 2040 compared to 2019 levels.** The report does not provide data on emission reductions.

Table 5: Scenarios' assumptions for emissions from *energy* in 2040.

	Estimated emissions in 2040 (Mt CO_2eq)	Estimated emissions in 2040 compared to 1990 [43]	Assumptions on measures and drivers	Data source
Strategic Perspectives, **-95% net scenario (2023)**	69	-96%	• Demand reduction and energy efficiency • PV and wind energy nearly multiplies by a factor of 7 between 2020 and 2040. • Direct Air Capture (DAC) is considered too energy-intensive and expensive until 2040. • Agriculture and forestry-waste contribute to energy production.	Kalcher et al. (2023)
Strategic Perspectives, **-90% net scenario (2023)**	71	-96%		
Strategic Perspectives, **-85% net scenario (2023)**	114	-93%		
Agora Energiewende, **EU Gas Exit Pathway (2023)**	93	-94%	• The power sector is quickest to reduce its consumption of fossil gas through wind and solar. • Power demand increases by 48% by 2040 due to the electrification of transport, buildings and industry. • 84% RE in 2040	Graf, A., Gagnebin, M. & Buck, M. (2023)
Climate Analytics, **1.5°C compatible range (2022)**	99	-94%	• Electrification and reduction of energy demand • Fossil fuel phase-out by 2035 • Rapid roll-out of wind and solar energy	Climate Analytics (2022)
EU Commission, **EU 2030 Climate Target Plan (2020)**	35	-98%	n/a	European Commission (2021)

[43] European Environment Agency (2023)

5.2 Industry

The industrial sector is accountable for 21% of the emissions in the EU, but its contribution increases when taking into account indirect emissions from power consumption, fossil fuel extraction and transportation, and waste disposal through incineration[44]. Industry is one of the sectors with substantial emission reductions in recent years. In 2020, emissions from industry **decreased by 39%** compared to 1990[45].

For 2040, six scenarios project the sector to reduce its emissions **between 78% (-85% net scenario) and 91% (1.5°C compatible range)** in comparison to 1990. In 2040, industrial emission would range between 106 Mt CO_2eq (Climate Analytics, 1.5°C compatible range) and 258 Mt CO_2eq (Strategic Perspectives, -85% net scenario).

The ESABCC report shows that CO_2 emissions from the industrial sector decrease between 78% and 106% in 2040 compared to 2019 levels.

Table 6: Scenarios' assumptions for emissions from *industry* in 2040.

	Estimated emissions in 2040 (Mt CO_2eq)	Estimated emissions in 2040 compared to 1990	Assumptions on measures and drivers	Data source
Strategic Perspectives, **-95% net scenario (2023)**	157	-87%	• Use of raw materials with efficiency and promotion of circularity. • Increase in recycling. • Alternative fuels used for feedstock production and limited for energy supply. • Carbon capture only applied to the remaining process emissions.	Kalcher et al. (2023)
Strategic Perspectives, **-90% net scenario (2023)**	192	-84%		
Strategic Perspectives, **-85% net scenario (2023)**	258	-78%		
Agora Energiewende, **EU Gas Exit Pathway (2023)**	117	-90%	• Increase in clean lead technologies and uptake of heat pumps. • Fossil gas use is halved by 2030 and completely phased out by 2050. • Fossil gas demand reductions are mostly driven by direct electrification and efficiency increases, renewable H2 and BECCS.	Graf, A., Gagnebin, M. & Buck, M. (2023)
Climate Analytics, **1.5°C compatible range (2022)**	106	-91%	• Limited role of non-fossil gases and fuels.	Climate Analytics (2022)

[44] Gagnebin, M. & Sauzay, A. (2022)
[45] European Environment Agency (2023)

			• Hydrogen used to provide high-temperature heat in industry.	
EU Commission, **EU 2030 Climate Target Plan (2020)**	244	-79%	Significant CCS only after 2040	European Commission (2021)

