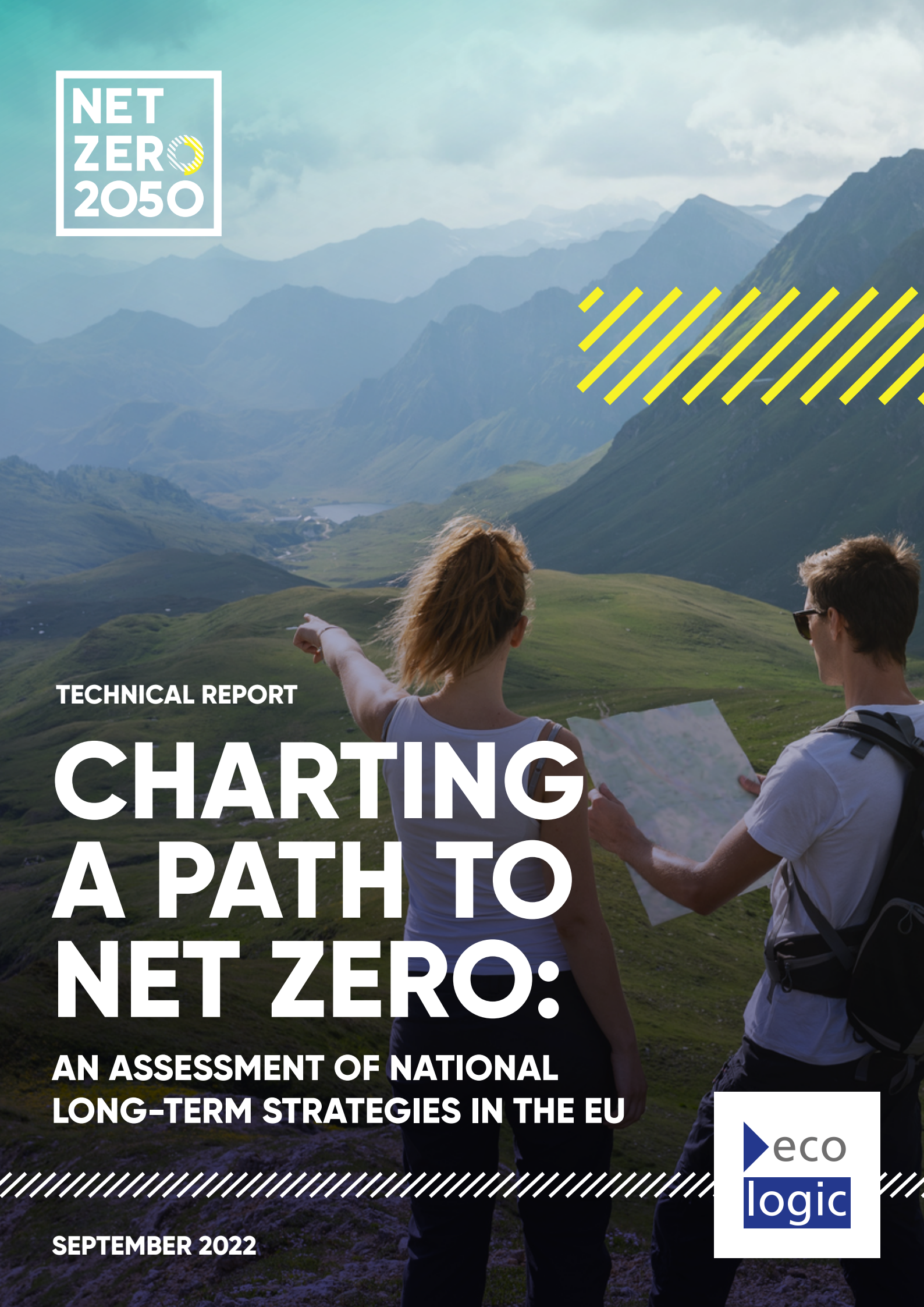

NET ZERO 2050

TECHNICAL REPORT

CHARTING A PATH TO NET ZERO:

AN ASSESSMENT OF NATIONAL LONG-TERM STRATEGIES IN THE EU

eco logic

SEPTEMBER 2022

ACKNOWLEDGEMENTS

We want to thank Erica Hope, Charlotte Billingham, Donal Mac Fhearraigh, Sharon Turner and Zoltán Massay Kosubek from the European Climate Foundation (ECF) for inspiration and support.

Furthermore, we are grateful for the support from Kamil Laskowski from WiseEuropa, Peter Robert Walke from Swedish Environment Institute Tallinn and Katarina Trstenjak from Jožef Stefan Institute. We also want to thank our colleagues Katharina Umpfenbach and Ewa Iwaszuk for content check and advice on readability.

Special thanks also goes to the national experts which helped us understand the relevance of national strategies in their country: Detelina Petrova, Ministry of Environment and Water of Bulgaria and Radu Dudău, Energy Policy Group (EPG); Michal Daňhelka, Ministry of Environment of Czechia and Karel Polanecký, Friends of the Earth Czechia; Erik Rasmussen, Ministry of Climate, Energy and Utilities of Denmark and Dan Belusa, The Danish 92 Group; Gwenaël Podesta, Ministry of the Ecological Transition and Nicolas Berghmans, Institute for Sustainable Development and International Relations (IDDRI); Martin Weiß, Federal Ministry for Economic Affairs and Climate Action of Germany and Sabine Gores, Öko-Institut; Krzysztof Kobyłka, WiseEuropa; Francisco Ferreira, ZERO and Pedro Barata, Environmental Defense Fund; Carlota Ruiz Bautista, Instituto Internacional de Derecho y Medioambiente (IIDMA) and Antxon Olabe, formerly Ministry of Ecological Transition of Spain.

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Note: This paper was produced within a larger project carried out for and with the European Climate Foundation. It is published together with a separate summary briefing.

Suggested citation:
Velten, Eike Karola, Nick Evans, Deyana Spasova, Matthias Duwe, Ramiro de la Vega, Laurens Duin, and Harrison Branner (2022): Charting a path to net zero: An assessment of national long-term strategies in the EU. Ecologic Institute, Berlin.

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DISCLAIMER

This report commissioned by the European Climate Foundation (ECF) as part of the Net zero 2050 series, an initiative of the ECF with contributions from a consortium of experts and organisations. The series aims to build a vision and evidence for the transition to net zero emission societies in Europe and beyond by mid-century at the latest, in line with the Paris Agreement objectives. The ECF is funded solely by private philanthropic organisations and does not have any financial ties to EU political bodies or to private entities.

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FOREWORD

True net zero emissions will not be arrived at by chance. Countries and regions need robust long-term decarbonisation strategies, with a clear articulation of the pathways needed in each sector, as a guide for near-term climate plans, policies and actions. It is therefore with great pleasure that I welcome the publication of this report on the state of countries' long term climate planning.

In recent years Ecologic Institute and the Climate Planning and Laws programme of the European Climate Foundation have worked in partnership with others to promote the importance of long-term climate planning, and to develop thinking, frameworks and tools to help carry it out it effectively. This included making the case for Long Term Strategies (LTSs) to be included in the EU Governance Regulation, with a structural linkage to National Energy and Climate Plans (NECPs). This assessment is a first in how well Member States, and the EU Commission have engaged with the planning framework that was ultimately adopted at European level. The core finding is that national LTSs vary greatly in the information they provide, the quality of their preparations and in their integration into national policy-making.

This timely analysis serves as an invaluable resource to support policy communities at national and EU levels as they grapple with the process of tracking, implementing and refining long-term pathways.

In 2023, EU countries will be prompted by the Governance Regulation to consider whether their LTS should be updated. This report makes clear that all EU countries should seize the opportunity to do so. It will be a failure if existing climate governance frameworks and planning pathways do not take into account the EU's increased climate ambition and the profound policy impacts of the cost-of-living crisis and Russia's war of aggression in Ukraine.

If national Long-Term Strategies are to serve their purpose in providing a robust strategic context for the development of sufficiently ambitious NECPs for 2030, as well as the data required by the EU Commission to effectively monitor policy consistency for net zero under the EU Climate Law, this report is a 'must read' for policy officials at EU and national levels.

It offers guidance about the range of inputs and activities that need to be marshalled to do this process well – for instance the need for clarity about the national long-term climate objective or vision, the need for up-to-date data, the value of robust arrangements for independent, expert peer review, the importance of sustained stakeholder engagement as the LTS is being developed, the need for cross departmental collaboration and a 'whole of government approach', and the need for dedicated arrangements to monitor follow up and implementation.

It should also be a powerful nudge to bring forward an urgent review of the Governance Regulation in order to strengthen and better enforce the framework's provisions and standards. At the same time, the EU's own LTS – 2018's 'Clean Planet for All' – can be updated in a process that is more genuinely shaped from the bottom up. Doing so could transform national ownership of the Union's climate neutrality objective, more securely anchoring the societal consensus that keeping the transition on track is necessary, possible and - just as importantly - that it can be achieved fairly.

Erica Hope

Director, Climate Planning and Laws

European Climate Foundation (ECF)

SUMMARY

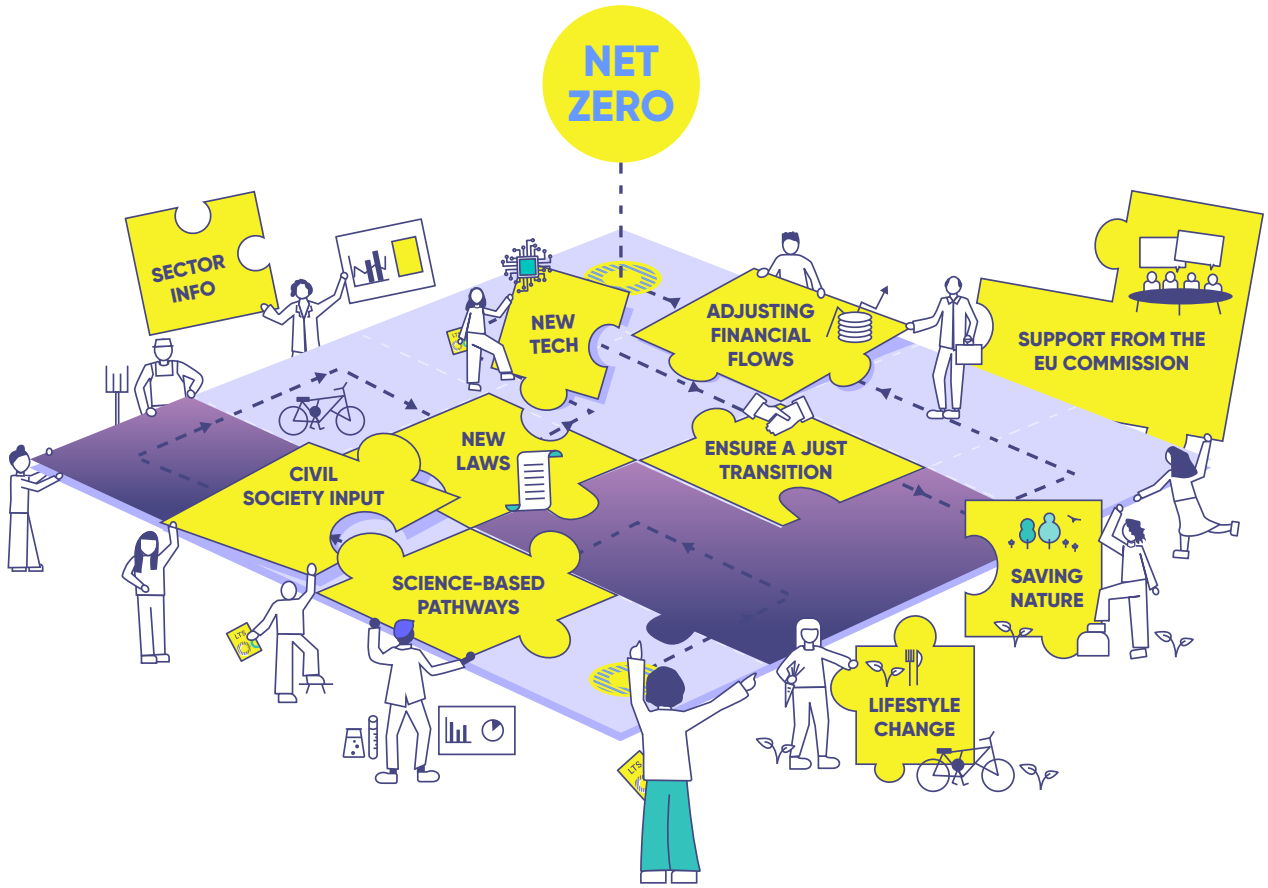

Figure 1: Puzzle pieces for charting a path to net zero emissions.

This report presents the findings from an assessment of the 22 long-term strategies (LTSs) of EU Member States available as of March 2022. It is complemented by a briefing that summarises the key findings and recommendations.

The analysis looked at two distinct qualities of strategies: the *vision* of a low-emission future represented in the pathways and projections of the LTS as well as the preparation and use of the strategy as a tool to guide policy decisions, in other words its *relevance* in national climate policy.

LTSs MAKE A DIFFERENCE, BUT MOST EXISTING DOCUMENTS NEED IMPROVEMENT

In several Member States developing an LTSs has had a positive impact on national policy already. However, the assessment found that to varying degrees most LTSs lack information on their long-term vision and some LTSs are already outdated. Strategies with missing or out-of-date information cannot sufficiently guide near-term policymaking. In addition, most LTS preparation processes fall short on participation, and the strategies omit detail on follow-up. This risks generating lower political support and ultimately reduces the use of the strategies as a tool to guide policies and interim targets.

POLICY RECOMMENDATIONS TO MAKE LTSs MORE EFFECTIVE

The EU should amend the Governance Regulation by:

1. **adding a mandatory template** asking for more detail on the long-term vision (scenarios and targets) and on preparation and use of the document
2. **adding mandatory regular updates** slightly ahead of the NECP updates
3. **requesting more effective participation** (early, meaningful, iterative) during preparation

National governments should create national ownership of the long-term vision by:

1. **engaging a wide variety of interests** in strategy preparation and revision, drawing on the national multilevel climate dialogue.
2. including an **independent peer review process** using scientific expertise, such as existing national climate advisory bodies, during LTS preparation and follow-up
3. integrating **a regular LTS review cycle** in national policy-making
4. specifying **a date for achieving climate neutrality** at national level with quantitative info for remaining greenhouse gas emissions and necessary removals

The European Commission should take an active role by:

1. providing **additional technical support**, e.g., capacity support, common modelling tools or parameters
2. launching a **forum for good practice experience sharing** among Member States, and for encouraging integrated planning processes across borders
3. **enforcing compliance** with the requirements for LTSs in the Governance Regulation including timely submission
4. creating a bottom-up vision for climate neutrality in the EU using the national LTSs and integrating it into an **update of the EU LTS**

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1 INTRODUCTION

"We are at a crossroads. The decisions we make now can secure a liveable future. We have the tools and know-how required."

Hoesung Lee, Chair of the IPCC, April 2022 during the release of the IPCC Working Group III report, Climate Change 2022: Mitigation of climate change.

1.1 LONG-TERM PLANNING FOR CLIMATE ACTION

Effective climate action requires targeted policies for structural change

The Paris Agreement provides the international framework to fight the global climate crisis and achieve net zero greenhouse gas (GHG) emissions by the second half of the century. In 2019, the EU agreed on the long-term climate target of climate neutrality by 2050 and enshrined this objective in the European Climate Law (ECL, Regulation (EU) 2021/1119), adopted in 2021. Accordingly, the EU must reach a balance between economy-wide GHG emissions and removals by 2050, further aiming to achieve net negative emissions thereafter (ECL, Art. 2). This means that EU Member States, on aggregate, must reduce their GHG emissions to a level which can be offset either through natural sinks or technical removals no later than 2050.

To achieve climate neutrality in this timeframe, Member States must implement policies now, that are in line with a pathway towards a net zero emissions future. Preparing and then adopting a robust and sufficiently detailed long-term climate strategy is a crucial step in this process. By engaging in long-term strategic planning only climate, countries show that they acknowledge the need for a shift to a decarbonised economy, as well as their willingness to act towards tackling these issues through systematic change (Rüdinger et al., 2018). These plans should include pathways that identify the necessary changes in the main emitting sectors and the economy as a whole. The plans need to take into consideration the specific national starting conditions and include economic, technical and social aspects, as well as other long-term objectives (e.g., adaptation needs or biodiversity goals).

Long-term planning offers a basis for today's decisions

Presenting a clear vision of a climate neutral future and ways to get there helps all involved to understand the scope of the net zero transformation and the impacts that might arise along the way. Long-term planning should outline crucial decision points, map existing and planned solutions, and identify actions needed today for new solutions to materialise in the future. With sufficient buy-in from leaders and government officials, long-term strategies (LTSs) supply a critical reference for political decisions across all policy areas (and possibly across electoral terms), and thus offer additional certainty for businesses and private citizens for their own choices e.g., regarding investments, practices or lifestyle change (see also Lebling et al., 2020; Waisman et al., 2021).

Long-term planning must be a regular, iterative process, not a one-off exercise

Having a long-term goal and working out through what pathways it can be achieved is useful to point in the direction that policy needs to aim for. However, any attempt to look into the future for more than a few years is by design fraught with uncertainty. Technological developments, and scientific research can move fast making other and new actions more viable or necessary. Both public opinion and the political landscape can rapidly change as well. For example, the *Fridays for Future* movement built up pressure for more immediate climate action in 2019; in EU climate policy, the targets for 2030 and 2050 were both formally increased in 2021, and the Russian attack on Ukraine has brought into question the reliance in particular on fossil fuel imports from the Federation and the use of gas as a bridge fuel towards net zero. All of these developments are evidence of the dynamic background against which climate policy needs to be made.

Flexibility to adapt to changing circumstances is key to effective policy, but these adjustments must not lead away from the long-term goal. Effective climate policy needs to be resilient to external dynamics through a combination of flexibility and adjustments at regular intervals. Accordingly, long-term strategies cannot be one-off documents but require regular review and updating in light of new and better information at least every five years, so that they can keep informing decisions on policy.

UN and EU rules demand long-term planning to inform near-term policy

LTSs have featured in international climate agreements for more than a decade already. At the 16th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 16 of the UNFCCC) in Cancun, Mexico, in 2010, developed countries agreed to develop national low-carbon development strategies (LCDS) (Decision 1/CP.16 in FCCC/CP/2010/7/Add.1). There was no agreement on a specific deadline for these strategies. The EU implemented the agreement in its Monitoring Mechanism Regulation, Art. 4 (MMR, Regulation (EU) No 525/2013). It required Member States to create LCDS in accordance with the COP 16 decision. The MMR also did not stipulate a deadline for submitting the LCDS but included only a deadline for Member States to report on the strategies' status.

The Paris Agreement, adopted at COP 21, re-emphasised and invited all parties to the treaty to develop so-called 'long-term low greenhouse gas emission development strategies' (LT-LEDS) in Article 4.19. As of April 2022, 50 countries and the EU have submitted a strategy, respectively (UNFCCC, 2022). The Glasgow Climate Pact, the official outcome of the COP 26, specified this, by urging all countries to communicate their LTSs by COP 27 in 2022 (Decision 1/CMA.3 in FCCC/PA/CMA/2021/10/Add.1). The decision also underlines the importance of aligning near-term climate targets with LTSs, to ensure policies implemented now are consistent with the long-term goals and asks for regular updates.

In the EU, most of the current framework for climate governance is laid down in the Governance Regulation (GovReg) (Regulation 2018/1999) besides other important documents including the European Climate Law (ECL, Regulation 2021/1119), the Climate Action Regulation (CAR; commonly referred to as Effort Sharing, Regulation 2018/842), the Renewable Energy Directive (Directive 2018/2001) or the Energy Efficiency Directive (Directive 2012/27/EU). The GovReg integrates national planning and reporting processes for climate and energy, establishing regular cycles for monitoring and review. Many Member States have their own systems for climate policy-making, many of these established through national framework laws. However, a significant number implement only what is required through international and EU obligations. The GovReg and related EU laws thus establish important minimum standards for national climate governance, irrespective of existing systems in Member States (Evans and Duwe, 2021).

Long-term signal not sufficiently prominent in EU climate governance?

The GovReg prescribes two distinct processes, aimed at different time horizons: National Energy and Climate Plans (NECPs) are meant to include details on policies and expected impacts up to 2030; national LTSs outline Member States' planning up to 2050. The regulation provides a detailed template for the NECPs, but mandates only key elements for LTSs, and includes a voluntary template with key headings for the LTSs. The Climate Action Regulation (Regulation 2018/842) further provides for binding quantitative targets for 2030 for every Member State but has presently no such national goals for 2050. The long-term direction is arguably not sufficiently prominent in EU climate governance. Political attention has clearly been focused on NECPs, and much less so on LTSs (Duwe, 2022).

This is also evidenced by the different treatment of those two documents by Member States as a whole. The GovReg (Art. 15.1) requires them to produce an LTS covering a 30-years period every ten years; voluntary updates are foreseen every five years. The first iteration was due by 1 January 2020. However, two years after the deadline had passed, five Member States had still not yet submitted an LTS (EC, 2022) and many had been submitted several months late (see also section 3.1.1). Due to the delay the European Commission (EC) has not yet been able to produce an assessment of the LTSs and the collective ambition they represent (which Article 15.9 GovReg requires them to do). NECPs, on the other hand, are complete and were largely on time, certainly in their final versions (which were due essentially at the same time as the LTSs, literally one day earlier).

The GovReg also included an obligation on the EU to develop its own LTS. The EC published its proposal in November 2018, titled "A Clean Planet for All". The document outlined a climate neutral future by 2050, which subsequently became the new EU long-term goal – showing the impact that a vision based on robust analysis can have. The EU LTS has not been updated since, and neither the GovReg nor the ECL include an obligation to do so.

The status quo: a diverse landscape of national LTSs

Whereas all NECPs had to follow a mandatory common template and were thus relatively easy to analyse and compare, the picture for LTSs is quite different. Given the different schedules (see section 3.1.1) and the low level of guidance for structure and content provided by the GovReg, national LTSs are a very diverse set of documents. Furthermore, Member States differ in the analytical capacity available for climate policy – and political attention varies also significantly (Duwe and Iwaszuk, 2019a). It is against this backdrop, that this analysis is taking place.

1.2 OBJECTIVE OF THIS REPORT

This report analyses the national LTSs of EU Member States available as of March 2022. It looks at their content, including targets and pathways considered, as well as the way in which these strategies are embedded in their national policy-making context. The objective of this analysis is to answer two key questions:

1 What is the long-term vision outlined in national LTSs?

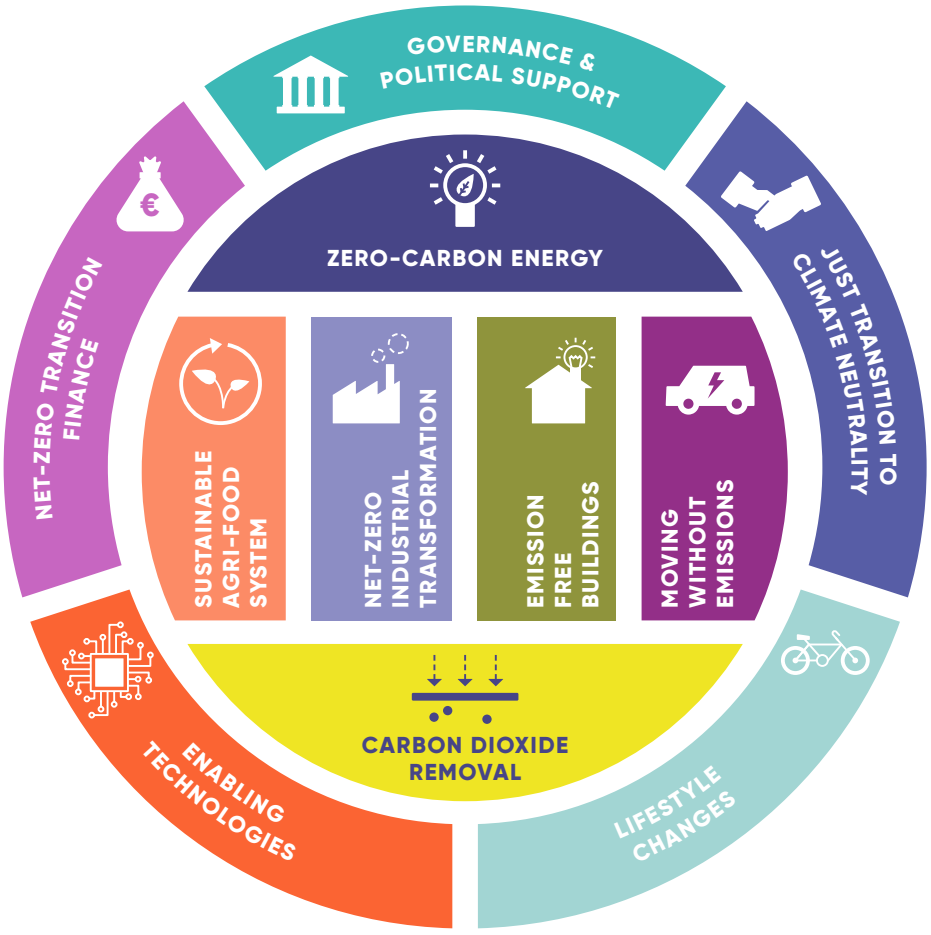
LTS vision pertains to a strategy's content, that is, its description of a net zero emissions future, how to get there and what enablers will drive the transition.

2 What is the relevance of the LTS in the national context?

LTS relevance focuses on the preparation process, follow-up and integration of the strategies to understand the impact of the document on climate policy decisions within the country.

On both questions, the goal was to assess and compare the information in the LTSs. We identified good practice examples, to better understand both content and process that make for an effective national strategy that can guide near-term decisions. On this basis, the study derives recommendations on how to improve the content and relevance of national LTSs.

Figure 2: Elements of a net-zero future



Source: Velten et al. (2021)

1.3 RESEARCH APPROACH

Drawing directly on the objectives specified, our analysis focused on I) the **vision** that the LTSs produce for the long term and II) the **relevance** of the strategies in the national context.

1.3.1 ASSESSING LTSs: WHAT MAKES A GOOD STRATEGY?

EU legal requirements

The EU formulates what it expects from a national LTS in the GovReg. For the long-term **vision**, Art. 15.4 specifies that national LTSs must include: a) total GHG emission reductions and enhancements of removals by sinks; b) emission reductions and enhancements of removals in individual sectors; c) expected progress on transition to a low GHG emission economy; d) expected socio-economic effect of the decarbonisation measures; and e) required investment.

On the **relevance** of the LTS in the national context, the law stipulates that national LTSs describe "links to other national long-term objectives, planning and other policies and measures" (Art. 15.4). In addition, the regulation requires coherence between the policies and actions detailed in the NECPs on the one hand and pathways and long-term ambition signalled by the LTSs on the other hand (Art. 15.6). However, there is no process specified for checking if the two planning documents are indeed consistent. When it comes to implementation and follow-up, the GovReg only prescribes a ten-year cycle, recommending interim updates after five years. Annex IV of the GovReg provides a suggested structure that LTSs "should" follow, without this being mandatory, and without adding much in terms of content.

Assessment methodology chosen

This means, EU guidelines are broad, rather vague and leave some room for interpretation. For a comprehensive coverage of the relevant thematic scope, i.e., which topics should be covered in an LTS, we considered the 11 elements of a net zero future described in Velten et al. (2021). These provide a good picture on sectoral and horizontal fields of action for reaching climate neutrality and should therefore also be part of an LTS (see Figure 2).

Considering the sectoral elements, we re-named and somewhat re-structured them along energy supply and energy demand (which includes transport, buildings, and industry) as well as agriculture and GHG removal. From the horizontal elements (outer ring in Figure 2), technologies, just transition, lifestyle change, and finance are considered as part of the *LTS vision*, and we added adaptation to climate change which is also one of the topics highlighted in Annex IV of the GovReg. Governance is covered under *relevance*.

In addition, we examined literature outlining themes and questions, pertinent to the assessment of strategies in an effort to complement and align our evaluation structure with the relevant topics and related depth of information found in **other LTS analytical studies**. More specifically, we checked IDDRI's six key features of a "good" LTS (Waisman et al., 2021) and Jotzo et al. (2021) who offer one of the few existing examples of a comprehensive methodology for assessing LTSs, including their preparation process, design and implementation elements, as well as a synthesis of best practices on specific elements from LTSs worldwide. In addition, we considered the methodological work within the UNIFY project (CAN Europe et al., 2021) and that of World Resources Institute (WRI) (Ross et al., 2021) as well as the 2050 Pathways Platform Handbook (Williams and Waisman, 2017) and the LTS development guide by the German Corporation for International Cooperation (GIZ) and NewClimate Institute (Hans et al., 2020).

Some studies rely on specific indicators, such as square meter floor space per person (e.g., Williams and Waisman, 2017). While this is in line with the depth of information included in an ideal case (see e.g., relevant indicators highlighted in Velten et al., 2021), we did not assess the LTSs on the basis of such granularity as it is generally lacking and even before getting to that level of detail, there were important differences in approach and quality to examine.

For the **vision** provided by the LTSs, we oriented our assessment primarily around a 2050 timeframe, searching for information pertaining to:

a) national climate targets and related pathways as well as aggregated sectoral information, the role of renewables and energy efficiency as well as GHG removal, and

b) elements of a net zero future, including technologies, behaviour change, finance and issues related to a just transition as well as adaptation to climate change.

For the **relevance** of the LTS, we focused on information about:

c) the strategy's preparation process with a check for compliance with the GovReg, the scientific basis of the strategy and participation,

d) strategy follow-up and implementation, and

e) strategy integration in the national context as well as coherence with other planning and role in policy making.

Details on the assessment methodology for each section are contained in the description of our findings in the respective segments below.

1.3.2 COMPILATION OF INFORMATION

Based on the content analysis, we developed **an assessment matrix** for collecting the relevant information from LTSs focussing more on the aggregated picture than detailed information for single sectors, on policy measures or specific indicators. Building on past experience assessing similar documents (Duscha et al., 2017; Duwe et al., 2016, 2019), we developed a set of questions to extract information from the national LTSs in a harmonised manner. The questions were mainly open questions asking for quantitative and qualitative information on a single topic. This allowed us to collect all relevant information in a structured way, considering that LTSs differ substantially on how and where information is provided. The assessment matrix also included questions on how easy it was to find relevant information and if the information was clear and comprehensive from the document.

We filled in the matrix for the 22 LTSs submitted by the end of December 2021. We downloaded all LTSs from the Commission's repository and cross-checked with documents on the UNFCCC repository.[1] There was no national LTS from Bulgaria, Cyprus, Ireland, Poland, and Romania by the time of writing.[2] We were supported in the collection of LTS information by partners of the Climate Record 2050 project, including WiseEuropa covering Czechia, Hungary and Slovakia, Józef Stefan Institute covering Slovenia and Croatia and Stockholm Environment Institute-Tallinn covering Estonia, Latvia, and Lithuania. They also analysed the respective LTSs in the context of the Climate Recon 2050 project (Climate Recon 2050, n.d.).

1. In Denmark and Estonia, the governments published additional updates following the initial submission of their LTSs, albeit focussing on 2030 (Climate Programme 2020) and 2035 (Estonian 2035 strategy). Nevertheless, in both cases we assessed primarily the LTSs from the Commission's repository.
2. Cyprus submitted its LTS end of September 2022.

Furthermore, we conducted **expert interviews for eight countries** to a) obtain more information on and appraisal of the relevance of the LTSs as we did not expect to find this information in the strategies themselves; and b) obtain some information on countries without a published strategy, specifically at what stage they are in the preparation process and reasons for the delay. We selected countries covering a broad variety in terms of economic prosperity (GDP/capita) and GHG emissions per capita, geographical location and LTS submission date (see Table A-4).

The semi-structured interviews comprised nine questions on preparation process, five on follow-up, and six on the strategy's role in the national policy making process. A final question asked for the interviewee's expert judgment of the overall relevance of the LTS in their respective country on a scale from one to five. We interviewed one to two experts per country; interview partners were a mix of government officials, representatives of scientific institutions, and NGOs.

1.3.3 CROSS-COUNTRY ASSESSMENT

Information from all national LTSs and interviews compiled in the matrix formed the basis for our cross-country analysis. We also integrated a consistency check with findings of other studies, including the LTS summaries as published on the EC website (Ricardo-AEA, 2019); an assessment table of existing strategies compiled by the EC in an annex to its 2021 climate action progress report (EC, 2021b); targets and pathways from CLIMACT's Pathways Explorer initiative (2021), which simulates NECP and LTS GHG pathways for EU countries and country-specific information from the UNIFY project (Sahin et al., 2021). We also cross-checked our findings with WRI's analysis of 13 EU Member States LTSs (Ross et al., 2021), which provides a summary amongst other on facilitation of the transition, and any processes to ensure the longevity of the documents – this was especially interesting for our assessment on the relevance of LTSs in a national context.

The report is structured around the two topics: long-term vision and relevance. Each sub-section under vision and relevance is organised as follows: First, we provide a general description of the importance of the aspect using existing literature and scientific evidence; wherever there is a legal obligation, it is clearly outlined as such. Second, we compare the available quantitative and qualitative information from the LTSs. Finally, we provide a quick summary overview across national LTSs.

2

THE LONG-TERM VISIONS IN THE STRATEGIES

National LTSs should guide countries on their way to climate neutrality by providing a picture of a net zero future and sketching pathways towards it. There are indeed different possibilities how climate neutrality can look like and how a country can reach the goal (see also section 1.1). This means there are different solutions to consider, to make available in time and to implement on different scales.

Therefore, LTSs should provide the knowledge about different net zero futures and related pathways that seem plausible today. On this basis, governments can decide on the most suitable path and prepare already today. This includes that LTSs should highlight relevant decision points taking into account any lead times for implementation and impact. Thus, LTSs should provide pathways *and* derive actionable information for near-term decision-making. Such information may relate e.g., to the role of efficiency and sufficiency, to the impact of different technologies and infrastructure, and guidance for investments and on lifestyle decisions.

The following assessment seeks to assess national climate targets, and planned changes in the sectoral and horizontal elements which describe how countries envision the net zero future. It includes five components: (1) long-term climate targets and related pathways, (2) sectoral GHG reductions, (3) GHG emission removal, (4) technologies, and (5) the horizontal elements.

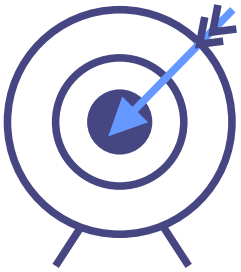
It must be noted that information was obtained almost solely from the LTS documents while additional laws, strategies and policy documents were mainly considered in the section about national targets to deliver up-to-date information.

Table 1: Analytical framework for an assessment of LTS vision

	DIMENSIONS	ASSESSMENT CRITERIA
LONG TERM CLIMATE TARGETS	**Net zero emissions**	Target year and status
	Emission reductions	Targets and status
	GHG reductions pathways	Interim milestones GHG pathways from scenarios
SECTORAL ELEMENTS	**Energy supply**	GHG emissions from electricity generation Renewables Fossil fuels and nuclear
	Energy demand	Primary and final energy consumption GHG emissions from transport GHG emissions from buildings GHG emissions from industry
	Agriculture	GHG emissions and related practices
	GHG removal	CO_2 removed and related practices and technologies
TECH	**Hydrogen**	Green vs. blue hydrogen Production, consumption and imports
	Biomass	Production, consumption and imports
	Carbon capture and utilisation and storage (CCUS)	Captured emissions Storage potential Research, development and deployment
HORIZONTAL ELEMENTS	**Lifestyle change**	Role and ways of lifestyle change
	Finance	Investment needs Distribution of public and private investment Environmental harmful subsidies
	Just transition	Impacts on gross domestic product Impacts on employment Cost distribution Impacts on health Impacts on the environment
	Climate impacts and adaptation	Expected impacts and their distribution Adaptation measures and costs

Source: own compilation

2.1 LONG-TERM CLIMATE TARGETS AND RELATED PATHWAYS



The EU aims to achieve climate neutrality by 2050 and has enshrined this target in the ECL. All Member States must contribute to this goal by setting their own climate neutrality target and/or defining concrete goals for GHG emission reductions and removals.

Countries should be clear on the role of emission reductions and removals and ideally include specific long-term reduction and removal targets (see e.g. Geden and Schenuit, 2020). LTSs should provide information about when and how these reductions and removals will be realised. This means strategies must include a description of pathways, including interim targets to paint a clear picture of what needs to happen in the short- and longer term.

2.1.1 NET ZERO EMISSIONS

Relevance of topic

Each Member State must contribute to reaching net zero emissions in the EU by 2050 (ECL, Art. 2). However, the temperature goals stated in the Paris Agreement require richer EU countries to reach net zero emissions even before 2050 with remaining Member States reaching it by 2050 the latest – all to give developing and emerging countries more time and still achieve a climate neutral world by mid-century.

Information in the LTSs

Almost all countries that have submitted an LTS include a net zero target; most are aimed at 2050 (See Table 2). However four countries – Finland, Austria, Sweden, and Germany – strive to meet the goal before 2050 with Finland's 2035 net zero the earliest. Finland has uniquely large areas of forest land and plans to rely on GHG removals through enhancing natural sinks function or using biomass for energy generation with emission storage (BECCS). Austria and Germany advanced their target years since the publication of their LTSs from 2050 to 2040 and 2045, respectively. Sweden aims to achieve net zero emissions by 2045 and net negative emissions thereafter.

At the time of writing, nearly half of EU countries have also enshrined their net zero target in a (climate) law. Yet, most of the LTSs do not refer to the laws directly as many were introduced after submission. For instance, the Portuguese climate law was approved on 31 December 2021, but the LTS submitted two years prior. Denmark's LTS submitted in 2019 states that the target will be included in a future climate law revision; this was then adopted in 2020. In March 2022, Finland integrated a climate neutrality target in a revision to its climate law, replacing the old 80% reduction target. Greece adopted its first climate law in May 2022 likewise enshrining a net zero national objective.

Seven countries do not mention a net zero target. This includes Belgium, where at a subnational level the regions of Wallonia and Brussels aim to achieve *carbon* neutrality by 2050 (*i.e.*, net zero CO_2 emissions and not all GHG emissions) while Flanders has set an overall target of reaching climate neutrality but does not state a year. The Netherlands, Croatia, Czechia, and Estonia provide no information on reaching climate neutrality. However, the Netherlands and Estonia do stipulate emission reduction targets by 2050 (see also next section on "Emission reductions").

Summary assessment

Almost all Member States with an LTS aim at achieving climate neutrality by 2050 at the latest. Ireland has a climate neutrality target in law but has not yet submitted an LTS. Croatia, Czechia, and Estonia do not stipulate net zero in their LTSs. The Dutch LTS does not refer to the term climate neutrality, but the emission reductions are similar in ambition. In short, almost all countries plan to contribute to the aggregated objective of achieving a climate neutral EU by 2050. However, richer countries with GDP above EU average should aim for climate neutrality before 2050. Austria and Finland are thus good examples with net zero dates at 2040 and 2035, respectively. Aside from the notable exception of Sweden no country specifically states that it wants to achieve net negative emissions thereafter.

Figure 3: Understanding potential pathways towards net zero

2.1.2 EMISSION REDUCTIONS

Relevance of topic

The net zero emission scenarios contained in the EU's LTS and the accompanying in-depth analysis (EC, 2018) show that emissions must fall by 91% to 94% on average in the EU, with the remainder of the goal reached via removals. Although national circumstances differ, this reduction range provides a baseline for each Member State to strive for. Other studies indicate that a 95% emission reduction should be considered the ambitious benchmark (IPCC, 2018). A limited emission reduction of 90% or below means higher reliance on CO_2 removal options which are, however, limited due to potential, costs and risks (see 2.2.4).

Information in the LTSs

Projected long-term emission reductions vary significantly in terms of scale and status (see Table 2). Most Member States stipulate a climate neutrality target while emission reductions by the respective year are provided as the outcome of one or more scenarios. The target is reached through different combinations of sectoral emission reductions and removals. This means that absolute emissions reductions by 2050 and their related pathways, when provided, are not always a firm goal or government commitment.

One notable exception is the Netherlands, which has the highest emission reduction target of 95% by 2050 compared to 1990. This is enshrined in the country's climate law. Sweden commits to reducing emissions by 85% by 2045 compared to 1990, which is in line with their climate neutrality target. Estonia includes a target of 80% and Lithuania stipulates a target of at least 80% with an aim to reduce net GHG emissions by 100% compared to 1990, covering the last 20% via natural sinks.

Most other countries provide emission reductions only as a scenario outcome. Hungary's LTS scenario shows an emission reduction of 95% by 2050 when compared to 1990. At least 85% reductions can be found in the French, Greek, Italian, and Spanish LTSs. The Portuguese LTS contains emission reductions of 78%-85%, the scenarios of Czechia reach 80% by 2050 and the Slovenian LTS covers 80%-90%. Adopted after the LTS was submitted, the Portuguese climate law further clarifies national ambition, setting a target of 90% (2050 vs. 2005). For Belgium, the regions' emission reductions add up to 85-87% for non-ETS emissions when compared to 2005.