5.3 Transport

The transportation sector is a significant contributor to GHG emissions in the EU, accounting for around a **quarter of total emissions**[46]. After a 14% decline in emissions in 2020 compared to the previous year – caused by the COVID-19 pandemic – emissions in the transportation sector surged by almost 9% in 2021. That same year, GHG emissions from transport in the EU amounted to 782 Mt CO_2eq – 16% more than in 1990. [47]

Six scenarios present projections on GHG emissions in the transportation sector in 2040. According to these scenarios, transport emissions in the EU are expected to fall **between 53% (EU Gas Exit Pathway) and 78% (-95% net scenario) by 2040**, compared to 1990. Transport emission range between 145 Mt CO_2eq (-95% net scenario) and 313 Mt CO_2eq (EU Gas Exit Pathway).

According to the ESABCC, the final energy demand in the transportation sector will be between 28% and 62% lower in 2040 than in 2019. The ESABCC makes no projection for emission trends.

Table 7: Scenarios' assumptions for emissions from *transport* in 2040.

	Estimated emissions in 2040 (Mt CO_2eq)	Estimated emissions compared to 1990	Assumptions on measures and drivers	Data source
Strategic Perspectives, **-95% net scenario (2023)**	145	-78%	• By 2040, at least 84% of the total car fleet will be electric and 46% of the truck fleet. • Shift to public transport and "mobility as a service". • Alternative fuels used for the remaining international transport emissions.	Kalcher et al. (2023)
Strategic Perspectives, **-90% net scenario (2023)**	195	-71%		
Strategic Perspectives, **-85% net scenario (2023)**	271	-60%		
Agora Energiewende, **EU Gas**	313	-53%	By 2040, refineries will have closed due to the electrification of transport.	Graf, A., Gagnebin, M. &

[46] European Environment Agency (2023)
[47] European Environment Agency (2023)

Exit Pathway (2023)				Buck, M. (2023)
Climate Analytics, **1.5°C compatible range (2022)**	219	-67%	• Electrification • Increase of energy efficiency in transport	Climate Analytics (2022)
EU Commission, **EU 2030 Climate Target Plan (2020)**	226	-66%	n/a	European Commission (2021)

5.4 Buildings

Buildings account for approximately **40% of the EU's annual energy consumption and 36% of annual GHG emissions** from the energy sector; this represents 15% of total GHG emissions in 2021[48]. Unlike the transportation sector, emissions from buildings in the EU have steadily decreased over time – i.e., in 2020, they were 27% below 1990 levels[49].

According to six scenario pathways, GHG emissions from the buildings sector in 2040 could range from 7 Mt CO_2eq (-95% net scenario) to 60 Mt CO_2eq (1.5°C compatible range). This would mean emission reductions **between 90% (1.5°C compatible range) and 99% (-95% net scenario) in 2040**, compared to 1990. The Commission has stated that "buildings and power generation can make the largest and most cost-efficient emissions reductions, in the order of 60% and more compared to 2015" [50]. However, while the sector offers significant potential for energy efficiency improvements and deployment of low-carbon technologies, the EU is not on track to meet these targets[51].

The filtered ESABCC scenarios feature the final energy demand in the buildings sector reducing between 13% and 37% in 2040, compared to 2019. The energy supply is expected to be mostly or completely decarbonised. The report does not provide further data on emission reductions.

Table 8: Scenarios' assumptions for emissions from *buildings* in 2040.

	Estimated emissions in 2040 (Mt CO_2eq)	Estimated emissions in 2040 compared to 1990	Assumptions on measures and drivers	Data source
Strategic Perspectives, **-95% net scenario (2023)**	7	-99%	• The energy renovation rate of building stocks increases to 3% from 2030 to 2040. • Renovations focus on energy+ or 0-emissions buildings.	Kalcher et al. (2023)
Strategic Perspectives, **-90% net scenario (2023)**	9	-99%		

[48] European Environment Agency (2022)
[49] European Environment Agency (2023)
[50] European Commission (2020)
[51] European Climate Foundation (2022)