Finland provides a large range for expected emission reductions—63% to 90% (2050 vs. 1990). These results come from three scenarios: "with existing measures" (WEM), continuous growth and a savings scenario; all achieve net zero by 2035 but assumptions about removals vary accordingly. Notably, the new Finnish climate law has a quantitative reduction target of 90% (2050 vs. 1990) and aims to achieve a 95% reduction.

Croatia offers the lowest emission reductions of 57% to 73% by 2050 based on 1990. The LTS outlines no GHG removal to compensate for the remaining emissions, but does not mention climate neutrality (see Table 2). Austria and Germany have advanced their target dates for climate neutrality since LTS publication so the emission reductions provided—72-84% and 85%-90% (2050 vs. 1990), respectively—need updating.

Slovakia states that it aims for 95% emission reductions, but the modelling only achieves 80% and is therefore not in line with the reduction or climate neutrality target. Denmark and Latvia modelled only WEM scenarios, which likewise do not achieve climate neutrality. Such modelling might provide a good starting point; however, for an LTS this is insufficient since the approach lacks exactly the information about what needs be done to achieve the target. Luxembourg provides no information at all and there is currently no LTS available from Bulgaria, Cyprus, Ireland, Poland, and Romania.

Summary assessment

There are just two Member States – the Netherlands and Hungary – that outline, that emissions must fall by 95% by 2050 when compared to 1990 with the Netherlands having enshrined it as a target in national law; Greece indicates a range of 85-95% from the scenarios. However, almost half of the EU countries (thirteen) aim at emission reductions equal to or even below 90% which seems insufficient from an EU perspective and when compared to EU net zero scenarios which show that emission reductions must be somewhere above 90% (EC, 2018). In addition, six countries do not provide sufficient information in their LTSs but e.g., only net emissions, only non-ETS emissions or only WEM scenarios not reaching climate neutrality.

Table 2. Long-term targets for climate neutrality and emission reductions

	CLIMATE NEUTRALITY GOAL?		EMISSION REDUCTIONS IN THE LTS	
	TARGET YEAR	IN CLIMATE LAW	LONG-TERM TARGET	STATUS
AT	New: 2040	(Yes), law being revised	72%-84% (2050 vs. 1990) not in line with new target	Scenario outcome from 4 scenarios
BE	N/A (1)	None exists	85%-87% (2050 vs.2005) for non-ETS emissions (2)	Indicative (3)
BG	N/A	No	No LTS submitted as of March 2022	
HR	N/A	No	56.8%-73.1% (2050 vs. 1990)	Scenario outcome from 2 scenarios: gradual / strong transition
CY	N/A	None exists	No LTS submitted as of March 2022	
CZ	N/A	No	80% (2050 vs. 1990); (LTS being revised)	Scenario outcome
DK	2050	Yes	Only scenario with existing measures (WEM) not reaching the target	
EE	2050 (EE2035)	None exists	80% (2050 vs. 1990)	Government commitment
FI	2035	Yes	63%-90% (2050 vs. 1990)	Scenario outcome from 3 scenarios: WEM, continuous growth, savings; all achieve net zero by 2035.
FR	2050	Yes	83% (2050 vs. 2015) [~86% (2050 vs. 1990)]	Scenario outcome
DE	New: 2045	Yes	85%-90% (2050 vs. 1990) not in line with new target	Government commitment
EL	2050	Yes	85%-95% (2050 vs. 1990)	Scenario outcome from 2 scenario sets: 2°C and 1.5°C
HU	2050	Yes	95% (2050 vs. 1990)	LTS scenario outcome
IE	2050	Yes	No LTS submitted as of March 2022	
IT	2050	None exists	87% (2050 vs. 1990)	Scenario outcome
LV	2050	(Yes), law drafted	Only scenario with existing measures (WEM)	
LT	2050	None exists	≥80% (4)	Government commitment
LU	2050	Yes	No info in LTS	
MT	2050 (carbon neutral)	No	80% (2050 vs. 1990)	Scenario outcome
NL	(Almost) 2050	(Yes), GHG target in law	95% (2050 vs. 1990)	Enshrined in law
PL	N/A	None exists	No LTS submitted as of March 2022	
PT	2050	Yes	85%-90% (2050 vs. 2005); [~78%-85% (2050 vs. 1990)]	Scenario outcome from 2 scenarios: “Peloton”; “Yellow Jersey”)
RO	N/A	No	No LTS submitted as of March 2022	

Table 2. Long-term targets for climate neutrality and emission reductions

	CLIMATE NEUTRALITY GOAL?		EMISSION REDUCTIONS IN THE LTS	
	TARGET YEAR	IN CLIMATE LAW	LONG-TERM TARGET	STATUS
SK	2050	None exists (draft in 2022?)	90% (2050 vs.1990); and 80% (2050 vs. 1990) not in line with the target	Government commitment; and LTS scenario outcome for WA
SI	2050	None exists	80%-90% (2050 vs. 1990) incl. WEM not in line with target	Scenario outcome from 3 scenarios without scenario assignment
ES	2050	Yes	90% (2050 vs. 1990)	Scenario outcome
SE	2045	(Yes), adopted by parliament	85% (2045 vs. 1990)	Government decision (by parliament)

Source: National LTSs; Ricardo-AEA (2019); Duwe (2022), additional research to reflect up-to-date status; (1) Wallonia and Brussels-Capital: Carbon neutral by 2050; Flanders aims to move towards climate neutrality; (2) Wallonia: 80-95% (2050 vs. 2005); Flanders: 85% (2050 vs. 2005); (3) Regional targets: government commitment. (4) Lithuania aims at reducing net GHG emissions by 100% compared to 1990 covering up to 20% of the remaining emissions via natural sinks.

2.1.3 GHG REDUCTIONS PATHWAYS

Relevance of topic

Immediate actions reducing emissions already in the period up to 2030 also reduces the total amount of emissions released to the atmosphere over the period up to 2050, thereby helping the EU and the world to stay within the remaining carbon budget (see e.g., Meyer-Ohlendorf et al., 2018). This means that emission reduction pathways with higher annual reductions in early years and lower ones in later years are preferable to those that are linear or even indicate late action.

Setting interim targets along the way to 2050 provides a point of reference to check if emission reductions are on track towards the long-term goal and with respect to the envisioned pathway. Although scenarios can also provide such a reference, firm targets or at least indicative but clear milestones provide a more stringent point of reference for policy makers and allows civil society to hold policy makers accountable.

Information in the LTSs

There are basically two sorts of LTSs: 16 LTSs include some sort of scenarios outlining pathways up to 2050 while six LTSs include no scenarios. The LTSs with scenarios, however, do not necessarily reach the national target (Denmark, Latvia, Slovakia) (see Table 24) and LTSs without scenarios can still include clear quantitative (interim) targets (Germany, Estonia, Lithuania). France also refers to its carbon budget approach, but it is applied only for the short-term.

Of the LTSs with scenarios, most show the reduction pathways in the form of graphs without clearly outlining the underlying numbers. This makes it hard to check specific values, but it shows that half of the 22 countries with an LTS assume emission reductions to be rather linear between 2020 and 2050. Two countries (Croatia and Hungary) outline a linear emission reduction pathway or rather late action with large emission reductions taking place near 2050. Finland is at least in one of its scenarios also aiming at early action with large emission reductions to happen before 2040. There are seven countries without sufficient information to identify the emission reduction pathway (Denmark, Estonia, Germany, Latvia, Lithuania, Luxembourg, the Netherlands) (see Table 3).

Five countries have interim targets after 2030, although they do not necessarily outline clear pathways. This includes Latvia aiming at an emission reduction of 85% by 2040 when compared to 1990. Germany follows with 70% by 2040 whereby this interim target was increased to 88% in the national climate law following the new climate neutrality target year. Lithuania also aims at 70% by 2040 with an 85% reduction of net emissions of which 15% is compensated by removals. Malta has an interim milestone of 60% by 2040. Estonia provides a reduction target of net emission of 80% by 2035 when compared to 1990.

Table 3: GHG emission reduction pathways and interim targets

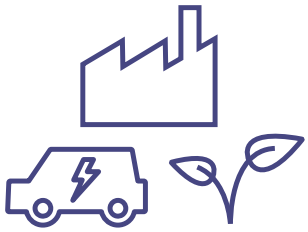
	INTERIM TARGETS FROM 2035 ONWARDS	SCENARIO OUTCOMES FOR INTERIM YEARS FROM 2035 ONWARDS	EMISSION REDUCTION PATHWAY
AT	No	Scenario outcomes in graph	Linear
BE	No	Scenario outcomes in graph	Linear
HR	No	44,8%-50,9% (2040 vs. 1990)	Late action to linear reduction pathway
CZ	No	64% (2040 vs. 1990)	Linear
DK	No	*Only scenario with existing measures*	
EE	Only for net emissions: *80% (2035 vs. 1990)*	*No scenario provided* [1]	
FI	No	Scenario outcomes in graph	Linear to early action
FR	No	Scenario outcomes in graph	Linear
DE	Old target as in LTS: 70% (2040 vs. 1990	*No scenario provided*	
EL	No	Scenario outcomes in graph	Linear
HU	No	Only scenario for net emissions: 64% (2040 vs. 1990)	Late action to linear reduction pathway
IT	No	Scenario outcomes in graph	Linear
LU	No	*No scenario provided*	
LV	85% (2040 vs. 1990)	Only scenario with existing measures not meeting the interim target	
LT	Only for net emissions: 85% (2040 vs. 1990) (with 15% removals)	*No scenario provided*	
MT	Milestone: 60% (2040 vs. 1990)	Scenario outcome in graph equals target [2]	Linear
NL	No	*No scenario provided; refers to available data in NECP*	
PT	No	65%-75% (2040 vs. 2005)	Linear
SK	No	60% (2040 vs. 1990) from scenario not meeting the 2050 target	Late action
SI	No	55%-66% (2040 vs. 2005)	Linear
ES	No	Scenario outcome in graph	Linear
SE	No	75% (2040 vs. 1990)	Linear

Source: own compilation based on national LTSs, and cross-check with Ricardo-AEA (2019). Excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland and Romania). (1) based on Estonia 2035 (see also Table 24); (2) Malta uses abatement potentials to outline the emission reduction by 2030, 2040 and 2050.

Summary assessment

Almost all LTSs with scenarios project rather linear emission reductions until 2050 with only three seeing key emission reductions to happen close to 2050 (Croatia, Hungary, Slovakia). Only Finland provides at least one scenario with early action leading to key reductions already before 2040. In addition, only five countries outline interim targets in their strategies. Additional 14 countries provide at least some indication from their scenario(s) either as a number in text or in a graph. This means that there is currently limited accountability for interim progress towards the 2050 goal in the EU Member States. This, however, may change with an EU GHG emission target for 2040 set according to the ECL (Art. 4(3)) and following obligations for Member States.

2.2 SECTORAL ELEMENTS



This section covers the sectoral elements (see Figure 2): energy supply and energy demand with information on transport, buildings and industry; as well as GHG emission reductions in agriculture and GHG removal from natural and technical sinks.

Sectoral information in the LTSs helps to better understand how much parts of the economy have to contribute to emission reductions and GHG removal. In general, when reaching climate neutrality, the remaining hard-to-abate (or 'residual') emissions are expected to come from agriculture (mainly from fertiliser use and animal husbandry), followed by transport (mainly aviation and heavy good vehicles) and industrial processes (mainly from non-metallic mineral products such as clinker and lime) (EC, 2018). They can be offset by natural or technical sinks to a certain extent. This means that all other sectors must reduce emissions close to zero or even reach net negative emissions. This applies to electricity generation, buildings, private mobility, and most of the industrial branches. However, there are national differences so that each country should investigate sectoral emission reductions and related national enablers.

2.2.1 ENERGY SUPPLY

Relevance of topic

Energy generation is the main source of emissions in the EU (EEA, 2021c). The in-depth assessment that formed the basis for the EU LTS (EC, 2018) shows that these emissions must fall to almost zero. This can be achieved through significant reductions in energy consumption (see section 2.2.2) and an almost complete shift to renewable energies including wind, solar, hydro and biomass (see section 2.3.2). Renewables will supply electricity, heat and fuels (e.g., green hydrogen; see section 2.3.1) while the role of conventional fuels will shrink to some particular applications – most predominantly air and heavy-duty transport.

Information in the LTSs

RENEWABLE ENERGIES

All EU countries see a significant shift to renewable energies as the primary source for covering the energy needs up to 2050. However, only half of the EU countries with submitted LTSs provide a specific share for the longer term (see Table 4). Thereby, the share of renewables in energy consumption varies from 53%-66% in Croatia to 82%-114% in Greece ([3]). Luxembourg outlines a share of renewables of 100% of energy consumption by 2050 and Spain of 97%. Belgium provides no information on the national level, but Wallonia and Brussels aim at 100% renewable energy by 2050 while Flanders aims at increasing the share of renewables as much as possible including a complete phase-out of fossil fuels in the electricity mix. The French LTS outlines, that by 2050, the energy mix will be carbon free supplied by a large share of carbon-free electricity. However, 2 $MtCO_2e$ remain as GHG emissions – possibly non-CO_2 emissions from fuel handling – leading to a reduction of 97% (see Table 5).

3. The share results from consideration of renewables directly and indirectly used and reaches a value above 100% particularly due climate neutral synthetic fuels. It is unclear which is the share of renewables without considering these indirect shares.

Table 4: Share of renewables in 2050

MS	SHARE OF RENEWABLES IN:			
	ENERGY CONSUMPTION	ELECTRICITY	HEATING & COOLING	TRANSPORT
AT	76-93%	100%	No info	
HR	53-66%	No info		
FL	64% / 80% / 78%	No info		Biofuels: 41-53%
EL	82-114% (*)	96-104% (*)	60-93% (*)	300-500% (*)
HU	ca. 90%	71%	No info	
IT	≥ 85-90%	95-100%	No info	100%
LT	90%	100%	District heating: 100%	90%
LU	100%	No info		
NL	No info	100% CO_2-neutral	No info	
PT	86%-88%	100%	66%-68%	94-96%
SI	≥ 60%	80%	50%	65%
ES	97%	100%	97%	79%

Source: own compilation based on national LTSs, and cross-check with Ricardo-AEA (2019).
Excluding countries without quantification, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland and Romania). (*) see footnote 1.

The expected role of renewables in *electricity* generation is more significant (with five countries stating that renewables will supply 100% of electricity in 2050). In contrast, the share of renewables is expected to be lower in heating and cooling and in the transport sector (see Table 4).

Countries with a high share of renewables in electricity generation by 2050 also have high GHG emission reductions in electricity supply. The outlined GHG reduction is above 90% for most countries providing data (ten out of 14) or even 100% (Belgium, Greece for one scenario, Lithuania, and Spain) (see Table 5).

FOSSIL FUELS AND NUCLEAR ENERGY

All countries consider a significant reduction in fossil fuel use by 2050. New nuclear is seen as an option only by a few countries, including Finland where two new nuclear power stations are currently being built; Czechia and Slovakia which want to keep nuclear power; and Slovenia which wants to decide by 2027 between a nuclear and a synthetic fuel pathway based on currently still missing cost estimates.

The phase-out of coal is envisioned in 12 countries plus three countries where coal is expected to play a minor role of less than 3% in primary energy consumption by 2050. Earliest was Sweden, phasing out coal energy generation in 2020 (two years in advance of the announced 2022 target year); Slovakia follows with the expected decommissioning of Nováky power plant in 2023 and Vojany power plant in 2025. Slovenia planned for 2040 in their LTS but now published a coal exit strategy with the end date for coal being 2033.

Table 5: Emission reduction in electricity supply between 1990 and 2050

MS	GHG EMISSION REDUCTION (2050 VS. 1990)	PATHWAY
AT	~24-73% for energy (including buildings and transport) (*)	Linear
BE	100%	
HR	61-93%	
FI	~80-98% (*)	Linear
FR	97%	Linear
EL	~97-101% (*)	
HU	98%	Linear
IT	88%	
LT	100%	
PT	~98% (*)	Linear
SI	99% (2050 vs. 2005)	
ES	~100% (*)	Linear
SE	~60% (1990 vs. 2045) (*)	

Source: own compilation and calculation based on national LTSs, Ricardo-AEA (2019) and EEA (2021c). (*) = percentages based on own calculation from absolute values. Excluding countries which do not provide an emission reduction figure, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).

Natural gas is considered as a transitional fuel by nine countries and Croatia still considers the choice of such an approach (Kobyłka and Laskowski, 2022). By 2050, nine countries either aim at phasing out fossil fuels in energy generation (Latvia, Lithuania, Luxembourg) or they aim at climate neutral or carbon free gas consumption (Austria, Slovenia) or energy consumption (Estonia, France); Greece and Finland still have a considerable share of natural gas in their energy consumption in some scenarios – these countries aim at using carbon capture and storage (CCS) to store such emissions. The role that natural gas will play in any future energy mix needs to be re-considered in the light of the Russian invasion of the Ukraine as a large share of the European gas consumption is currently supplied by the Russian Federation.

Mineral oil and its products also see a drop until 2050 but compared to coal or natural gas, mineral oil use still seems to be more widespread. Exemptions include Portugal which outlines a phase-out of mineral oil by 2040; Luxembourg and Latvia envision a phase-out of all fossil fuels including mineral oil in energy generation by 2050; Italy assumes a limited share of 0.5% of primary energy consumption in 2050 – the country assumes that final energy consumption will be predominantly electrified and covered by renewable energies, but oil and gas will continue to be used in 2050, especially where they are difficult to substitute.

There is no information on the role of fossil fuels and nuclear in the LTSs of Belgium, Germany, Denmark, Spain, the Netherlands, and Malta.

Table 6: Role of fossil fuels and nuclear in the LTSs

	COAL	NATURAL GAS	MINERAL OIL	NUCLEAR
AT	Rapid phase-out of coal without specific date	Gas consumption should be CO_2 neutral by 2050	Use of heating oil will practically be reduced to zero	No consideration of nuclear power
HR	No new coal but existing plants can still operate	22%-29% of PEC	21%-24% of PEC	Zero with 2043 as expected operating ending of Krško
CZ				2 of 3 scenarios build on Dukovany plant
EE	Transitioning "to climate neutral energy production"			No info
FI	Phase-out in 2029 (parliament approval)	Relatively high share in 2050	Sharp drop in mineral oil consumption	1-2 plants to start operation by 2030
FR	Phase-out by 2022 in power generation and heat production	No specific info (but "carbon-free energy production by 2050"	By 2028, phase-out in heating in private and government buildings	
EL	Phase-out of lignite for power generation before of 2030	1%-14% (of FEC in 2050 (4 scenarios)	4%-22% of FEC in 2050 (4 scenarios)	No nuclear
HU	4% of PEC in 2050 (early action scenario)	8.7% of PEC in 2050 (early action scenario)	11% of PEC in 2050 (early action scenario)	23% of PEC in 2050 (early action scenario)
IT	1% of PEC in 2050	4% of PEC in 2050	0.5% of PEC in 2050	No nuclear
LV	Phase-out of fossil fuels for energy generation.			
LT	Phase-out of fossil fuels in energy production by 2045			No nuclear
LU	Phase-out of all fossil fuels by 2050 (government commitment)			No nuclear
PT	Phase-out of coal power generation in 2030 (enshrined in law)	~ 10% of PEC in 2050; phase-out of gas-fired power generation in 2040	Expected phase-out in 2040	No nuclear
SK	Decommissioning in 2023 and 2025 (Nováky and Vojany); earlier in the transition scenario			
SI	Phase-out by 2040 (now 2033 according to exit coal strategy)	Only CO_2-neutral gases by 2050	Phase-out of fossil fuels by 2050 in transport; significant reduction in building sector	Phase-out by 2043 according to one scenario and no phase-out under nuclear scenario

Source: own compilation from the national LTSs. Excluding countries which do not provide a figure or clear phase-out statement, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).

Summary assessment

All countries envision a clear shift to renewables with some differences depending on the use of natural gas and nuclear in the energy mix in 2050. Luxembourg clearly states that it will turn to 100% renewable energy and that it will phase-out all consumption of fossil fuels; however, the LTS provides no scenarios on how to achieve this objective. Latvia and Lithuania also aim at phasing out fossil fuels in energy generation but Latvia states no clear target for renewables and the scenario does not reach the climate neutrality target; Lithuania aims at a share of 90% renewables and 90% emission reduction in transport which implies some form of conventional fuel generating the 10% energy and 10% emissions. Estonia, Finland, France, and Greece outline a carbon-free or rather carbon-neutral energy production by 2050 whereby the LTSs of Finland and Greece state that the countries will still have natural gas and mineral oil products in their energy mix and related emissions will be captured and stored or balanced with technical or natural sinks. Portugal provides a very good overview on their future energy mix including clear phase-out dates for coal, gas-based power generation and the use of mineral oil products.

Table 7: Energy consumption reductions by 2050

	PRIMARY ENERGY CONSUMPTION (PEC) REDUCTION	FINAL ENERGY CONSUMPTION (FEC) REDUCTION	PATHWAY
AT	No info	38%-52% (vs. 2005)	
HR	25%-34% (vs. 2005)	25%-37% (vs. 2005)	Linear from interim values
EE	No info	12% reduction target (2050 vs. 2019) for residential sector	
FI	~ 1200-1250 PJ (depending on scenario); 14% (vs. 2005) (low emission scenario)	~ 240-260 TWh depending on scenario); 16% (vs. 2005) (low emission scenario)	Linear
FR	No info	Almost 50% (vs. 2015)	Linear
EL	21%-51% (vs. 2005) (depending on scenario)	No info	Linear or late action depending on scenario
HU	No info	30%-37.4% (vs. 2007) (depending on scenario)	Linear or late action depending on scenario
IT	No info	40% (vs. 2018); 49% (vs. 2005)	
LV	65% reduction compared to reference with PEC = 118 PJ; 37% (vs. 2005)	No info	
PT	44%-47% (vs. 2015); 53%-50% (vs. 2005)	25%-28% (vs. 2015); 36%-35% (vs. 2005)	Linear
SK	No info	≤ 40 TWh; 33% (vs. 2005)	Linear
SI	50% (vs. 2020); 41% (vs. 2005)	32% (vs. 2020); 44% (vs. 2005)	Linear

Source: own compilation based on national LTS and calculations of energy consumption reductions compared to 2005 of Ricardo-AEA (2019). Excluding countries which do not provide a figure and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).

2.2.2 ENERGY DEMAND

Relevance of topic

Energy consumption is responsible for around 77% of EU GHG emissions (EEA, 2021c). Moving towards net zero GHG emissions requires a reduction of energy consumption across all sectors to supply the rest mainly via renewable energies (see also section 2.2.1). According to the in-depth assessment for the LTS (EC, 2018), primary energy consumption must fall in the order of 31%-42% by 2050 when compared to 2005 (which translates to roughly 25-37% when compared to 1990). The most important levers include a shift towards public transport, non-motorised mobility and electric vehicles in the transport sector, deep renovations of buildings and the energy-intensive industry switches to fuels that are based on renewable energies (e.g., green hydrogen or synthetic fuels). These three sectors play a key role in reducing energy demand to move to a carbon-free society.

Information in the LTSs

PRIMARY AND FINAL ENERGY CONSUMPTION

Energy efficiency is seen as the second important pillar (next to the shift to renewables) to reach a climate neutral energy system. For example, France sees energy efficiency as one of the key levers in their transition; Austria states that energy efficiency measures are among the most economically beneficial levers for avoiding GHG emissions; and Latvia references the 'energy efficiency first' principle throughout the document.

There is no country already specifying a target for total energy consumption reductions by 2050 besides Lithuania. The country aims at achieving a at least 2.4 times reduction in primary and final energy intensity compared to 2017 which translates roughly into 50-58% by 2050.

Only 13 countries outline their primary and/or final energy consumption reductions (see Table 7) with very varying information such as the countries refer to different base years, and Latvia calculates the reduction against a reference case. Some do not provide a reduction but rather the energy consumption (with varying units). This makes it difficult to compare. Ricardo-AEA (2019) did some recalculations which are included in Table 7. From a rather broad view, most countries indicate that they will reduce energy consumption by 2050 somewhere in the order of 30-50%.

The pathways for energy consumption reductions are rather linear for six of the eight countries providing them. Hungary shows a linear or late energy consumption reduction depending on the scenario. In the Greek LTS, energy consumption differs significantly for the different scenarios with scenarios focusing on new energy carriers (NC2 and N1.5 scenarios) showing a decreases of primary energy consumption until 2035, with a rapid increase thereafter due to development of hydrogen production and synthetic fuels. There are five countries that also provide interim milestones (Croatia, Finland, Hungary, Lithuania, and Slovenia).

Most other LTSs provide qualitative information about where efficiency improvements are most important with e.g., the three regions of Belgium highlighting buildings as most important, Croatia highlighting buildings and transport, Malta highlighting buildings and industry and Czechia and Luxembourg highlighting energy efficiency in buildings, transport and industry. Luxembourg has no quantitative target but outlines that energy efficiency needs to be improved by renovations of buildings, near-zero energy and circular new constructions, efficient product standards, efficient production processes, active mobility and public transport, electric vehicles and the integration of the energy and transport sectors, the orientation of the most efficient energy carriers towards the different uses, the initiatives of active demand participation, the deployment of flexibility solutions on the energy networks and the more efficient distribution of energy thanks in particular to new technologies. Czechia states that by 2050 fuel consumption per vehicle-kilometre must be reduced by 30%-70%, heat losses of buildings need to fall by 30%-50% in private buildings and commercial buildings heating consumption will decrease by 30%, consumption of hot water by 10% while energy consumption for cooling will remain the same; industry has to see a reduction of annual energy consumption by 3% per year.

Some other LTSs have a rather general statement that energy efficiency is important including Germany, Italy, and Sweden. For example, Italy outlines that energy efficiency will be increased in line with European principles and can contribute to positive effects such as the protection of natural resources, improved energy security and energy independence by reducing energy demand. The Netherland have no information on energy efficiency in their LTS and refer to their NECP for any information.

TRANSPORT

Twenty LTSs cover emission reductions from transport, with most of them also providing quantitative information, generally from modelling results (see Table 8 for overview). Only Estonia and Lithuania provide an indicative target – Estonia for 2035 and Lithuania for 2050. However, it remains open how the emission reductions will unfold over the specified time frame.

Thirteen countries provide the emission reduction expected in the transport sector by 2050. Belgium and Italy plan for a zero-emission transport sector by then. Slovenia (98%), France (97%), and Spain (98%) closely follow; Greece and Portugal as well with at least one of their scenarios. In contrast, the LTS of Croatia shows an emission reduction of 28 - 55% by 2050 which is at the lower end.

Only eight Member States mention how the reductions will be distributed over time: the majority of these countries (Finland, France, Greece, Malta Portugal and Spain) indicate that emission reductions will be linear; Croatia mentions that emissions will be reduced mainly by the end of the period; and Slovenia expresses that the reductions will be delayed until 2030 and progress gradually thereafter. More rarely, Member States present quantitative information for more than one year, including for instance 2040 and 2050 (Finland, Malta, Portugal, Slovenia, and Spain). In addition, single targets for earlier points in time, such as 2035 (Estonia) or 2040 (Slovakia), were also included.

Table 8: Emission reduction in transport between 1990 and 2050

MS	GHG EMISSION REDUCTION (2050 VS. 1990)	PATHWAY
BE	100%	
HR	28-55%	Late action
FI	~68-97% (*)	Linear
FR	97%	Linear
EL	88% / 99.5%	Linear
HU	~78% (*)	
IT	100%	
LT	90%	
PT	84-85% / 98%	Linear
SI	99%	Delayed until 2030
ES	98%	Linear
SE	~25% (*) (1990 vs. 2045)	

Source: own compilation and calculation based on national LTSs, Ricardo-AEA (2019) and EEA (2021c). (*) = percentages based on own calculation from absolute values. Excluding countries which do not provide an emission reduction figure, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).

In addition, many countries identify concrete actions to achieve emission reductions. The most common aspect is the required shift to alternative means of transport which should be promoted (Estonia, Malta and the Netherlands), including the use of public transport (Austria, Lithuania, Malta, Portugal and Lithuania). Another key element is fuel switch. Primarily, LTSs outline the electrification of transport as a way to decarbonise road (Malta and Lithuania) and rail transport (Latvia) as well as the use of alternative fuels such as biofuels, hydrogen and synthetic fuels in some applications (Italy, France, Greece, Spain and Sweden). However, hardly any country addresses which fuel is expected to be used for which mode of transport and in what proportion. Italy provides the most comprehensive description in this context. Their LTS envisages that half of the energy demand for transport will be covered by electricity (from renewable energy sources) and the other half by biofuels, hydrogen and synthetic fuels in 2050. Biofuels, hydrogen and synthetic fuels will be mainly used when direct electrification is difficult to achieve. This applies, for instance, to heavy duty transport and shipping. In the case of aviation, only biofuels and synthetic fuels are considered as viable options.

BUILDINGS

Most Member States address the building sector in their LTS. Out of the 17 LTSs that cover building, ten present emission reductions for the year 2050 from their scenarios (see Table 9), with some countries also providing interim milestones for 2040 (Malta, Portugal, Slovenia, and Spain).

Hungary, Italy, Lithuania, and Spain aim to reduce 100% of their building-related emissions by 2050 and Greece pursues 90 to 100%. In the other countries, full decarbonisation is not planned: France and Slovenia, for example, are planning a 95% reduction in emissions (compared to 1990) in the entire building sector; and Portugal, on the other hand, aims for a 96-97% in residential and a 100% emission reduction in the service sector (compared to 2005).

As part of these scenario projections, six Member States have determined how emission reductions should develop over the period to 2050. The majority plans to reduce emissions linearly until 2050 (France, Greece, Portugal, Slovenia, and Spain). The LTS of Malta, which outlines the abatement potentials in each sector, however, indicate that the country could take immediate action to reduce emissions already by 2030.

Table 9: Emission reduction in buildings between 1990 and 2050

MS	GHG EMISSION REDUCTION (2050 VS. 1990)	PATHWAY
BE	88-90%	
HR	55-74% (includes fuel combustion in agriculture, forestry and fishing)	
FR	95%	Linear
EL	90-100%	Linear
HU	~100% (*)	
IT	100%	
LT	100%	
PT	~96-97% (*)	Linear
SI	95%	Linear
ES	100%	Linear

Source: own compilation and calculation based on national LTSs, Ricardo-AEA (2019) and EEA (2021c). (*) = percentages based on own calculation from absolute values. Excluding countries which do not provide an emission reduction figure, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).

About half of the Member States (also mention explicit actions to decarbonise the building sector in their LTSs. Most frequently it is stated that the energy efficiency of buildings is to be improved (Latvia, Estonia, and Greece) with references to energetic modernisations (Finland, Portugal and Spain), deep renovations (Croatia, Italy and Malta) and that new buildings should be designed according to the principles of nearly zero emission buildings (Croatia and Spain). Additionally, energy consumption in buildings needs to undergo a fuel switch to renewable energy (Austria and Spain). In some cases, countries outline corresponding technological solutions such as heat pumps (Greece, Portugal and the Netherlands) or electrified hobs (Italy). Alternatively, some countries indicate that they are also considering the use of fuels (based on renewable energy) when direct electrification is not possible (Austria, Italy, and the Netherlands).

INDUSTRY

Twenty-one Member States report on the decarbonisation of industry, with 17 of those countries also providing quantitative information. Typically, countries only present scenario estimates of emission reductions in industry. Only Lithuania aims at fully reducing industry-related emissions by 2050 by phasing-out the use of fossil fuels and using environmentally safe carbon capture and utilisation.

In most cases, countries calculate emission reductions for the year 2050. Besides Lithuania, Greece is also aiming for a complete decarbonisation of the industry in one of the applied scenarios. Hungary follows with a 98% reduction, Belgium with 94-95% and Spain with 91% compared to 1990 levels. Greece and Finland present the lowest emission reduction in one of their scenarios, respectively.

Table 10: Emission reduction in industry between 1990 and 2050

MS	GHG EMISSION REDUCTION (2050 VS. 1990)	PATHWAY
AT	~83-84% (*)	Late action
BE	~94-95% (*)	
HR	64-83%	
FI	~56-90% (*)	Linear
FR	81%	Linear
EL	48-106%	Linear
HU	98%	Linear
IT	84%	
LT	100%	
PT	~67-68% (*)	Linear
SI	87%	Late action
ES	~91% (*)	Linear
SE	~61% (*)	

Source: own compilation and calculation based on national LTSs, Ricardo-AEA (2019) and EEA (2021c). (*) = percentages based on own calculation from absolute values. Excluding countries which do not provide an emission reduction figure, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).

How emission reductions are to evolve until 2050 is only covered by nine Member States. In most of these countries (Finland, France, Greece, Hungary, Portugal and Spain), it is envisaged that emissions will be reduced linearly over time. Malta mentions that it wants to take immediate action, whilst Austria and Slovenia intend to take late action. Some Member States also present interim milestones. Lithuania and Slovenia, for instance, mention that by 2040 emissions will be reduced by 100% and 60-70% respectively. Croatia, on the other hand, envisages a 54-58% reduction in emissions for the year 2030.

Member States usually present a wide range of measures to reduce emissions from industry in their LTSs. About a third of the LTSs include plans on decreasing the overall energy demand in industry by improving energy efficiency, meeting the remaining energy demand with renewable energy, and electrifying industrial processes as much as possible. Austria, Italy, Luxembourg and Spain plan to substitute some high-carbon processes with clean hydrogen; Finland mentions the use of biofuels; and Sweden wants to switch to renewable energy carriers in industry. In addition, some countries plan to capture emissions from industrial processes such as from cement and steel production including Croatia, Czechia, France, Greece, Italy, Lithuania, Luxembourg and Sweden.

Summary assessment

Member States demonstrate different levels of detail and ambition in their LTSs to reduce GHG emissions. This can be seen, for example, in the fact that the expected emission reduction for 2050 in transport lies between 25-100%, in buildings between 55-100% and in industry between 48-106%. The ways in which Member States aim to achieve these emission reductions refer to a reduction of energy demand and a shift to clean sources including electrification, synthetic fuels and green hydrogen. In transport and buildings, LTSs also highlight the role of behaviour changes but without clearly quantifying what this means in terms of emission reductions. For industry, Member States also mostly consider decarbonisation through efficiency improvements and fuel switching. Some countries plan to offset the remaining emissions from industry through carbon capture and storage (see also Section 2.3.3).

2.2.3 AGRICULTURE

Relevance of topic

The EU agriculture sector is facing a three-fold challenge: ensuring food security for all Europeans, guaranteeing a fair income for farmers, and reducing the impacts on the climate and the environment associated with current practices. In 2019, the agriculture sector was responsible for around 11% of total GHG emissions in the EU. When compared to 1990, agricultural GHG emissions fell by 21%, but they have stabilised at around 380-390 Mt CO_2e since 2005 and trends vary widely at the national level (EEA, 2021d). Over 80% of total agricultural GHG emissions are methane (CH_4) emissions from enteric fermentation and nitrous oxide (N2O) emissions mainly from fertilisation of soils (EEA, 2021a). GHG emissions and removals from land use, land use change and forestry are not part of the agricultural sector and therefore discussed separately (see section 2.2.4).

Under existing technology and management options, agricultural emissions can never be fully eliminated, only reduced though e.g., efficient fertiliser use and using animal excrement and organic residues for biogas production, thus generating energy while preventing methane to enter the atmosphere (COM, 2020b). Although there is still potential for livestock farms to reduce their GHG emissions by applying on-farm climate actions, changing consumer behaviour towards more healthy diets is expected to be just as important in terms of reduction potential (COWI et al., 2021; EC, 2020a).

Information in the LTSs

Almost all countries have a section on agriculture in their LTS (except for Denmark and Estonia), although there are big differences in how much detail they provide. Some countries project emission reductions for the agriculture sector by 2050, ranging from 22% in Slovenia (base year 2005), to 79% in Hungary (base year 1990) (see Table 11). The rest of the countries do not provide any figure or just under a scenario that does not reach the long-term target.

France projects that agricultural emissions are approximately halved by 2050, to which end the country describes the changes that need to materialise by then, including a reduction of livestock and surplus nitrogen, as well as a maximised soil cover. Italy also indicates that over time, agricultural land and production are to be reduced. The French LTS points out that the agriculture and forestry sector record the lowest emission decreases, but that the efforts required are no less ambitious compared to other sectors. However, even with a 46% reduction, remaining emissions would be 48 Mt CO_2e. For Italy, a 33% reduction would entail remaining emissions of 23 Mt CO_2e and Spain a 60% reduction would leave 19 Mt CO_2e by 2050. By contrast, Slovakia's LTS contains only a WEM projection which shows a slight increase (0.9%) of agricultural emissions by 2040 referring to storage rules for organic fertilisers and the right feeding strategy. To reverse this trend, the Slovakian LTS acknowledges that the country has to adopt additional measures.

Where LTSs show a pathway up to 2050 for agricultural emission reductions, this is generally linear. Malta's estimates show that emission reductions start late after 2040.

Table 11: Emission reduction in agriculture between 1990 and 2050

MS	GHG EMISSION REDUCTION (2050 VS. 1990)	PATHWAY
AT	~39-50% (*)	
BE	55-59%	
HR	51-56%	
FI	~32-60% (*)	
FR	46%	Linear
EL	55% (non-CO_2 emissions)	Linear
HU	79%	
IT	33%	
PT	~26-52% (*)	Linear
SI	22%	
ES	~57% (*)	Linear
SE	~37% (*)	

Source: own compilation and calculation based on national LTSs, Ricardo-AEA (2019) and EEA (2021c). (*) = percentages based on own calculation from absolute values. Excluding countries which do not provide an emission reduction figure, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).

Countries plan to reduce GHG emissions in different areas whereas in about half of the LTSs the description of specific agricultural measures to reduce GHG emissions is limited. In the others, changes in diet are often mentioned as driving factors for reducing GHG emissions related to the agriculture sector and in some cases these changes are integrated in the LTS scenarios; for example, the main scenario in Austria assumes a long-term changeover to a climate-friendly diet. But also, France, the Netherlands, Luxembourg, Slovakia, Finland, Croatia and Slovenia point at the significance of dietary changes. Other highlighted measures include optimising nitrogen supply in crops (e.g., highlighted by Spain), the use of precision agriculture (e.g., Italy), channelling increasing amounts of manure into biogas production (e.g., Finland), reducing food loss and waste (e.g., Luxembourg), and maximising soil cover according to the principles of agro-ecology (e.g., France).

Summary assessment

In conclusion, eight LTSs (Croatia, Finland, France, Hungary, Italy, Malta, Slovakia, Spain) analyse agriculture more in-depth compared to others. Countries expect to achieve different levels of emission reduction mainly in the order of 30-60%. The exception is Hungary that outlines an emission reduction of 79%. There are some governments that plan to reduce agricultural production as part of a broader set of measures (France, Italy), whereas most others mainly focus on the implementation of improved technological and management options. However, it becomes clear in eight countries that dietary changes are a key ingredient in reducing agricultural emissions beyond the implementation of technical measures and sustainable farming practices. Eight countries do not outline their agricultural emission reductions as part of a scenario that meets their climate neutrality target.

2.2.4 GHG REMOVAL

According to the net zero emission scenarios of the EU LTS, EU Member States will need GHG removals to compensate for the remaining, hard-to-abate emissions in the order of 300-500 Mt CO_2e (EC, 2018). Removals – either natural carbon sinks or technical GHG removal stored, e.g., in underground formations – play a central role in most projections achieving net zero emissions by mid-century. However, options differ widely when it comes to their maturity, potentials, costs, risks and benefits (IPCC, 2018).

Therefore, natural and technical GHG removal should not be overestimated in a country or across the EU and their use should account for other societal and environmental concerns, such as human health and biodiversity.

Relevance of the topic

The land use and forestry sector covers sequestration (natural sinks) and emissions from land use, land use change, and forestry (also abbreviated as LULUCF), which includes carbon stores such as soils and peatlands and biomass such as trees. Depending on national land cover, most of the Member States' land use and forestry sector currently generates net removals. In 2019, forest land in the EU removed 329 Mt CO_2 resulting in net emission removal of 249 Mt CO_2 from land use and forestry whereby the trend of the past 15 years goes into the wrong direction showing a reduction of the net removal in the EU (EEA, 2021c, 2021d). While the sink function of forests will be central, also decreased emissions from land use (and increased soil sequestration) will be required for the EU LULUCF sector to achieve the estimated net sink of 300-500 Mt CO_2 by 2050 (EC, 2018).

Besides natural sinks, technical options including the use of biomass for energy generation coupled with carbon capture and storage (BECCS), direct air carbon capture and storage (DACCS), biochar, enhanced weathering, ocean alkalinisation and ocean fertilisation can remove carbon dioxide. These technical options store the emissions in geological reservoirs or via chemical processes. They differ widely when it comes to their maturity, potentials, costs, risks and benefits with BECCS appearing to be the most promising option (see e.g. McDonald et al., 2021; IPCC, 2018). The in-depth analysis of the EU LTS estimates a technical removal from BECCS and DACCS of 50 – 260 Mt CO_2e by 2050 depending on the focus on natural sinks or technical removal, respectively (EC, 2018).