Strategic Perspectives, **-85% net scenario (2023)**	13	-98%	• Renewable share for heating reaches 100% in 2040 through heat pumps and district heating.	
Agora Energiewende, **EU Gas Exit Pathway (2023)**	12	-98%	• Buildings are nearly fossil gas free by 2040 due to efficiency, heat pumps and decarbonised district heating improvements. • Assumes a phase-out of coal and oil by 2035.	Graf, A., Gagnebin, M. & Buck, M. (2023)
Climate Analytics, **1.5°C compatible range (2022)**	60	-90%	• Deep renovations • Heat pumps and district heating • No hydrogen	Climate Analytics (2022)
EU Commission, **EU 2030 Climate Target Plan (2020)**	32	-95%	n/a	European Commission (2021)

5.5 Agriculture

Agriculture was responsible for emitting approximately **11% of all greenhouse gases** in the EU in 2021. Methane emissions, specifically, account for more than 54% of the total emissions from this sector[52]. Between 2005 and 2021, emissions from agriculture remained largely unchanged.

Six scenario pathways assume that GHG emissions of the agriculture sector range between 173 Mt CO_2eq (-95% net scenario) and 290 Mt CO_2eq (1.5°C compatible range). This would constitute a change in emissions **between 40% (1.5°C compatible range) and 64% (-95% net scenario)** for the sector, compared to 1990.

According to the ESABCC, agricultural emissions will fall by 20% to 62% in 2040 compared to 2019.

Table 9: Scenarios' assumptions for emissions from *agriculture* in 2040.

	Estimated emissions in 2040 (Mt CO_2eq)	Estimated emissions in 2040 compared to 1990	Assumptions on measures and drivers	Data source
Strategic Perspectives, **-95% net scenario (2023)**	173	-64%	• Reducing food waste • Plant-based diets • Agriculture and forestry-waste	Kalcher et al. (2023)
Strategic Perspectives,	195	-60%		

[52] European Environment Agency (2023)

-90% net scenario (2023)			contribute to energy production.	
Strategic Perspectives, **-85% net scenario (2023)**	197	-59%		
Agora Energiewende, **EU Gas Exit Pathway (2023)**	283	-42%	(Solid) biomass prioritised for energy and non-energy purposes.	Graf, A., Gagnebin, M. & Buck, M. (2023)
Climate Analytics, **1.5°C compatible range (2022)**	290	-40%	n/a	Climate Analytics (2022)
EU Commission, **EU 2030 Climate Target Plan (2020)**	261	-46%	n/a	European Commission (2021)

5.6 Waste

The contribution of the waste sector to total GHG emissions is not substantial: in 2021, the waste sector contributed to just **3% of emissions in the EU**[53].

According to the EEA, emissions from waste decreased by 41% between 1990 and 2021, and in 2021 amounted to 109 Mt CO_2eq[54]. Six scenarios for 2040 provide ranges for emissions from waste between 41 Mt CO_2eq (1.5°C compatible range) and 92 Mt CO_2eq (-90% net scenario) – which constitute emission reductions **between 50% (-90% net scenario) and 78% (**1.5°C compatible range**)** compared to 1990 levels.

According to the ESABCC, methane emissions from waste will see a reduction of between 45% and 59% from 2020 to 2040.

Table 10: Scenarios' assumptions for emissions from *waste* in 2040.

	Estimated emissions in 2040 (Mt CO_2eq)	Estimated emissions in 2040 compared to 1990	Assumptions on measures and drivers	Data source
Strategic Perspectives, **-95% net scenario (2023)**	66	-64%	Bio and e-fuels compensate emissions in waste treatment.	Kalcher et al. (2023)
Strategic Perspectives, **-90% net scenario (2023)**	92	-50%		
Strategic Perspectives,	60	-67%		

[53] European Environment Agency (2023)
[54] European Environment Agency (2023)

-85% net scenario (2023)				
Agora Energiewende, **EU Gas Exit Pathway (2023)**	75	-59%	n/a	Graf, A., Gagnebin, M. & Buck, M. (2023)
Climate Analytics, **1.5°C compatible range (2022)**	41	-78%	n/a	Climate Analytics (2022)
EU Commission, **EU 2030 Climate Target Plan (2020)**	90	-51%	Value includes "non-CO_2 other"	European Commission (2021)

5.7 LULUCF

In the past decade, removals from LULUCF in the EU have decreased. In 2021, removals were 230 Mt CO_2eq – 5% less than in the previous year and 10% less than in 1990[55]. For 2030, the EU has set a new target of 310 Mt CO_2eq[56], which would mean a 35% increase in current levels of removals. No specific quantitative targets for the sector post-2030 exist on the EU level[57].