Information in the LTSs

NATURAL SINKS

All Member States with a climate neutrality target refer to removals to compensate for the remaining emissions. In general, there is no target set for removals but any quantification of natural and technical GHG removal is the outcome of one or more scenarios reaching climate neutrality. Only Malta, specifically excluded any contributions to their target from removals in its LTS due to the very low potential of natural carbon sinks on the island.

The LTSs mainly focus on natural sinks and less so on technical removal (see Table 12). There are five countries that assume that natural sinks will remain more or less stable, removing similar amounts of CO_2 from the atmosphere in 2050 when compared to 2019. This includes Hungary, Italy, Slovakia, and Spain. Hungary wants to stabilise its land use and forestry removal at 4.5 Mt to 5 Mt CO_2 (5.6 Mt in 2019); Italy aims at re-establishing a natural carbon sink of 45 Mt CO_2 by 2050 through fire-fighting and sustainable soil management whereby the country already achieved a removal of 42 Mt in 2019. Slovakia assumes removing 4.4 Mt up to 7 Mt CO_2 in 2050 (6.3 Mt in 2019) through land use and forestry. Spain's LTS outlines a mix of afforestation, promotion of forestry, restoration of wetlands and pastures and measures to improve the organic carbon content of soils to achieve 37 Mt CO_2 in 2050 (which is in line with the removal of 38 Mt in 2019). Slovenia aims at removing 2.5 Mt CO_2 in land use and forestry which is below the 2019 level of 0.1 Mt CO_2 removal but in line with the average over the past 10 years.

However, other countries including Austria, Finland, France, Latvia and Portugal assume a doubling or even higher increases to compensate for remaining emissions. Thereby Austria and Finland provide different scenarios for removals leading either to increased natural or technical removal (see next section). The Portuguese LTS show a doubling of removals to achieve 11.8-13.4 Mt CO_2e from agriculture and forestry in 2050. Beyond that, it provides limited information, focusing on forest fire control and productivity increases across forestry species as important levers to reach the targeted increase in natural carbon sinks by 2050. France wants to more than double its removals from natural sinks from 31 Mt CO_2 in 2019 to 67 Mt CO_2 in 2050 plus capturing and storing 10 Mt CO_2 of bioenergy emissions. The country aims at increasing resilience of forests and adapting to climate impacts, optimising forests as a natural carbon sink and increasing wood harvesting and related wood products sink function. At the same time, there is the objective of "sustainable and multifunctional forest management" including biodiversity preservation and economic value and employment creation. Latvia assumes to remove 4 Mt CO_2 in 2050 while it could only remove 1.2 Mt CO_2 in 2019 due to forest ageing and deforestation. The country wants to "seriously evaluate" all land use changes and support reforestation.

Lithuania outlines a removal of 8.6 Mt CO_2 in 2050 coming from CCS/CCU and land use and forestry without specifying the respective contributions.

The Swedish LTS does not specify to what extent removals must increase but acknowledges that additional action is needed to reach climate neutrality in 2045, and that this includes net removals from forests and other land types as well as BECCS. The country has developed its own strategy for attaining such removals (Swedish Government, 2020). LTSs of Croatia, Estonia, Luxembourg and Germany outline that additional removal should come from agriculture and forestry also without clear quantification. Denmark has not yet decided on the role of land use and forestry, and Czechia, Greece and the Netherlands provide no information on removals at all. Belgium provides no information at the national level and at the regional level only some qualitative information.

Table 12: Natural and technical GHG removal in the LTSs

	GHG REMOVAL (MT CO2) FROM SCENARIO(S)			
	FOCUSSING ON NATURAL SINKS		FOCUSSING ON TECHNICAL SINKS	
MS	NATURAL SINKS	TECHNICAL SINKS	NATURAL SINKS	TECHNICAL SINKS
AT	17.0	0.0	3.9 - 0	8.8 - 18.7
FI	25-28	0	16.4	14.0
FR			67	10
EL	N/A	0 - 4.8 (2.7 BECCS+ 2.1 DAC)	N/A	0.9 - 8.5 (2.9 BECCS + 5.6 DAC)
HU	4.5 - 5	Non-quantified BECCS uptake		
IT	45	0		
LV	4	0		
LT	8.6 (natural and technical sinks)			
PT	9 - 11.8 - 13.4	0		
SK	4.4 - 7	0		
SI	2.5	0		
ES	37.0	0		

Source: own compilation based on national LTSs and cross-check with Ricardo-AEA (2019).
Excluding countries which do not provide any figure, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).

The pathways up to 2050 are generally rather linear (e.g., in Finland, Latvia, or Portugal) or not specified at all. The Slovenian LTS, however, indicates immediate action and increasing sinks until 2025 which then stabilises until 2050. In contrast, Slovakia seems to assume late action when analysing data from emissions and removals in the land use and forestry sector (Kobyłka et al., 2022).

The information on natural sinks is limited when it comes to the nature of natural removals and the specific underlying actions, i.e., how the estimated removals will be achieved. In general, all countries focus on the role of forestry while land use and land use change play a limited role. Sustainability aspects including biodiversity or ecosystem services are mentioned but mostly in a rather generic sentence. However, some countries refer to their separate forest strategies, which could not be evaluated in the context of this report. Some countries have additional annexes outlining e.g., land coverage in particular forest area and timber harvesting volumes including Austria, Finland, and France.

TECHNICAL REMOVAL

There are six countries – Austria, Finland, France, Greece, Lithuania, and Sweden – that refer to technical carbon dioxide removal and here mainly to BECCS in their LTS. Austria and Finland have several scenarios in their LTS outlining opposing strategies for forests: as one extreme, the focus is on protecting the forests and limiting wood harvesting leading to higher natural removal; or the strategy is to increase wood harvesting for using biomass as a source for energy generation in combination with CCS or as materials which lowers the natural sink function but increases the technical removal via BECCS/CCU.

Austria expects the largest increase in removals from natural sinks and/or technical solutions when compared to the other Member States. This also includes CCU and CCS besides acknowledging "major obstacles or uncertainties with regard to the technological solutions, for example with regard to domestic storage capacities or permanent and safe storage" (translated from Austrian LTS, p.20) (see also section 2.3.3). Different scenarios show natural and technical removal to compensate for 12.7 Mt to 22.2 Mt CO_2e in 2050 with different assumptions on natural and technical removal. The scenario with only natural sinks refers to 17 Mt CO_2e from natural sinks in 2050 which is 4-times higher than the removal in 2019. Other scenarios assume a stable removal from natural sinks but additional 8.8 Mt -18.3 Mt CO_2e to be removed through BECCS; or no natural sinks due to a higher energetic use of biomass but 18.7 Mt CO_2e from BECCS.

The Finnish LTS scenarios show a range of 16.4-40.0 Mt CO_2e net removal. The WEM assumes a net removal from land use and forestry of 25-28 Mt CO_2e over the period which is almost doubling the 14.7 Mt CO_2e removal in 2019 but was reached in some former years. The scenario at the lower end expects roundwood removals to reach a clearly higher level than the other two scenarios which lowers the sink function of forest land. Instead, the scenario adds additional 14 Mt CO_2e removal from BECCS so that total removal equals 30 Mt CO_2e in 2050.

Greece's LTS shows different scenarios that outline the role of BECCS and DACCS with different options of storing and/or using the captured carbon dioxide with no link to natural sinks. The scenarios focusing on energy efficiency show a limited role of 0 to 0.9 Mt CO_2e captured and stored using BECCS while the scenarios focusing on new energy carriers include a removal of 2.7-2.9 Mt CO_2e from BECCS and 2.1-5.6 Mt CO_2e from DACCS. Thus, Greece is the only country taking into account DACCS in one of their scenarios and also highlighting options for storing and using the emissions (see also section 2.3.3).

France assumes a doubling of natural removals plus capturing and storing 10 Mt CO_2 of bioenergy emissions. Lithuania just outlines a removal of 8.6 Mt CO_2 from natural and technical removal without stating the respective contributions. Sweden provides no estimates but assumes that BECCS will play a role to remove emissions.

Summary assessment

Overall, CO_2 removals via land use and forestry receive quite some attention in the LTSs. However, it is difficult to assess if natural sinks appear to be overestimated from an EU perspective. The reason is that a third of the Member States have not included any numbers while five countries assume a stable removal and five countries assume a doubling or even higher increases to compensate for remaining emissions; two of them (Austria and Finland), however, also outline a rather limited natural removal in another scenario with high wood harvesting rates which is then compensated by using BECCS in the same order of magnitude. In addition, is remains rather unclear how Member States want to stabilise or even increase the removal and how this is aligned with biodiversity objectives.

There are only six countries that refer to technical CO_2 removal with four providing a quantitative estimate. This means that most countries count on natural sinks to offset their remaining emissions. In the four countries and their different scenarios, the technical removal varies quite significantly from zero to almost 20Mt CO_2 to be removed via BECCS in 2050 in Austria. Austria and Finland, thereby, clearly outline the interlinkage between natural and the BECCS technical sink in the form of different scenarios that either focus on stringent forest protection limiting wood harvesting or significantly increasing wood harvesting limiting the natural sink function but using wood as material and for energy generation with emission storage (BECCS). Only Greece considers DACCS in one of the scenario sets.

2.3 TECHNOLOGIES

New and existing technologies will enable the transition in all sectors of the economy. This includes technologies to electrify heating and moving vehicles, new industrial production processes in chemical & plastics, cement or iron and steel industry, and for biomaterials and digitalisation (Escobar and Laibach, 2021; IEA, 2017; Rissman et al., 2020). The selected three technologies here – hydrogen and biomass (although rather an energy carrier than a "technology") and carbon capture, utilisation, and storage (CCUS) – are particularly important enablers for the transition to net zero emissions. However, at the same time, availability is supposedly limited or connected to imports (in the case of hydrogen and biomass) or exports (in the case of CO_2 emissions to be stored).

2.3.1 HYDROGEN

Relevance of topic

For many Member States, hydrogen represents an important facet of LTSs to reach climate neutrality by 2050. This importance lies partially within hydrogen's versatility; the energy dense gas can be used for storage in the power sector, an energy carrier option in heating and transport, and a feedstock in industry. However, to play a large role in a decarbonised energy system, hydrogen will have to be produced in ways which render it carbon-free. This means either production through water electrolysis using carbon-free electricity, so called green hydrogen, or production through natural gas reforming, coupled with CCUS, so called blue hydrogen. The relative roles blue and green hydrogen will play in the long-term depends on research and development of CCUS and particularly CO_2 storage options for blue hydrogen, as well as the availability of carbon-free electricity for green hydrogen. Next to this, hydrogen is also the required feedstock for synthetic methane and synthetic fuels. Synthetic methane and fuels can be considered carbon neutral if both the hydrogen and carbon used for production have zero net carbon footprint, meaning the hydrogen must be green hydrogen and the carbon must be sourced from DAC or a biogenic source such as biomass. It needs significant electricity input, both for the synthesis to methane or fuels and for the production of hydrogen.

Information in the LTSs

Almost all countries include some statement on hydrogen use as part of their strategy to reach climate neutrality. The level of detail regarding hydrogen varies, with 12 countries providing only qualitative information on planned hydrogen use, while the other seven countries (see Table 13) include quantitative as well as qualitative information. The quantitative values for hydrogen differ in the unit of measurement used and whether they provide information on use or production; France and Italy provide values for just production, Austria and Hungary provide values for use, and only Greece and Portugal provide values for both production and use. Additionally, Austria and Malta discuss plans for hydrogen imports, albeit only qualitatively.

For instance, Austria's LTS identifies blue hydrogen as a transition technology, to be used for a defined period of time, while green hydrogen will see utilisation in the middle- and long-term. Austria also places considerable emphasis on the use of sustainable hydrogen to decarbonise energy intensive sectors of industry. This includes the steel, chemical (ammonia and methanol production), mineral-oil, and tile industries. However, Austria notes that cost-efficient full supply of industry based on sustainable hydrogen may depend on hydrogen imports in the long-term, hence the importance of hydrogen management on a European and global level. In this context, Austria expresses support for a European Hydrogen Strategy, in which the EC lays out a clear roadmap for hydrogen production and distribution, including consideration of a global hydrogen trade and increased financing options for sustainable hydrogen use.

Portugal emphasises the importance of hydrogen to decarbonise the transportation sector next to electricity to replace the current fossil fuel vehicle fleet. Alkaline electrolysis using renewable electricity is expected to produce the required hydrogen. This demand will entail 2% to 4% of electricity generation to be used in hydrogen production by 2040 and 5% to 7% by 2050. This will involve critical investments in hydrogen infrastructure, such the hydrogen supply network.

Table 13: Information on hydrogen use, generation, and imports by 2050

	QUANTIFIED INFORMATION ON HYDROGEN	GREEN VS. BLUE HYDROGEN
AT	3-3.5 billion Nm^3 of storage requirement by 2050	Blue hydrogen as a transition technology, green in the middle- and long- term
BE		The economy of green hydrogen and not low-carbon (blue) hydrogen will be developed
HR	15.9-30.2 ktoe consumption by 2050, range from three scenarios	Does not differentiate between green and blue hydrogen
FI		Does not differentiate
FR	~ 45 TWh of electricity used for hydrogen production by 2050, 7.5% of total electricity consumption (excl. network losses)	The development of green hydrogen (i.e. renewable) will be supported and supervised.
DE		Does not differentiate
EL	1-30% share of synthetic fuels in total energy consumption, 2.5-74.5 TWh for production of synthetic fuels, range from five scenarios	Rules out blue hydrogen due to restrictions on CO_2 storage; green hydrogen is the main direction
HU	11-15% of final energy consumption	Decarbonisation of industrial production by implementing pilot projects that encourage the use of "green" hydrogen
IT	110-170 TWh (25-30%) of electricity generation used for hydrogen production	Most mentions of hydrogen are qualified as green hydrogen
LV		States green hydrogen has an increasingly important role
LT		Green hydrogen will be used to balance excess electricity from renewable energy sources
LU		Only considers green hydrogen and plans to pursue the development of hydrogen certification to ensure the consumption of a truly decarbonised and renewable product
MT		Discusses powering Malta with 100% green hydrogen, however supply will be contingent upon import from other countries
NL		Envisages a significant role for green hydrogen as a fuel for industry and both heavy and long-distance transport
PT	13.0-21.5 PJ or 4% of final energy consumption, 5-7% of electricity generation for hydrogen production	States produced hydrogen will mainly be green
SK		Does not differentiate
SI		Does not differentiate
ES		Most mentions of hydrogen are qualified as green
SE		States use of green hydrogen for steel production is conceivable by 2045

Source: own compilation based on national LTSs.
Excluding countries which do not provide any figure, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).

Greece embeds its plans for hydrogen within a larger discussion of the production and utilisation of synthetic fuels, primarily synthetic methane. The Greek LTS includes four target scenarios which call for varying percentages of synthetic fuels, which encompasses both hydrogen and synthetic methane, in the final energy consumption mix, from 1-30%.

Other Member States, such as France, the Netherlands, Greece, Finland, Hungary, Germany, and Italy, also see hydrogen as essential for the decarbonisation of the transport sector as well as certain industries. All have at least some plans to use hydrogen as a fuel in commercial and heavy transport, replacing fossil fuels in this sector. Some, such as Italy, Hungary, and Slovakia, plan this to be staged with hydrogen-natural gas mixtures fuelling transport before transition to 100% hydrogen. In industry, Finland, Sweden, Slovakia, and Italy explicitly mention the importance of hydrogen to reduce emissions in steel production. Malta touches upon using hydrogen as storage option to mitigate the intermittent nature of most renewable energy sources.

Summary assessment

Many of the Member States include hydrogen in their LTSs and touch upon at least qualitatively how hydrogen will enable them to decarbonise. Member States which plan to utilise hydrogen focus mostly on hydrogen as a fuel for the decarbonisation of heavy transport and in industry, notably in steel production. For the large number of Member States which name hydrogen as a necessary part of their LTSs, relatively few have elaborated on a quantitative plan for hydrogen expansion and deployment in the targeted sectors. Several Member States mention the need for sustained research and development for breakthrough technologies concerning blue and green hydrogen and Malta clearly states use of green hydrogen will be contingent upon import from other countries. This means that information is too limited to derive conclusions about overestimations and EU import needs.

2.3.2 BIOMASS

Relevance of topic

Biomass constitutes the organic material that living ecosystems produce, which can be used for many applications, such as heating and cooling, electricity generation and transport fuels but also for bio-based products and materials. Biomass used to produce energy – also known as bioenergy – currently makes up around 60% of all renewable energy in the EU, with the heating and cooling sector using about 75% of all bioenergy (Scarlat et al., 2019). In 2016, the forestry sector supplied around 60% thereof, with the remaining shares accounted for by agricultural biomass (almost 27%) and waste (12%). In the same year, the demand for bioenergy was met with around 96% of domestically produced biomass.

The use of sustainable biomass will play a significant role in achieving climate neutrality by 2050. Energy consumption from biomass is expected to double or even triple by 2050 in the EU, which increases by an additional 50% when considering material use as well. However, at the same time, the intensity of biomass harvesting from forests is considered to be already 'unsustainable' and needs to be reduced (Andersen et al., 2021; Catuti et al., 2020).

Information in the LTSs

There is limited information on the use, generation and imports of biomass in the LTSs. While at least 15 countries include qualitative information (Austria, Belgium, Czechia, Estonia, Germany, Hungary, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Slovenia, Spain, Sweden), only six countries provide also quantitative information (Croatia, Czechia, France, Greece, Portugal, Slovakia); five countries discuss the role of biomass in the context of using BECCS (Austria, Finland, France, Italy, Portugal) whereby Austria considered the role of biomass when creating the different pathways but did not provide separate results for this topic. Denmark does not have any information on biomass.

As Table 14 shows, Croatia, Czechia, France, Greece, and Portugal include projections for biomass use by 2050, with Greece providing these figures per sector as well. Czechia together with Slovakia also provides information on domestic biomass generation.

Czechia is the only country that provides a comparison of biomass import dependencies for the different scenarios. In the scenario that allows for the imports of electricity and biomass, in addition to a high increase in renewables, there are biomass imports amounting to 100 PJ solid biomass and 20 PJ liquid biomass in 2050,[4] whereby imports of solid biomass are capped at 100 PJ and imports of 25 PJ biofuels. The own production is 233 PJ biomass in the same year and under the same scenario. The Czech LTS states that this scenario is only illustrative, and a as a result, does not determine whether it is technically possible to import the required biomass and from which country. In comparison, the other scenarios do not import biomass and compensate these with higher liquid fuel or coal imports. Greece includes information on timber imports ranging from 0.42-0.66 without providing the unit and also not stating where the timber is expected to come from. The Croatian LTS assesses for the different scenarios the domestic energy generation and import (in GWh) but only provides a general figure and does not further distinguish between energy sources.

More than two-thirds of all countries that submitted an LTS explicitly indicate in which sector or for what purpose they expect to use biomass. Malta does not include explicit statements in what sectors biomass will be used but indicates that biogas will play a minor role in energy production. Six countries (Italy, Luxembourg, Portugal, Slovenia, Spain, France) specifically mention a role for biomass in industry, with two countries (Latvia, Lithuania) indicating this for the construction sector. Moreover, the Dutch LTS states that in time, sustainable biomass will only be used in sectors where no cost-efficient alternative is available, such as aviation and shipping.

Thirteen countries (Croatia, Estonia, France, Greece, Italy, Lithuania, Luxembourg, Malta, the Netherlands, Slovakia, Slovenia, Spain, Sweden) at least briefly touch upon sustainability aspects related to the use of biomass, in specificity ranging from stating that biomass will only be used in the context of organic waste collected from households to produce renewable biogas (Malta), to ensuring that the production of biomass "[...] will have to take into account the context of climate change and sustainability criteria" (France). Spain indicates that improved forest management could lower risk for fires and improve the conservation of natural areas and wild species. Portugal does not discuss the topic of sustainable biomass but mentions the trade-off with air quality (see also section 2.4.3). The regional strategy for Brussels points out that the use of biofuels is considered unsuitable due to the impact on air quality.

4. Numbers as provided in the description of the scenario on page 119; table 5 on page 123 seems not in line with the numbers in the text.

Table 14: Quantitative information on biomass use, generation and imports by 2050

	BIOMASS USE	DOMESTIC BIOMASS GENERATION	IMPORTS OF BIOMASS
FR	460 TWh	N/A	N/A
CZ	Sum of domestic generation and imports	105-233 PJ (based on using max. theoretical potential) (range over scenarios)	100 PJ solid + 20 PJ liquid biomass (scenario C1 with imports of electricity and biomass)
EL	4.7-5.5 Mtoe	N/A	
HR	656-957 GWh	N/A	N/A
PT	16.1-21.0 PJ of FEC	N/A	N/A
SK	N/A	120 PJ (theoretical potential)	N/A

Source: own compilation based on national LTSs.

Excluding countries which do not provide any figure, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland and Romania).

Summary assessment

It becomes clear from the LTSs that the use of biomass will play an important role by 2050; more than two-thirds of all countries that submitted an LTS explicitly state that biomass will be part of the energy production. Thirteen countries touch upon sustainability aspects related to biomass but the LTSs generally do not go into detail to clearly indicate what qualifies as sustainable biomass and related challenges for domestic production.

Only six countries (Croatia, Czechia, France, Greece, Portugal, Slovakia) provide both qualitative and quantitative information on biomass. However, there is only Czechia showing information for a) expected biomass use by 2050, and b) domestic biomass generation, while also considering biomass imports. This makes it challenging, if not impossible, to better understand how much countries rely on the use and imports of biomass to achieve (or move towards) climate neutrality by 2050 and to what extent this is feasible.

2.3.3 CARBON CAPTURE AND UTILISATION AND STORAGE

Relevance of topic

Carbon capture, utilisation and storage (CCUS) refers either to carbon capture and storage (CCS) or to carbon capture and use (CCU). CCS is an integrated chain of technologies, which comprises capture, transportation, and storage of CO_2 (IOGP, 2019). Storage options include injecting the CO_2 – in dense or liquid form – into geological formations, such as saline formations or depleted oil and gas fields, or in site mineral carbonation or carbon mineralisation, whereby concentrated CO_2 streams are injected into geological formations to mineralise in the pores (Bey et al., 2021). CCS is generally not a negative emission technology, but it prevents emissions from entering the atmosphere. Only the combination with bioenergy (BECCS) leads to negative emissions. With CCU, the captured CO_2 is processed into different applications, such as fuels, chemical building blocks or buildings materials. This means that depending on the application, the CO_2 enters the atmosphere after a certain period (IEA, 2019). The storage time is particularly short when storing CO_2 in synthetic hydrocarbons, which are used almost immediately as fuels. This practice can therefore be a valid option in a circular economy but does not directly store or reduce emissions.

Information in the LTSs

The great majority of countries provide information on CCUS, except for Belgium (where information is only available in regional strategies), Denmark, Luxembourg, Estonia and Lithuania. However, also most of the other countries only include qualitative information on CCUS and the degree of specificity varies: one-third of the countries include general statements in their LTS indicating a (potential) future role for CCUS (Croatia, Germany, Hungary, the Netherlands, Portugal, Slovakia, Malta, Sweden, Spain, Latvia), whereas six include projections of captured emission at least in one of their climate neutrality scenarios (Austria, Finland, France, Italy, Greece, Czechia).

The volume of captured emissions is only available for a few countries. In the French LTS scenario, in 2050, industrial emissions of around 5-6 Mt CO_2 are captured next to 10 Mt CO_2 of negative emissions generated with energy production installations using BECCS. CCS should be considered as soon as the environmental and economic conditions are met to store concentrated CO_2 emissions. CCU may be considered as an alternative to storage (in e.g., new energy carriers, anaerobic digestion and in manufactured products).

Italy considers CCS as a possibility to "zero the emission residue", equal to 20-40 Mt CO_2. This is mainly relevant for industry (energy and non-energy). From the steel and cement industry alone, about 10-20 Mt CO_2 might be captured by CCS in 2050.

Czechia outlines the use of CCS for power generation in one scenario. It includes CCS for coal-fired (1,666 MW) and gas-fired (3,334 MW) power generation in 2050. This would mean to capture and storage 35 Mt CO_2.This scenario is a rather theoretical case to check what CCS would be needed if Czechia would follow a "business as usual" pathway but still would want to achieve its 80% emission reduction target.

The Greek LTS provides the most detailed overview of the use of technical removals (including CCUS) (see also Table 12), which includes both the source of CO_2 as well as its intended use/destination. It includes four scenarios that either assume increased energy efficiency and electrification (Estonia) or the adoption of new energy carriers (NC), and which make a further distinction between ambition levels (2°C versus 1.5°C):

Table 15: CO_2 emissions captured and stored according to the LTS of Greece

		SCENARIOS			
		EE2	NC2	EE1.5	NC1.5
CO2 captured and stored		No use	4.8 Mt CO2	6.7 Mt CO2	18.4 Mt CO2
Captured CO_2	Captured from bioenergy		2.7 Mt CO_2	0.9 Mt CO_2	2.9 Mt CO_2
	Industrial processes			4 Mt CO_2	4.6 Mt CO_2
	Combustion of mineral fuels			1.7 Mt CO_2	5.4 Mt CO_2
	Air capture		2.1 Mt CO_2		5.6 Mt CO_2
Stored CO_2	Stored in materials		0.4 Mt CO_2	0.9 Mt CO2	1 Mt CO2
	Stored in synthetic fuels		4.4 Mt CO2		7.4 Mt CO2
	Underground storage			5.8 Mt CO2	10 Mt CO2

Source: own compilation based on the Greek LTS.

Portugal states that CCS only has technical and economic viability in the cement sector, with BECCS and CCU to produce e-fuels perceived as not being cost-effective, without mentioning specific figures. Spain outlines for different sectors the potential for GHG reductions through CCS (but also other new technologies). For the iron and steel industry, as well as the petrochemicals industry, the reduction potential is around 10%. For the cement sector, this potential is approximately 5%. Sweden indicates that a large-scale expansion of CCS in the steel industry could lead to additional electricity consumption of 2-5 TWh.

Information on storage potential is limited in the strategies. One exemption is the Austrian LTS which points out significant obstacles and uncertainties related to the application of CCS, such as domestic storage capacity and permanent and secure storage. In this context, a law currently prohibits the storage of CO_2 at least until 2023; it is evaluated every 5 years based on international experiences. In Austria, it is estimated that there is a potential domestic storage volume between 400 and 510 Mt CO_2, or 6.5 times the current annual CO_2 emissions. Therefore, Austria considers the alternative of using long-distance transports to storage sites outside the country in the long-term.

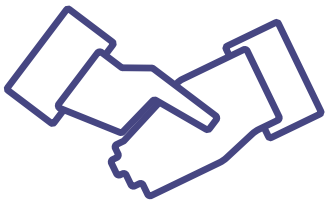
France estimates the domestic storage potential at 1-1.5 Gt CO_2, but at the same time notes that this potential is still not particularly well-known on land and unknown at sea. The French LTS states that the latter seems more feasible and socially acceptable compared to the former. Greece describes the low availability of suitable underground options, which will not exceed 140 Mt CO_2, but should suffice for capturing and storing CO_2 emission from the low use of natural gas and from industrial processes in 2050. Hungary states they have limited capacities to store carbon, and as a result, they would focus primarily on CCU. Latvia notes CO_2 storage sites are currently not economically feasible.

Many technical, environmental and economic uncertainties remain regarding CCUS so there is a need for research, development and deployment. Malta states that they could play a role as a test bed for new carbon technologies (including CCS), in partnership with larger countries/private partners. On a general level, Slovakia, Latvia and Lithuania highlight their support for additional research into CCUS. Spain states that CCS pilot projects have been implemented, but that the related costs and uncertainty related to the process makes implementation difficult, although the potential for emission reductions for producing iron and steel, petrochemicals and cement, are evident. Sweden highlights their long-term government programme called "Industry Leap" ("Industriklivet"), which supports the development of technology and processes that reduce or remove process related GHG emission from industry. The programme started in 2018 and is planned to run until 2040. In 2020, the budget was around EUR 58 million (SEK 600 million).

Summary assessment

Most countries at least briefly touch upon the topic of CCUS, but there are significant differences between how much detail they provide. Although the majority formulates general statements on the use of CCUS, there are six countries that include quantitative information in their LTS, of which Italy indicates the largest use of CCUS to help achieve climate neutrality; 20-40 Mt CO_2 are expected to be captured by 2050 of which approximately a quarter to half using CCS in the steel and the cement industry. Czechia follows with its CCS-scenario and 35 Mt CO_2 captured and stored. Both countries, however, provide no information on storage. Only some LTSs highlight the limited storage potential as an issue: Hungary explains that as a result they will focus on CCU, whereas Austria mentions the possibility of exporting CO_2 to third countries in the long term. Particularly Austria explains that there are still barriers and uncertainties related to the application of CCS.

2.4 HORIZONTAL ELEMENTS



There are crucial elements that drive the transition and reduce emissions across several sectors. We consider lifestyle change, finance, and just transition. In addition, we included adaptation to climate change and related synergies and conflicts with mitigation. Although the relevance of these cross-sectoral elements is high, the GovReg specifically asks only for investment needs to be included in the LTSs as well as "to the extent feasible", socio-economic, health, and environmental impact – here considered under just transition – and adaptation is in the voluntary template in a sub-heading.

2.4.1 LIFESTYLE CHANGE

Relevance of topic

The transition to climate neutrality requires gradual but profound societal adjustments, as changes in behaviour and practices are drivers of decarbonisation (EC, 2020b; Schanes et al., 2019) Behavioural climate change mitigation can take the form of a variety of actions, most commonly in the transport, housing and food sectors (i.e., driving less, reducing room heating temperature or shifting to a plant-based diet). Such changes can result in significant GHG emission reductions in both the short- and long-term. However, lifestyle change is dependent on public awareness, social conditions, customs, and institutions which means that governments face the challenge of raising collective knowledge on lifestyle impacts on the environment, promote low or zero-emission alternatives and enhance regulation and economic incentives (Dubois et al., 2019; Velten et al., 2021).

Information in the LTSs

Almost all countries with an LTS (besides Denmark, Hungary and Sweden) include qualitative information on the subject but to differing extents. In Belgium, Czechia and Portugal, for example, behaviour change is mentioned merely as either important or necessary for the climate transition, while all other countries attempt to deliver specific outcomes, measures or actions. Estonia, Lithuania, and France present also quantitative data, with Lithuania providing quantitative targets for almost all sectors.

Nine countries (Austria, Estonia, France, Germany, Greece, Italy, Lithuania, Malta, Slovenia) mention behaviour change in the context of mobility. Provisions include a reduced need for mobility, restructuring taxes and levies in favour of climate-friendly transport, an enhanced preference for using public transport, car sharing and cycling in cities, and a shift towards active travel. Estonia specifically aims to increase the share of public transport, cycling or walking to 45–55% in total commuting in 2035 and Lithuania to at least 60% of urban travel by 2030.

A change in diet is foreseen by seven countries - Austria, Croatia, France, Lithuania, the Netherlands, Slovakia and Slovenia. In their LTSs, Member States put an emphasis on climate-friendly, plant-based diets, less food waste and support for local food production. Lithuania specifically aims at to reduce food waste by 50% per capita by 2030 based on 2019 levels.

Estonia, France, Latvia, Lithuania, and Slovenia also examine behaviour change in the context of goods and services, and circular economy, by ways of encouraging sustainable production and consumption patterns, as well as increasing product reuse.

France specifically calls for a reduction in energy through individual behaviour heating temperature by an average of 1°C by 2050, while Italy constitutes that citizens need to carry out 'invasive' interventions for the in-depth renovation of buildings. Lithuania aims at 30% of households to be active consumers producing and storing own renewable electricity by 2030.

Six countries have plans for raising public awareness about the importance of behaviour change. These are Croatia, Estonia, Lithuania, Luxembourg, Slovakia and Spain. Among the planned measures are the development of repair workshops in Estonia, the improvement of education regarding heating in Lithuania, the preparation of campaigns to change consumer behaviour in Slovakia and the strengthening of social acceptance for projects and infrastructure necessary for decarbonisation in Spain.

Summary assessment

Overall, Member States provide largely qualitative information on lifestyle change. The LTSs examine the topic from various angles and touch upon mobility, diet, heating, and circular economy, to differing extents. A significant difference in the way countries include the topic in their strategies relates to whether they merely identify lifestyle change as necessary for climate neutrality, or whether they propose concrete measures, actions and targets. Our analysis shows that Member States largely attempt to fit in the second group. Lithuania stands out as the only country clearly outlining specific targets on behaviour change in various sectors. The French LTS provides an in-depth reflection on lifestyle change in the context of various sectors and includes quantitative information.

2.4.2 FINANCE

Relevance of topic

The restructuring of the economies to achieve climate neutrality as outlined in the LTSs of the Member States will require significant investment and mobilisation of both public and private funds. This will involve not only the creation or enlargement of public funding sources on the EU, national, and state levels, but also reordering of the private financial investment playing field, in order to reorient financial streams. This entails policies which increase the viability and security of low-carbon investments while disincentivising investments which are climate harmful. This goal is also outlined in Article 2.1.c of the Paris Agreement, which calls to make finance flows consistent with a pathway towards low GHG emissions and climate-resistant development.

Information in the LTSs

Almost all LTSs contain information on financing aspects. The Member States which provide guidance on finance solely qualitatively include four, while 12 also provide numbers on investment needs until 2050. These are mainly the additional investment needs, i.e., investments which are associated with reaching the 2050 climate target and come on top of what would have been invested in the reference case. The order of magnitude is about 1-2% of GDP with two outliers: Hungary and Slovakia expect additional investment needs of more than 4% of GDP up to 2050.

Nine LTSs also provide a breakdown for sectors. These sectors are most commonly buildings, transport, industry and energy or electricity, as well as less frequently households, agriculture, water, waste, and land use. Some Member States provide total investment needs per sector for the entire period up to 2050, while others break down needs by decade or even average annual sector investment. Across the LTSs with sectoral breakdown transport is the sector with the highest investment needs, with six of the nine LTSs allocating the most investment to this sector. Investment needs for buildings and energy/electricity are the next highest, while reported investment needs for industry vary greatly between Member States.

Table 16: Investment needs by 2050

	TOTAL INVESTMENT NEED	ADDITIONAL INVESTMENT NEED
HR		EUR 14.4-22.6 bn (2031-2050) 0.96-1.51% of GDP
CZ	EUR 1,135-1,285 bn (2010-2050) (range over 3 scenarios)	EUR 183-335 bn (2010-2050) (range over 3 scenarios) [~2% of GDP (*)]
FI		EUR 100 bn (2020-2050) [~1% of GDP (*)]
FR	EUR 126 bn per year (2034-2050) [~5% of GDP (*)]	
EL	EUR 38.1-39.1 bn per year (2031-2050; range over 6 scenarios, excluding transport) 1.9-2.9% of GDP per year (2030-2050)	
HU		EUR 42 bn / 75.9 bn (2020-2050; early and late action scenarios) 4.8% of GDP per year (2020-2050, early action scenario)
LV		EUR 16 bn per year (2020-2050) 1.35% of GDP per year (2020-2050)
MT		EUR 15.3 bn (2020-2050) [~3% of GDP (*)]
PT	EUR 1,017 bn (2016-2020)	EUR 85 bn total or ~ EUR 2.1-2.5 bn per year (2016-2050) 1.2% of GDP per year
SK		EUR 196 bn (2031-2050) 4.2% of GDP per year
SI	EUR 66-72 bn (2021-2050)	EUR 21-26.5 bn (2021-2050) [~1-2% of GDP (*)]
ES	EUR 500 bn (2031-2050)	EUR 300 bn (2031-2050) [~1% of GDP (*)]

Source: own compilation based on national LTSs and cross-check with Ricardo-AEA (2019).
Excluding countries which do not provide any figure, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).
Notes: Additional investment needs refer only to investment needs associated with reaching 2050 climate neutrality goals, while total investment needs refer to both investment needs associated with reaching climate goals along with investment needs associated with reference or business as usual scenarios i.e., investments which would have been made in the normal course of economic growth regardless of climate neutrality goals. For countries which provided investment needs in national currencies, exchange rates to EUR were based upon the European Central Bank average for 2019.
Abbreviations: bn = billion; R&D = research and (product) development.

Table 17: Sectoral breakdown of investment needs by 2050

	SECTORAL BREAKDOWN OF INVESTMENT NEEDS				
CZ	Additional investment, for the period 2010-2050, range over three scenarios				
	Buildings: EUR 12.5-23 bn	Transport: EUR 8.5-17.9 bn	Industry: EUR 253 bn		
FI	Total investment over the period 2020-2050				
	Energy system: EUR 20 bn	Building repairs: EUR 24 bn	R&D: EUR 35 bn		
FR	Total investment, for the period 2034-2050				
	Buildings: EUR 28 bn / year	Transport: EUR 85 bn / year	Energy and networks: EUR 13 bn / year		
EL	Total investment for the period 2030-2050, range over six scenarios				
	Industry: EUR 0.1-0.4 bn / year	Households: EUR 4.0-5.4 bn / year	Services and Agriculture: EUR 1.2-1.4 bn / year		
HU	Additional investment, for the period 2020-2050, range between early and late action scenarios				
	Agriculture: EUR 2.3 bn	Waste: EUR 1.47 bn	Industry and product use: EUR 0.4 bn		
MT	Total net marginal investment, for the period 2020-2050				
	Buildings: EUR 2.6 bn	Energy: EUR 2.9 bn	Industry: EUR 0.5 bn	Transport: EUR 9.0 bn	Waste/Water: EUR 0.3 bn
PT	Additional investment, for the period 2016-2050				
	Electricity: EUR 21.1 bn	Transport: EUR 32 bn	Buildings: EUR 21.9 bn	Industry: EUR 6.6 bn	
SK	Additional investment, for the period 2030 to 2050				
	Industry: EUR 0-0.2 bn / year	Households: EUR 1-8 bn / year	Services: EUR 0.9-4 bn / year	Transport: EUR 0.5-7 bn / year	
SI	Additional investment, for the period 2021-2050				
	Households: EUR 0.4 bn	Services: EUR 0.6 bn	Industry: EUR 3.5 bn	Electricity: EUR 3 bn	Transport: EUR 6 bn

Source: own compilation based on national LTSs and cross-check with Ricardo-AEA (2019).
Excluding countries which do not provide any figure, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).

Half of the LTSs also provided information about the role of government spending or otherwise divided discussion on public and private sector funding. The need for public and private sector investment is emphasised across the LTSs to reach climate neutrality. For reference, the Spanish LTS indicates it expects only 20% of the necessary investments to be made by the public sector, with the remaining 80% of necessary investments coming from the private sector. The successful mobilisation of private funding is frequently addressed in the LTSs through discussion of sustainable finance, and the need for the Member States to create a solid framework for this at the national and international level. This will be accomplished through numerous mechanisms which focus on providing the proper signals and incentives to investors to mobilise private capital and ultimately reorient financial flows to fund a low-carbon economy. As an example, the LTS of France aims for changes in both public finance management and private finance guidance in order to meet investment needs. These changes seek to reach the goal of nearly doubling the current yearly climate investments, from EUR 45.7 billion spent in France in 2018 in public and private investments on climate action to EUR 32-41 billion additional invested per year to meet the French 2024-2028 carbon budget.

Six Member States (Germany, Italy, Latvia, Luxembourg, Portugal, Slovakia) also address contradicting support such as environmentally harmful subsidies or fossil-fuel subsidies in their LTSs. These Member States clearly denounce subsidies to fossil fuels, with both Germany and Italy articulating the double burden these subsidies place on public budgets, in that they led to higher current public expenditure as well as higher present and future environmental and health costs. Italy maintains a catalogue of environmentally harmful and favourable subsidies which is updated on an annual basis. Latvia and Slovakia single out heating fuel subsidies and coal subsidies respectively for elimination, and Latvia and Germany both also explicitly state that support for harmful subsidies should be reallocated to renewables and forward-looking, socio-ecologically just measures, respectively.

Summary assessment

Reasonable attention in the LTSs is allocated toward finance, with over four fifths of the reporting Member States including finance sections and two thirds of these including specific values for total investment needs. These are mainly the additional investment needs in the order of 1-2% of GDP; only Hungary and Slovakia expect significantly higher additional investments of more than 4% of GDP up to 2050.

There is significant acknowledgement of the necessity of mobilising both public and private funds. The Spanish LTS specifies the expected share of 20% public and 80% private investment. Other LTSs have large parts of their finance sections addressing EU and multinational level public funds available to draw climate investment from; relatively less information is devoted to funds at the national and state level. Six LTSs also address contradicting support such as fossil-fuel subsidies which should be eliminated.

2.4.3 JUST TRANSITION

Relevance of topic

The transition to climate neutrality must be just and inclusive to ensure societal support. Benefits and negative side-effects are very likely to occur with different magnitude within and across countries, societal groups, regions and industries, causing distributional challenges for the EU and its Member States. The EU estimates that, at least 237,000 jobs related to coal, peat and oil in 108 European regions are at risk of losing their jobs during the transition (Regulation (EU) 2021/1056 establishing the Just Transition Fund).