For 2040, six scenario pathways provide ranges between -313 Mt CO_2eq (1.5°C compatible range) and -471 Mt CO_2eq (-95% net scenario) – or an increase of emission removals **between 50% (1.5°C compatible range) and 125% (-95% net scenario)**, compared to 1990.

According to the ESABCC, removals from the LULUCUF sector will stand at **a minimum 273 Mt CO_2 between 2040 and 2050, which would constitute a 31% decrease compared to 1990.**

Table 11: Scenarios' assumptions for emissions from *LULUCF* in 2040.

	Estimated emissions in 2040 (Mt CO_2eq)	Estimated emissions in 2040 compared to 1990	Assumptions on measures and drivers	Data source
Strategic Perspectives, **-95% net scenario (2023)**	-471	-125%	• Afforestation, better forest management and restoration of peatlands • Agriculture and forestry-waste contribute to energy production.	Kalcher et al. (2023)
Strategic Perspectives, **-90% net scenario (2023)**	-413	-98%		
Strategic Perspectives, **-85% net scenario (2023)**	-369	-77%		

[55] European Environment Agency (2023)
[56] European Parliament (2023)
[57] Duwe, M. et al. (2023)

Agora Energiewende, **EU Gas Exit Pathway (2023)**	-361	-73%	Based on the LULUCF+ scenario from the EC Climate Target Plan impact assessment.	Graf, A., Gagnebin, M. & Buck, M. (2023)
Climate Analytics**, 1.5°C compatible range (2022)**	-313	-50%	n/a	Climate Analytics (2022)
EU Commission, **EU 2030 Climate Target Plan (2020)**	-351	-68%	n/a	European Commission (2021)

5.8 Technological removals

Five scenarios provide data on technological removals, ranging **between 36 Mt CO_2 (-95% net scenario) and 77 Mt CO_2 (Gas Exit Pathway)**. The -90% and -85% net scenarios envision removals of 61 Mt CO_2 and 59 Mt CO_2, respectively, and the EU Commission's EU 2030 Climate Target Plan -62 Mt CO_2.

The ESABCC's scenarios feature between 5 and 70 Mt CO_2/year CCS, between 0 and 166 Mt CO_2/year CCU in industry in 2040, and BECCS and DACCS between 50 and 200 Mt CO_2 in 2040.

Table 12: Scenarios' assumptions for *technological removals* in 2040.

	Estimated emissions in 2040 (Mt CO_2eq)	Assumptions on measures and drivers	Data source
Strategic Perspectives**, -95% net scenario (2023)**	-36	• All scenarios feature CCUS which includes end-of-pipe, DAC and biogenic.	Kalcher et al. (2023)
Strategic Perspectives**, -90% net scenario (2023)**	-61		
Strategic Perspectives**, -85% net scenario (2023)**	-59		
Agora Energiewende, **EU Gas Exit Pathway (2023)**	-77	• CCS, includes -23 Mt CO_2 emissions through BECCS. • Limited BECCS in industry	Graf, A., Gagnebin, M. & Buck, M. (2023)
EU Commission, **EU 2030 Climate Target Plan (2020)**	-62	n/a	European Commission (2021)

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Annexes

Annex A: Estimated EU emission budgets

Figure 8: Total amount of GHG and CO2 emissions and removals under current EU targets and policies.

	Greenhouse gas emissions	CO_2 emissions (81.49%)	CO_2 removals	total CO_2 budget
2020[11]	3.377	2.752	-270	2.482
2021-2030	30.676	24.998	-2.568	22.430
2031-2040	17.354	14.141	-3.100	11.041
2041-2050	7.524	6.131	-3.100	3.031
Total	**58.930**	**48.022**	**-9.038**	**38.984**

Source: Trio, 2022.

Figure 9: Total amounts of GHG and CO2 emissions and removals under CAN Europe's proposed policy.

	Greenhouse gas emissions	CO2 emissions (4)	CO2 removals (5)	Total carbon budget
2020	3.377	2.752	-270	2.482
2021–2030 (1)	24.679	20.111	-4.515	15.596
2031–2040 (2)	11.058	9.011	-6.000	3.011
2041–2050 (3)	5.065	4.127	-6.000	-1.873
Total	**44.179**	**36.001**	**-16.785**	**19.216**

Source: Trio, 2022.

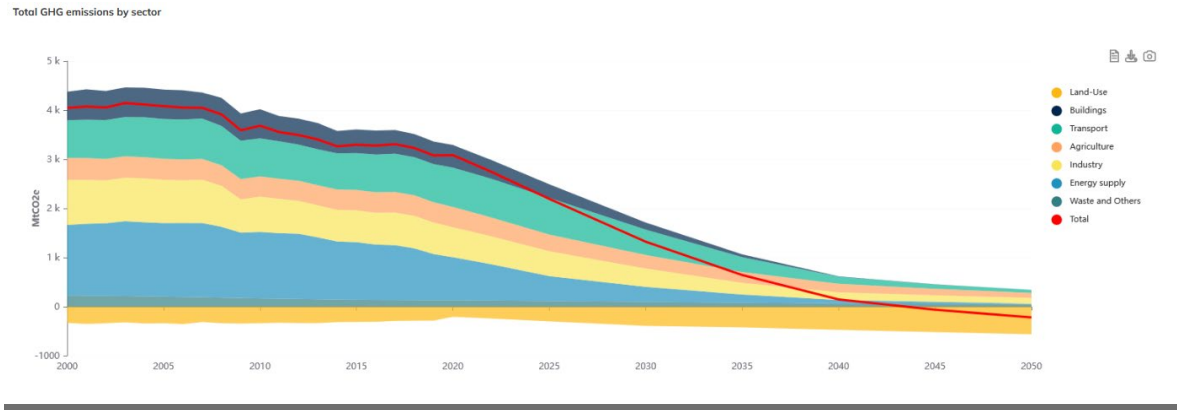
Figure 10: Maximum CO2 budgets for Germany and the EU.

	Germany			EU-28 (2020) or EU-27 (2022)		
Climate targets in °C Probability of achieving climate targets	**1.75 67 %**	**1.5 50 %**	**1.5 67 %**	**1.75 67 %**	**1.5 50 %**	**1.5 67 %**
Calculation from 2020 on the basis of IPCC SR15[1]						
Global CO_2 budget from 2018 in Gt	800	580	–	800	580	–
Maximum CO_2 budgets from 2020 in Gt	**6.7**	**4.2**	**–**	**47.0**	**31.6**	**–**
Year until which CO_2 budget lasts in case of linear emission reduction	2038	2032	–	2045	2037	–
Updated calculation from 2022 on the basis of IPCC AR6[2]						
Global CO_2 budget from 2020 in Gt	775	500	400	775	500	400
Maximum CO_2 budget from 2022 in Gt	**6.1**	**3.1**	**2.0**	**39.5**	**23.1**	**17.1**
Year until which CO_2 budget lasts in case of linear emission reduction	2040	2031	2027	2052	2039	2035
Percentage reduction per year in case of linear emission reduction from 2022	5.4 %	10.8 %	16.9 %	3.3 %	5.6 %	7.6 %
Percentage reduction in 2030 (compared with 1990)	65 %	92 %	100 %	48 %	61 %	72 %

Source: German Advisory Council on the Environment, 2022.