At the same time, the transition is expected to bring several benefits. It creates new opportunities for industry and jobs. So far, measures under the EU climate and energy targets for 2020 have contributed to an increase in EU employment of around 1-1.5%, with further increases expected during the upcoming transition period. GDP will double by 2050 (compared to 1990), even though the EU is undergoing a fundamental transition (EC, 2018). In addition, the transition is expected to bring benefits for society and the environment. This includes healthier citizens, lower energy costs for households, greener cities, cleaner air and more space for nature (EC, 2021a).

Information in the LTSs

The impacts of the transition are multidimensional and therefore affect several sub-areas. This is also reflected in the LTSs which include reference to the impacts of the transition on the economy, on the society with respect to employment, cost distribution and health, as well as on the environment with respect to air and water quality and biodiversity. An overview of how Member States view the impact of the transition on these sub-areas is given in Table 19.

The LTSs show that the impact on the economy is generally estimated to be positive across the countries (see Table 19). However, the exact quantitative impacts are only described by a relatively small proportion of countries (see Table 18). Only in Italy, GDP growth is lower than under the reference in a preliminary analysis which is possibly a result of increasing marginal costs for reducing the residuals emissions towards 2050 – Italy delivers no further information but the country expects a large use of CCS to capture remaining emissions (see section 2.3.3) which is still a costly technology. The largest positive impact on GDP is expected in Finland under the continuous growth scenarios which however lead to a reduction of available jobs due to the expected dependency of employment on the use of arable land. In contrast, in its other scenarios, job creation is positive.

A mixed picture for employment is supported when looking at the other countries with quantified impact: Hungary, Portugal and Spain outline a positive employment effect but Estonia and Slovakia a reduction of jobs. However, the remaining part of the countries do not determine quantitative impacts but describe the foreseeable impacts at least in words, mainly referring to overall positive impacts on job creation. Some of these countries assume benefits for employment, with one part not providing any further details (Lithuania and Slovenia) and the other part assuming growth effects related to the energy (Hungary and Latvia) or building sector (France, Luxembourg and Croatia). For some countries, the impacts on employment are associated with job cuts just in specific economic sectors. For example, Malta and Portugal expect a job decline in traditional transport, Germany in coal-based electricity production, Spain in tourism and Slovakia in manufacturing.

Table 18: Quantified expected impact on GDP and employment by 2050

COUNTRY	IMPACT ON GDP BY 2050	IMPACT ON EMPLOYMENT BY 2050
EE	Plus 0.287–0.44 billion EUR/year between 2015–2050	Minus 1,270 jobs between 2015–2050
FI	Plus 1.6% and 6.1% (dependent on scenarios) vs. WEM	Plus 0.1% and minus 1.2% (dependent on scenarios) vs. WEM
FR	Plus 3-4% in 2050 (WAM vs. business-as-usual (BAU))	
HU	Plus 0.4 pps on average over 2020-2050; 2.9% vs. 2.5%	Plus 183,000 new jobs vs. BAU
IT	0.1% reduction of annual growth rate (2030-2040 vs. BAU); from 2040 the gap increases	
LV	Plus EUR 2.5 billion cumulative over 2020-2050	
PT	Plus 0.5%-0.9% vs. BAU	Plus 0.1% vs. BAU
SK	Plus 3% in WAM vs. WEM	Minus 0.9% in WAM vs. WEM
ES	Plus 1% vs. BAU	Plus 1.6% vs. BAU
SE	Plus/minus 1% when achieving climate neutrality by 2045 (from external study)	

Source: own compilation based on national LTSs and Ricardo-AEA (2019).
Excluding countries which do not provide any figure, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland and Romania).

Twelve Member States mention how the costs of the transition are distributed across society. Most of these countries only provide general statements: Austria expects general cost savings to emerge as a result of improved energy efficiency; Finland highlights that income inequalities might occur; and eight others mention that energy poverty could arise as a negative side-effect of the transition. Estonia is the only country that looks beyond these general impacts and identifies a specific region that will be affected due to its underlying characteristics – the Ida-Vidraa region. The region is characterised by high levels of poverty and unemployment and strong reliance on shale oil production. The workers in this region will be particularly exposed to the transition and in need of support.

Despite this observation, only six LTSs clearly describes how to address the cost challenge: Luxembourg, for instance, expect that the transition will have negative impacts on lower income households and will provide cash transfers and subsidised loans to address this issue. The remaining part mention measures to alleviate energy poverty. In this context, Belgium plans to support low-income households, Slovenia foresees a support scheme to increase energy efficiency in buildings, Croatia and Lithuania want to promote renovations, and Slovakia considers providing heat pumps for this purpose. In addition to these measures, some countries also refer to principles according to which a just transition should take place. Some mention that the benefits (Belgium) as well as the costs (Italy) should be equally distributed during the transition. Others mention that the transition should be equitable (Spain and Austria), socially fair (Greece) and leave no one behind (Italy).

The impact of the transition on human health is covered by 11 LTSs, with all of these showing positive impacts on health. Benefits are expected from behavioural changes, such as switching to more active modes of transport like cycling (Austria) or healthier dietary habits (Finland). The most commented aspect is that a reduction in air pollution will lead to better air quality and a decrease in respiratory diseases.

The positive link between decarbonisation and air quality is relevant in almost all LTSs also when it comes to the description of impacts on the environment. Austria and Luxembourg outline improvements of air quality from the electrification of transport, Germany and Latvia from the shift to renewables and Finland and Slovenia from improved heating options. Czechia outlines that in 2050 annual cost of controlling traditional air pollutants could fall by EUR 50 billion and that improved air quality results in health care expenditure savings. Only Slovakia expects a negative impact of the transition on air quality from the switch to biomass combustion which will lead to higher particle pollution.

The impact of the transition on biodiversity as well as on water quality and availability receives limited attention – the information generally refers to the impacts of climate change and not of the transition. Some countries, however, see the transition as an opportunity to preserve natural areas and wild species (Estonia, Lithuania) or suggest that increasing the efficiency in the bioeconomy will have a positive impact on water availability (Austria).

Summary assessment

Most Member States expect that the transition will come with benefits for the aspects considered here although some also see negative side-effects in particular sectors, due to the phase out of fossil-fuels or for certain groups of society. The depth of information varies thereby from half a sentence to more than a page of information; any quantification only relates to GDP and employment impacts. Countries show here positive numbers besides in particular Italy which expect a lower GDP growth and employment than under the reference. Information on who will be affected, where and why is only included in a few LTSs (e.g., Estonia).

Table 19: Overview of the expected impacts of the transition

MS	IMPACTS OF THE TRANSITION ON…						
	ECONOMY	EMPLOYMENT	COST DISTRIBUTION	HEALTH	AIR	WATER	BIODIVERSITY
AT	Positive	Positive	Recognised	Positive	Positive	Positive	
BE			Recognised & addressed				
HR		Positive	Recognised & addressed	Positive	Positive		
CZ	Positive			Positive	Positive	Positive	
DK	No info – to be included in future updates of the strategy						
EE	Positive		Recognised		Positive	Unclear	Positive
FI	Both	Unclear		Positive	Positive		
FR	Positive	Positive	Recognised & addressed	Positive	Unclear	Positive	Unclear
DE	Positive	Unclear			Positive		Unclear
EL		Unclear					
HU	Positive	Both		Positive	Positive	Positive	
IT	Negative					Unclear	
LV	Positive	Positive	Recognised & addressed	Positive	Positive		
LT			Recognised & addressed	Positive	Positive		Positive
LU		Both	Recognised & addressed	Positive	Positive	Positive	Positive
MT		Both	Recognised				
NL		Both			Positive		Positive
PT	Positive	Both		Positive	Positive		Positive
SK	Positive	Negative	Recognised & addressed		Negative		
SI		Positive	Recognised & addressed		Positive	Unclear	
ES	Positive	Positive	Recognised & addressed	Positive	Positive		Positive
SE	Both	Both					

Source: own compilation based on national LTSs and Table 18: Quantified expected impact on GDP and employment by 2050.
Excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland and Romania).
Note: "positive" means that a country mainly refers to benefits, "Negative" means it refers to risks and negative side-effects, "Both" means that the country refers to benefits and risks, and "Unclear" means that the LTS refers to further research needs to clarify the impacts; "Recognised" means that a Member State identifies the transitional costs and their distribution for society; "Addressed" means that a Member State mentions measures to counter these arising costs.

2.4.4 CLIMATE IMPACTS AND ADAPTATION

Relevance of topic

The impacts of climate change can already be felt at present and are adversely affecting prosperity, nature, and people. Some of the most widespread climate impacts are weather extremes such as changing precipitation events, droughts, fire events or hot extremes in the ocean and on land (IPCC, 2022a). Europe has not been unaffected by the impacts of climate change in the past and it is very likely that the intensity and frequency of extreme events will increase in the coming decades, with fatalities among vulnerable groups in particular (EEA, 2019). The impacts of climate change thus make it imperative to take appropriate measures to protect the most affected and vulnerable. Adaptation means to adjust to the changing climate by responding to the dimensions of climate impacts with appropriate countermeasures. In this context, synergies of mitigation and adaptation action help to progress on both fronts. The EU asks its Member States to report on adaptation in the voluntary LTS template; in addition, countries had to submit their national adaptation strategies to the EC by 15 March 2021 and must then update them every two years (GovReg, Art. 19). This means that national adaptation strategies already exist in parallel to the LTSs.

Information in the LTSs

Climate impacts are considered in most LTSs, with few exceptions (e.g., Denmark, Finland, France, and Germany). However, the degree to which climate impacts receive attention varies significantly. In the LTSs of Luxembourg, Malta, Portugal and Spain, the main concern revolves around changing precipitation patterns and rising temperatures. In this context, Malta expects that climate change will lead to a deterioration of air quality due to lower precipitation and longer pollen seasons. Portugal and Spain, on the other hand, are concerned about water becoming a scarce resource, which is why Spain wants to increase its water efficiency. For some other countries, a much more in-depth description of climate impacts was carried out: Austria refers, among other things, to rapid melting of glaciers, thawing of permafrost soils, and an increase in bark beetle infestation; Latvia and Italy report a higher risk of fires and emerging diseases; and Sweden describes higher risks for flooding, landslides, rockfalls and erosion.

Despite some comprehensive descriptions of climate impacts, most countries do not report on vulnerable groups and sectors that will be most affected by them. Malta is the only country that mentions adverse effects on vulnerable groups, by linking rising temperatures to a higher risk of dehydration for agricultural workers, children, and the elderly. In terms of sectors affected, some countries expect rising temperatures to affect their agricultural sector (Croatia, Luxembourg, Malta, and Spain) and others their transport sector (Latvia and Lithuania) or hydroelectric power generation (Portugal).

Following the analysis of climate impacts, the LTSs typically outline key measures to adapt to the effects of climate change with significantly varying extent. Most countries refer to their adaptation strategy in their LTSs (Austria, Finland, France, Luxembourg, the Netherlands, and Sweden) with most of them highlighting no specific adaptation action in the LTSs. However, Luxembourg aims at promoting nature-based solutions and initiatives for wetlands which will benefit mitigation and adaptation to climate change and nature protection. France, Malta, Lithuania, and Slovenia also refer to the protection of nature (i.e., natural carbon sinks, the restoration of habitats, the implementation of nature-based solutions and green infrastructure) benefitting mitigation and adaptation. France also highlights the need for reducing urban heat islands, limiting soil sealing and rainwater runoff. Other countries also outline key adaptation measures: Czechia, for instance, plans to alleviate negative climate impacts through afforestation; Hungary wants to prepare its transport infrastructure for rising temperatures by installing heat-resistant pavements; and Slovakia tries to address the risk of water scarcity by improving water retention and management and sees synergies between mitigation and adaption in the agricultural sector.

However, most countries do not clearly specify who will be responsible for financing adaptation with the exception of Slovakia and Sweden. In Slovakia, financing should be provided by central, regional, and local state authorities. Sweden, on the other hand, has established a National Knowledge Centre for Climate Change Adaptation to support stakeholders in adaptation.

Summary assessment

Climate impacts are comprehensively addressed by most Member States. Nevertheless, there is often a lack of a sound vulnerability analysis that indicates which groups and sectors will be most affected by the impacts. With a few exceptions (Malta, Luxembourg, Spain, and Portugal), most Member States have not defined vulnerable groups or sectors.

Many countries reference their national adaptation strategy but only about half of the LTSs present specific adaptation actions and often these are not presented in a systematic manner. Those providing information identify nature to offer benefits for mitigation and adaptation to climate change. There is no clear discussion about conflicts. Funding also remains mostly unpresented.

3

STRATEGIES' RELEVANCE IN THEIR NATIONAL CONTEXT

Arguably, the true value of an LTS lies in its impact on national climate policy-making. A strategy may look good on paper, containing a plausible and detailed vision of the future, but it may fail to have any effect on actual measures and policy instruments to realise the wide-reaching economic and structural changes required.

National governance of the long-term transformation varies significantly by Member State, ranging from robust, often longstanding, national systems of regular planning and monitoring enshrined in a climate law to the minimal institutional competencies required to deliver on EU and UN obligations (Evans and Duwe, 2021). For those countries that go beyond the basic EU requirements in terms of governance elements, the degree to which these systems translate or have been adapted to the EU baseline varies. For instance, whereas in Spain a national climate law engrains the LTS/NECP cycles more or less one-for-one at a national level, in Denmark climate planning and monitoring in the Danish Climate Act does not perfectly reflect the EU cycle, and as such, the obligation to produce the NECP/LTS could be considered as *additional* or higher-level reporting on top of an existing national system. This comparison illustrates how differently the EU planning tools are *used* at a national level, often due to the extent a country has its own policy cycles for planning and monitoring progress in place.

Thus, the potential power that an LTS could wield as a driver for ambitious climate action depends on the role it is given in a national governance system, i.e., its overall *relevance* (Duwe and Iwaszuk, 2019b; Ross et al., 2021; Rüdinger et al., 2018). This relevance can be seen from its position in relation to other planning processes and in the degree of buy-in by government and private actors. The following assessment seeks to measure 'LTS relevance' based on the analysis of three components: (1) strategy preparation, (2) responsibilities or processes established for strategy follow-up and (3) strategy integration in the wider national governance system, most importantly its alignment with near-term planning outlined in the NECP.

It should be noted that for most countries information was obtained solely from the LTSs and cross-checked against the summaries provided by Ricardo-AEA (2019). As such, we relied heavily on the level of detail reported in the submissions themselves to gauge relevance. For eight countries further insights gained from expert interviews helped supplement information contained in the strategies, offering a more comprehensive picture in these cases.

Table 20: Analytical framework for the assessment of LTS relevance

	DIMENSIONS	ASSESSMENT CRITERIA
 PREPARATION	**Compliance with legal requirements**	Meeting the submission deadline Inclusion of mandatory elements Use of the proposed common template
	Scientific basis	Underlying methodologies (scenarios and modelling) Expert advice and review
	Participation	Inter-ministerial coordination and political support Stakeholder engagement Public involvement and consultation
 FOLLOW-UP	**Implementation responsibilities**	Clear responsibilities for implementation outlined in LTS document Creation of new institutions, processes or new obligations on existing ones
	Monitoring and revising	Policy learning cycle for review and revision Revision status and current prospects for updating
 INTEGRATION	**Position of LTS in national climate governance landscape**	Role in national governance and legal status Featured in a climate framework law Reference to other national planning processes
	Reference to and coherence with NECPs	Submission timing Methodological consistency and target alignment Ministerial responsibilities for LTS/NECP development

Source: own compilation

Figure 4: Enhancing LTS relevance for net-zero.

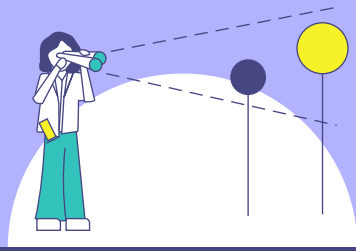
ENHANCING LTS RELEVANCE FOR NET ZERO

POLITICAL AND SOCIETAL PARTICIPATION

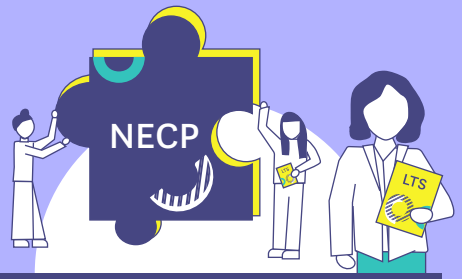
LONG TERM STRATEGY CREATED

PARLIAMENT INVOLVED

POLICY MAKING MILESTONE

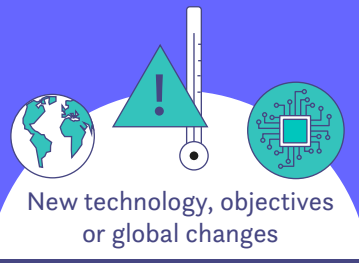


POLICY COHERENCE OVER TIME



LTS-NECP COHERENCE

TRACKING PROGRESS TOWARDS NET ZERO



EVENTS

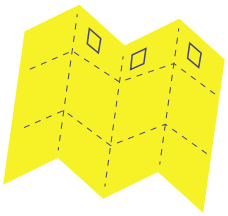
REVIEW LTS EVERY 5 YEARS

PREPARATION

IMPLEMENTATION

MONITORING

3.1 STRATEGY PREPARATION



The details of an LTS's preparation process shed light on how serious the country took the long-term planning exercise. Was the submission in accordance with EU regulation? Is the strategy based on a robust climate protection scenario and the best scientific evidence? Did LTS development involve stakeholder participation and public consultation?

The answers to these questions point to the scientific validity of the strategy as well as what measures the government undertook to safeguard transparency and enhance buy-in across ministries and by non-governmental actors, all crucial to the credibility of the LTS in national discourse (Duwe and Iwaszuk, 2019a). These same elements are arguably more important for those countries without a framework climate law. Such laws often create dedicated avenues for coordination, stakeholder consultation and scientific input on national climate policy-making and, to the extent that they enshrine long-term targets, serve as a beacon to guide near-term policy-making (Duwe and Evans, 2020). A robust LTS preparation process that ensures a solid scientific basis, stakeholder input, and coordination between ministries cements an LTS's role in national policy-making and can enhance the credibility of a government's climate actions. Further, an on-time submission and adherence to guidelines show that a country is proactively engaged in EU climate governance.

Therefore, the assessment of LTS preparation was based on three elements:

1. **compliance** of LTS documentation with the concrete provisions in the GovReg,
2. the **scientific basis** that informs the strategy (e.g., climate protection scenario and/or underlying modelling plus expert review and input), and
3. the degree of **participation** by different governmental and non-governmental actors in strategy development (as a means to measure potential buy-in).

3.1.1 COMPLIANCE WITH LEGAL REQUIREMENTS

Relevance of the topic

For the purposes of this report, compliance with legal requirements is operationalised along three dimensions all based on regulatory provisions: (1) adherence to submission deadlines, (2) inclusion of mandatory content and an adequate planning horizon, and (3) use of the proposed template. More specifically, Article 15.1 of the GovReg obliges Member States to prepare and submit their first strategies by 1 January 2020, and subsequently thereafter in a ten-year cycle – the next iterations are due 1 January 2029. On content, Article 15.4 provides a list of elements that Member States must include in their LTS, while Article 15.1 stipulates that national LTS must have 'a perspective of at least 30 years.' Annex IV proposes a standard template for the content and structure of submissions.[5] Each of these three elements under compliance is uniquely important.

Regular submission deadlines help to keep countries aligned with the planning cycles established by EU climate governance, facilitating a similar pace of transformation and some degree of coordination.[6] Additionally, national strategies must be delivered together or within a reasonable time frame to enable the EC to produce an assessment of aggregate ambition and check whether it aligns with the EU's overall goal (as defined in Art. 15.9 GovReg). Likewise, timely submissions facilitate a comparative evaluation by external observers (such as the one you are reading right now). Finally, if long-term planning lags too far behind the development and revision of the NECPs this could lead to a lack of cohesion between the two planning horizons (Sartor et al., 2017; see also NECP coherence in Section 3.3.2).

5. Additional language in the GovReg places further obligations on Member States when it comes to public and stakeholder participation in the LTS development processes – Articles 10 and 11, respectively. We evaluate participation separately in Section 3.1.3.

6. The obligation to produce LTSs was in fact included in the predecessor regulation to the GovReg, the Monitoring Mechanism Regulation or MMR (Regulation (EU) No 525/2013) – see also section above. While the MMR did not stipulate a deadline, it is for this reason that some Member States developed a national strategy prior to the specifications let forth the GovReg.