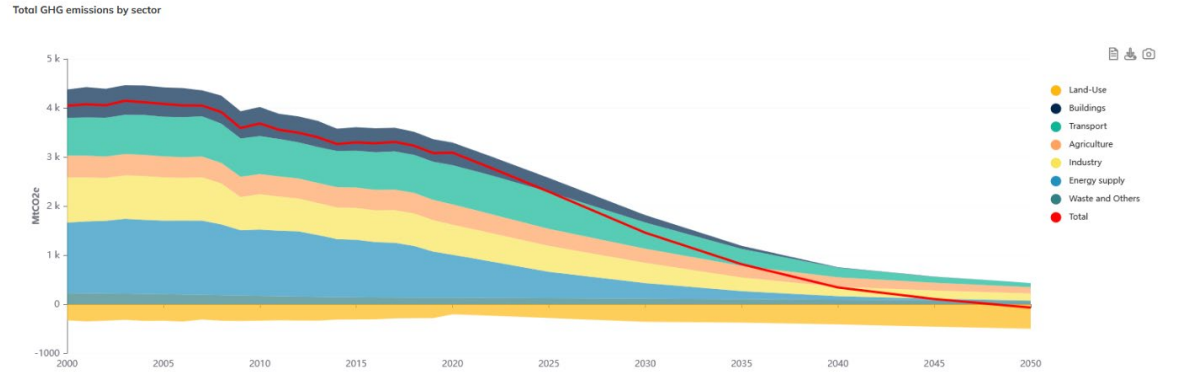
Annex B: Scenarios for 2040 GHG emission reductions.

Figure 11: -95% net by 2040 scenario.



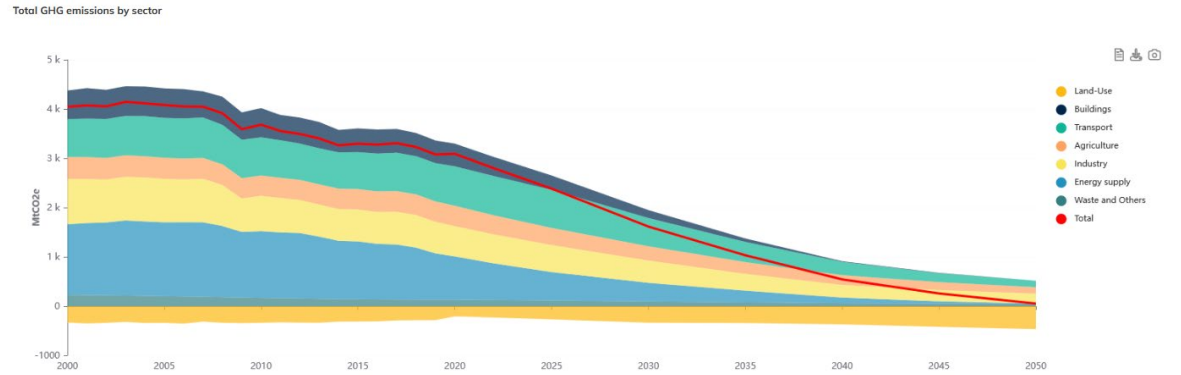
Source: Climact 2050 Pathways Explorer.

Figure 12: -90% net by 2040 scenario.



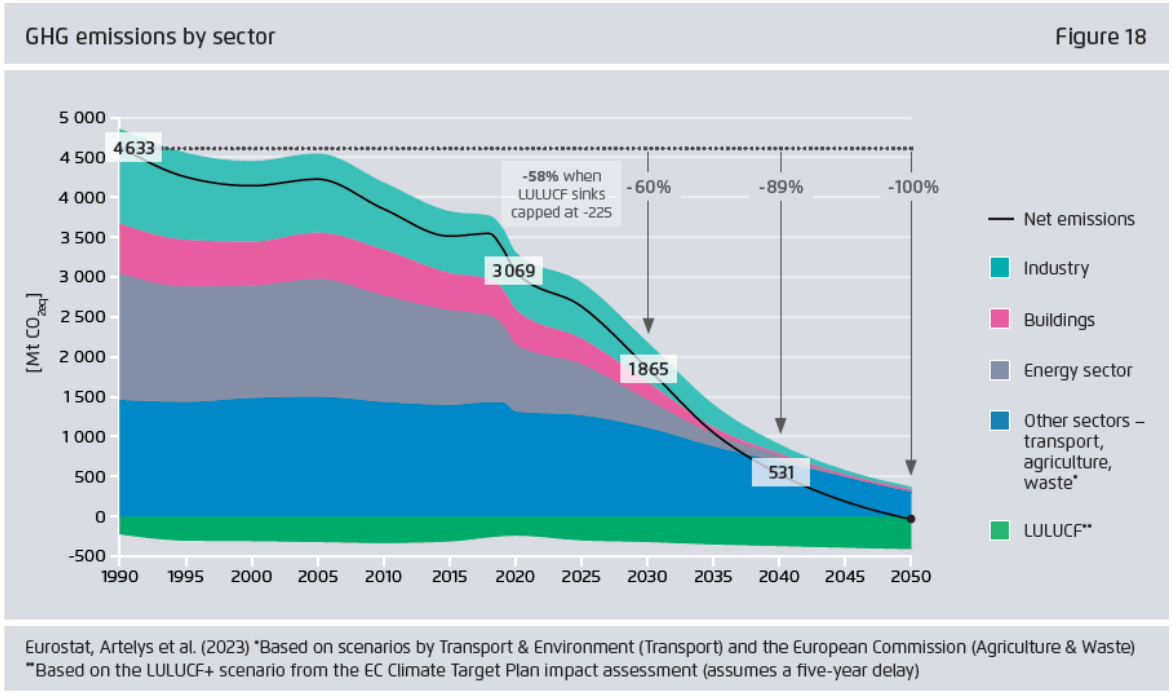
Source: Climact 2050 Pathways Explorer.

Figure 13: -85% net by 2040 scenario.



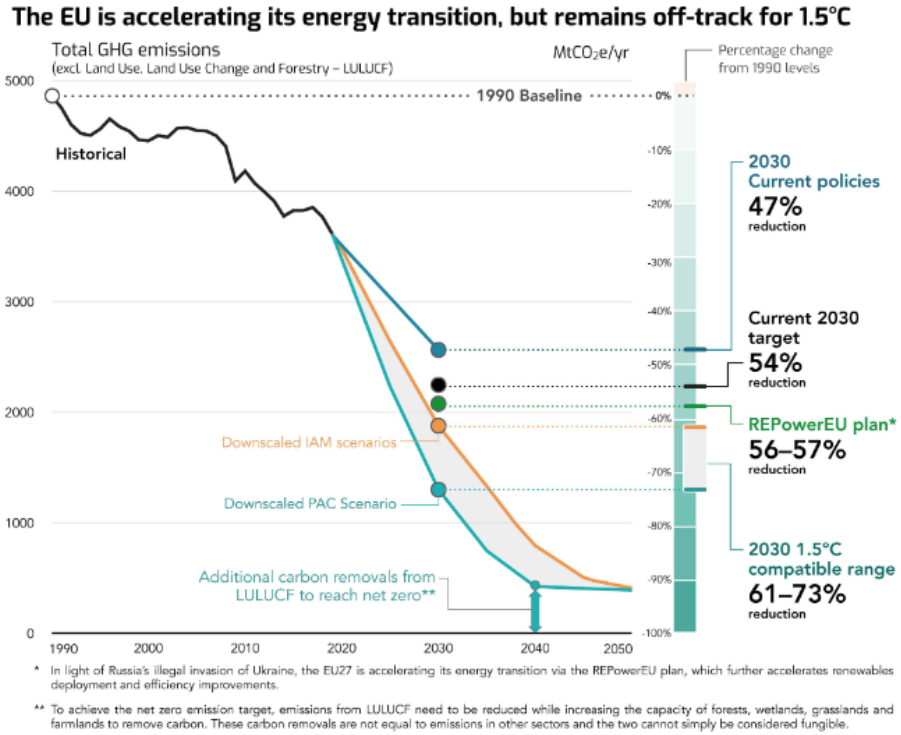
Source: Climact 2050 Pathways Explorer.

Figure 14: EU Gas Exit Pathway.



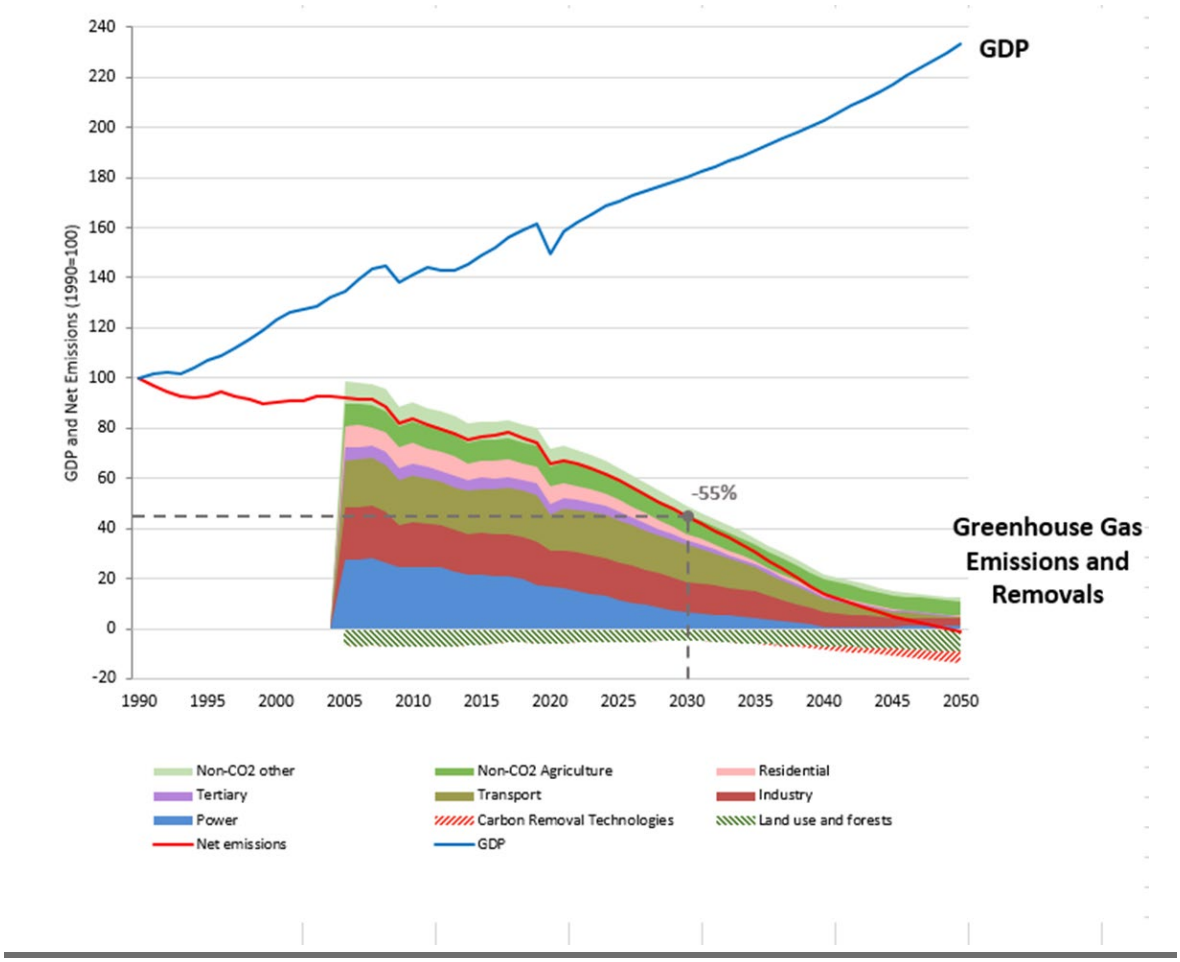
Source: Graf, A., Gagnebin, M. & Buck, M., 2023.

Figure 15: 1.5°C compatible range.



Source: Climate Analytics, 2022.

Figure 16: EU 2030 Climate Target Plan.



Source: European Commission, 2020.

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