The mandatory content and time horizon ensure standardisation in the substance of the national documents. At a bare minimum, the strategies should incorporate the information needed to facilitate an EU-wide evaluation of long-term ambition spelled out for a 30-year period (i.e., 2050). The exercise of compiling the emissions data and the other sector-specific information required by Article 15.4 of the GovReg in and of itself could get a Member State thinking about long-term transformation, and at the very least forces national governments to build capacity in terms of scenario-building and modelling (Duwe et al., 2017).

Member States are not legally obliged to employ the template proposed in Annex IV of the GovReg (the text says they 'should' use it, not that they 'shall'). Still, there are numerous added benefits to using a pre-set structure. First, uniformity in the way information is presented makes it easier to compare and contrast national submissions and facilitates quicker reference. Further, the template goes beyond the mandatory elements outlined above, asking for information on public and stakeholder participation in the creation of the LTS, scientific methodologies, national legal and political context among other things. As such, those countries that adhere to the template may provide a fuller picture of their long-term climate ambition. Nonetheless, even if an LTS does not follow the suggested template this does *not* mean that crucial information is missing, although it may be harder to find in the document itself. Strategies that were published before the adoption of the GovReg, for example, did not have the template as guidance, and thus could not be prepared with it in mind.

In the following section, we assess each dimension in turn.

Information in the LTSs

DEADLINE

At the time of analysis, all but five EU countries had submitted an LTS. However, of these, only nine strategies were actually delivered by the 01 January 2020 deadline – the Greek and Lithuanian strategies followed within a couple weeks. Four Member States submitted their LTSs in the first quarter of 2020 and were therefore only marginally late (Belgium, Finland, France, and Slovakia). Italy, Slovenia, and Spain, among others, did not produce a strategy until many months or over a year after the initial submission date, and Hungary, Luxembourg, and Malta were more than 18 months late with their LTSs. A key insight from the interviews is that the lack of capacities and technical know-how for scenario development was a common bottleneck, especially considering the need to produce both the NECP and LTS more or less simultaneously. The pandemic also seems to have led to delays in at least a handful of cases (e.g., France, Poland).

Table 21 provides an overview of countries grouped into those that submitted early and on time (i.e., within a month of the deadline), those that were late by two months to a year and those that were over a year late, plus those still missing as of February 2022. Notably, two countries reused a strategy document prepared in the context of previous reporting requirements under the MMR instead of developing a new strategy (Czechia and Germany).

Table 21: LTS submission dates

PRE-DEADLINE PUBLICATIONS	ON TIME (WITHIN A MONTH DEADLINE)	DELAYED	LATE	OVERDUE (AS OF FEB 2022)
Germany (Nov 2016)	Austria (Dec 2019)	Belgium (Mar 2020)	Italy (Jan 2021)	Bulgaria
Czechia (Mar 2017)	Netherlands (Dec 2019)	France (Mar 2020) (4)	Croatia (Jun 2021)	Cyprus
Portugal (Jun 2019)	Denmark (Dec 2019)(1)	Slovakia (Mar 2020)	Slovenia (Jul 2021)	Ireland
	Estonia (Dec 2019) (2)	Finland (Apr 2020)	Hungary (Sep 2021) (4)	Poland
	Latvia (Dec 2019)	Spain (Nov 2020)	Luxembourg (Oct 2021)	Romania
	Sweden (Dec 2019)		Malta (Oct 2021)	
	Greece (Jan 2020)			
	Lithuania (Jan 2020) (3)			
TOTAL: 3	TOTAL: 8	TOTAL: 5	TOTAL: 6	TOTAL: 5

Source: own compilation based on national LTSs; cross-checked with Ricardo-AEA (2019) and UNFCCC (2022). Note: (1) Denmark's Climate Programme 2020 serves as an update to the LTS and was submitted as part of biennial reporting to the EU in March 2021; (2) In 2021, the Estonian government published a new Estonia 2035 Strategy ('EE2035') but has not yet submitted this officially to the EC; (3) initial submission date but existing revision; (4) already a revised strategy.

At present, at least three Member States – Czechia, Croatia, France – are in the midst of revising their LTS and thus are on track to publish an update in line with the five-year schedule proposed (but not required) in the GovReg. These are due by 01 January 2024 'where necessary'. The Estonian government published a new strategy (titled Estonia 2035) in 2021 but has not yet submitted this document officially in part because in its current form is still lacks some of the required information. Denmark submitted its Climate Programme 2020 in March 2021 as an update to its LTS, although all key information focuses on 2030.

It is important to note that the unscheduled upwards revision of the EU headline climate targets – now firmly established in the ECL – threw a wrench into national climate planning. Obliged to pursue greater ambition, numerous countries revised their national targets in the midst of LTS development, which may have resulted in delays in submission. In Germany, for example, the newly adopted national climate neutrality target is not reflected in the current LTS.

MANDATORY CONTENT AND TIME HORIZON

Article 15.4 of the GovReg clearly stipulates the information that Member States are required to present in each iteration of their strategies, outlining five mandatory elements. These are listed in the introduction to this report, and each element is assessed in detail for substance in Section on LTS vision. The regulation further stipulates a 30-year time horizon for the strategy as a whole.

To aid in the descriptive analysis, countries were placed along a four-degree scale ranging from 'compliant' to 'non-compliant' based on information provided in the LTSs on each of the five elements plus the time horizon (see Table 22 for a summary; a complete overview and brief description of the assessment methodology can be found in Table A-2).

The level of compliance with mandatory content *did not vary much* by Member State. In total, 13 countries were found to be 'compliant,' for providing detail across all elements, with an additional six strategies characterised as 'mostly compliant'. The latter group may have left out specifics or only provided partial information on one or more mandatory elements. As such, under our assessment framework, the vast majority of Member States' strategies submitted so far (19/22) include most of the required content and addressed the prescribed time horizon.

The strategies of Belgium, Denmark and the Netherlands were found to be 'mostly non-compliant' for omitting crucial sectoral GHG data and provide limited or no information on the socio-economic dynamics of the transition. Despite a lack of sufficient detail on many elements, the Netherlands took a unique approach to presenting the info, with a table overview of the elements dictated by the GovReg. This made it especially easy to account for information (see Dutch LTS, p. 19). In Denmark GHG data only goes through 2040 and therefore cannot be said to have an adequate time horizon; the strategy is also missing detail across all other elements. Still, no countries were found to be completely non-compliant.

Table 22: LTS compliance with mandatory content and time horizon

COMPLIANT	MOSTLY COMPLIANT	MOSTLY NON-COMPLIANT	NON-COMPLIANT
Austria	Czechia	Belgium	
Croatia	Estonia	Denmark	
Finland	Germany	The Netherlands	
France	Greece		
Hungary	Slovakia		
Italy	Sweden		
Latvia			
Lithuania			
Luxembourg			
Malta			
Portugal			
Slovenia			
Spain			
TOTAL: 13	TOTAL: 6	TOTAL: 3	TOTAL: 0

Source: own compilation based on national LTSs; cross-checked with Ricardo-AEA (2019), excluding countries without an LTS (Bulgaria, Cyprus, Ireland, Poland, Romania). Note: Countries were assessed across the five mandatory elements as being (1) 'compliant,' (2) 'mostly compliant,' (3) 'mostly non-compliant' and (4) 'non-compliant'. Additional details on the assessment methodology can be found in the appendices, Table A-3.

Most countries included at least a 2050 time horizon. Sweden has pledged to reach climate neutrality already by 2045, and accordingly its strategy has a shorter time-horizon. Nonetheless, the Swedish LTS is five years short of the GovReg time horizon requirement, even though it was found to be mostly compliant overall. An important note here is that while nearly all strategies indicate a target for 2050, and thus have in the most basic sense a '30-year time horizon', the underlying scenarios may present shorter futures (e.g., Denmark, Germany, Netherlands, and Slovakia). This general lack of quantitative detail in post-2030 modelling outputs was found in several strategies, see Sectionn 3.1.2 on scientific methodologies below. For example, the strategies for Germany, Latvia, and the Netherlands read more as aspirational roadmaps for the post-2030 timeframe. They expand information included in the NECPs but deliver little concrete data to support the qualitative statements.

Indeed, the GovReg does not specify the depth or type of information (e.g., quantitative or qualitative) or the format of presentation nor does it spell out in concrete terms how the 30-year time horizon should be addressed concretely. As a consequence, two widespread shortcomings were missing quantitative data, especially in the long-term, and a general lack of sector-specific detail. Instead, only a qualitative description of pathways, socio-economic projections or investment trends were provided. For instance, while 18 out of 22 countries provide quantitative figures for emission reductions, only 12 provide quantitative estimates for removals. In most cases, quantitative information also seems to be missing overall for the buildings and natural sinks. When it comes to socio-economic, environmental, and health impacts even fewer strategies presented robust quantitative information. For instance, Italy provides a general view on the possible impacts of the LTS but fails to provide exact figures for the socio-economic effect on workers, industries and the economy as a whole. See Table A-3 in the appendices to this report for a table with full detail across all mandatory elements for all countries.

As emphasised across this report, the minimum standards set forth in the GovReg are such that basic compliance does not automatically lead to meaningful information. In an attempt to match the provisions of the regulation, the framework we used to assess compliance in this section allowed for either qualitative or quantitative information. However, only five countries provided quantitative long-term figures for all mandatory sectors: France, Hungary, Italy, Portugal, Slovenia and Spain. Three additional countries come close: Austria combined multiple sectors into a single 'energy' indicator, thereby failing to provide sufficiently disaggregated data, Greece misses data on natural sinks and Finland leaves only the buildings sector out, providing detail across all other elements. It can be implied that the underlying information exists but was not made explicit in the strategies.

TEMPLATE

A descriptive analysis of template use was based on whether the overarching structure outlined by in Annex IV of the GovReg was implemented, including headings, sub-headings and the presentation order of topics. See Table 23 for an overview.

Use of the template varied by Member State – five countries largely followed the structure, while another five did not. The remaining 12 countries seemed to have used the template more as general guidance, adopting some elements or mixing up the sequence of topics. The way in which countries customised the template to suit their own purposes varied. For instance, some made use of the proposed chapter headings but not sub-chapter structure (e.g., Austria), while others left out sub-headings on individual sectors (e.g., Estonia). The Belgian LTS serves as a good illustration of how many countries accounted for the general order of content and sectors without implementing the proposed template perfectly. Unsurprisingly, those strategies that pre-date the GovReg, i.e., Czechia and Germany, do not follow the template at all; the Czech strategy is instead based on the UNFCCC reporting guidelines.

Even countries that largely adhered to the template may have changed or added minor elements. For instance, Italy moved the section on public consultation to an annex and Malta did not incorporate a section on energy efficiency. As such, strictly speaking, only three countries stuck to the proposed template closely (Croatia, Finland and Slovakia). However, because the LTS template itself is not as detailed as the NECP template in Annex I of the GovReg nor is it required, it is not surprising that Member States opted to expand or alter the outline to fit their own needs. Still, considering the aim of having a template was to ensure that EU national strategies are comparable, this lack of standardisation in structure could be seen as a failure on the part of Member States. The variable order of information may make a comparative assessment more challenging or time intensive. This was the case in our analysis.

Table 23: LTS use of the template provided in Annex IV of GovReg

NO	PARTLY	YES
Czechia	Austria	Croatia
France	Belgium	Finland
Germany	Denmark	Italy (1)
Luxembourg	Estonia	Malta (1)
Portugal	Greece	Slovakia
	Hungary	
	Latvia	
	Lithuania	
	Netherlands	
	Slovenia	
	Spain	
	Sweden	
TOTAL: 5	TOTAL: 12	TOTAL: 5

Source: own compilation based on national LTSs, excluding countries without an LTS (Bulgaria, Cyprus, Ireland, Poland, Romania).
Note: (1) with minor variation (e.g., missing or added section, slightly different order)

Summary assessment

More than half of EU Member States were late in submitting their LTSs, and five strategies were still missing at the time of writing. Only nine countries submitted up-to-date LTSs by or within a month of the 01 January 2020 submission deadline. The delay in LTS submissions is especially poor performance compared to the timeliness of NECP submissions. Considering the GovReg's requirement that these two documents be aligned, it is concerning that in so many cases apparently LTS development took a backseat to the NECP. In a few cases, old strategy documents, dating back to pre-GovReg, were submitted well in advance of the deadline. This is equally problematic because it suggests that either the NECP was based on an already outdated long-term vision or that the LTS is in immediate need of revision to be in coherence with medium term policy action (for more on this topic see Section 3.3.2).

Almost all EU Member States provided enough information on mandatory content in their LTSs to be considered 'mostly compliant' with EU regulation. However, even though most countries presented a 2050 future and checked most or all of the boxes on the five mandatory elements, the level of detail varies significantly. Only a handful of strategies incorporated quantitative figures across all elements and often sector-specific information was missing, most commonly for electricity, buildings and LULUCF. This may have been avoided had the GovReg provided more concrete guidance on the type and depth of information that was deemed mandatory. Italy, Portugal, Slovenia and Spain stand out as good practice examples for including quantitative data on all mandatory sectors as well as economy-wide emission and removals through 2050 (Austria and France omit only minor detail and could be counted in this group).

Overall, the LTS template provided in Annex IV of the GovReg seems to have served more as general guidance and was not used directly as the structure for organising most Member States' strategy documents. Still, five strategies more or less followed the outline, changing only small elements. However, arguably, the finding that LTSs were as a whole mostly compliant with the mandatory content is more important than how they structured or ordered the information.

3.1.2 SCIENTIFIC BASIS

Relevance of topic

Scientific evidence is an instrumental contribution to governmental action on climate, not least because of the complexities of decision-making across multiple decades. A vision of the future presented in a national LTS is only as valid as the underlying assumptions and analysis it is built from. The following assessment of the scientific basis is comprised of two dimensions: (1) whether the LTS is based on a robust methodology and (2) the extent of expert advice and review, including the form and depth of input.

To serve as a blueprint for national climate action, strategic planning must be based on the best scientific evidence available (at the time) and a robust methodology for forecasting emission reductions and socio-economic trends (Duscha et al., 2017; Duwe et al., 2021). In concrete terms, the targets, timing, reductions and removals and, to the extent they are included, specific measures and actions described in each LTS must factor into a background assessment of decarbonisation pathways, often in the form of *climate mitigation scenarios* and associated modelling. The modelling techniques do not have to be designed specifically for the strategy – although they should ideally be tailored to the intricacies and economy-wide nature of climate policy questions (Rüdinger et al., 2018). Perhaps more important is whether the resulting scenarios can be integrated into overarching national planning processes (e.g., through an extension of past models) and are consistent with the approach used for the NECP.

A second critical component of scientific basis is *who* is involved. Often, governments have in-house capacity to develop climate mitigation scenarios, but many also seek external expert scientific advice and review either through an open tender process for consultancy or expert working groups on specific topics. A growing number of EU countries have established dedicated scientific climate advisory bodies composed of researchers and scientists with core expertise in fields relevant to national climate policy-making (EEA, 2021b). External scientific experts may also be asked to review and ensure the validity of the government's methodologies and underlying assumptions, overall enhancing transparency in the process (Averchenkova et al., 2018; Evans and Duwe, 2021). In addition, by engaging with the scientific discourse, governments create buy-in from national experts in the wider policy community (IPCC, 2022b).

Information in the LTSs

METHODOLOGY: SCENARIOS AND MODELLING UNDERLYING THE LTS

The LTS template from Annex IV of the GovReg prompts countries to provide information on methodologies and the underlying scientific evidence in an annex to the strategy itself (i.e., Section 5 – Annexes). Some countries followed the template and attached relevant information, while others put methodological details in a separate section in the body of the strategy. As presented in Table 24, in a majority of cases, strategies incorporate at least some information on underlying scenarios, even though these do not always have a time horizon through 2050 or describe pathways that reach the national target.

Table 24: Scenarios underlying national LTSs

NO SCENARIO OR LITTLE TO NO MENTION OF UNDERLYING METHODOLOGIES	SCENARIO THAT …	
	DOES NOT REACH THE NATIONAL LONG-TERM TARGET	APPROACHES THE NATIONAL LONG-TERM TARGET
Estonia (1)	Denmark (2)	Austria*
Germany	Latvia	Belgium (3)
Lithuania	Slovakia	Croatia (4)
Luxembourg		Czechia (4)
Netherlands		Finland*
Sweden		France*
		Greece (5)
		Hungary*
		Italy*
		Malta (5)
		Portugal*
		Slovenia*
		Spain*
TOTAL: 6	TOTAL: 3	TOTAL: 13

Source: own compilation based on national LTSs; cross-checked with Ricardo-AEA (2019), excluding countries without an LTS (Bulgaria, Cyprus, Ireland, Poland, Romania).

*Note: * Eight LTSs elaborate national net zero target conform pathways (= climate neutrality in Finland, France and Portugal), while others focus on emission reductions; (1) Estonia's original LTS includes 80% net emission reductions by 2050, which does meet the climate neutrality target established in the new EE2035 strategy. The revised EE2035 strategy includes no modelling through 2050; (2) BAU modelling only through 2040; (3) National pathways in the Belgian LTS are based on aggregate regional scenarios; (4) Qualitative long-term target only; (5) GHG removal is partly unclear (e.g., the Greek LTS accounts for technical but not natural sinks)*

As an overarching observation, information on LTS methodology is often lacking in detail and thus difficult to assess for scope and depth of analysis. For example, Estonia, Malta, the Netherlands and Sweden offer only a cursory description of their respective methods to elaborate long-term scenarios. Sweden, for instance, only refers to a separate study on reaching net zero emissions by 2050 that was used as a basis for the qualitative information provided in its LTS. Likewise, the Dutch LTS provides a list of references for external studies upon which the strategy is based but does not go into detail on specific scenarios or methodologies, albeit it does mention that modelling info can be found in the NECP (MEACP, 2019, pp. 17–18). Lithuania and Luxembourg, likewise, make vague or little mention of the methods used for determining emission reduction pathways.

The Estonian case is unique because where the original LTS provides some information on a long-term pathway through 2050, this is not aligned with the country's newer 'EE2035' scenario. The latter includes the climate neutrality target but no projections or underlying modelling for 2050, which makes the roadmap published in May 2021 read more as an aspirational document, rather than a robust blueprint for reaching net zero emissions.

Across all countries, the assessment found substantial differences between approaches, including the time horizon of the projections, the scope of analysis, and the types of scenarios, not to mention the actual modelling techniques employed. We also examined whether or not scenarios were developed specifically for the LTS. The following insights can be gained from a comparative assessment.

DIFFERENT TIME HORIZONS: Three countries only described scenarios for the near-term, i.e., 2030 or 2035 (Belgium, Germany, and the Netherlands) – sometimes these were one and the same as those developed for each country's NECP. For example, in the German LTS, scenarios were developed only for the 2030 sectoral targets and no extra modelling was done for 2050. Similarly, the Belgian LTS aggregates expected regional emission levels per sector by 2050 without modelling these separately. As such, the Belgian LTS is based on regional planning methodologies not described in the strategy itself and notes that regional variability in emissions data by sector is a possible limitation to the validity of the national strategy (Belgium LTS, p. 3). The Danish strategy describes qualitative BAU pathways through 2040 but no additional measures and is especially vague on the methodological basis. The submission itself does not mention any further scenarios. Notably, much of the Danish LTS is based on a previous political agreement on climate neutrality for 2050 (Belusa, 2022).

A total of 12 strategies describe detailed long-term modelling of economy-wide emissions through 2050 (the third column in Table 24, omitting Belgium for reasons mentioned previously). Still, some sub-elements had a shorter timeframe. For example, one of Czechia's baseline scenarios with existing policies was only considered through 2040, and Slovenia's macro-economic impact assessment is for 2030.

DIFFERENT SCOPES OF ANALYSIS AND TYPES OF SCENARIOS: Methodologies underpinning Member State LTSs also differed in their scope of analysis (e.g., economy-wide or sectoral coverage, inclusion of socio- and macro-economic impacts) and the number and types of scenarios modelled (e.g., with or without additional policies, technology deployment, etc.).

The majority of strategies are based on scenarios built from models that consider economy-wide trends with sector-specific inputs. However, some strategies described modelling unique to individual sectors. For instance, Slovenia incorporated specific models for power sector capacity expansion and transport. Likewise, Estonia elaborated multiple scenarios for each of the main sectors, combining these into five different roadmaps for 2050 – albeit the long-term scenarios are only descriptive in the new 'EE2035' document.

LTSs also differ in the number and type of scenarios serving an informative basis. Broadly, these fit into one of three categories: The first (and largest) group of strategies elaborate on the familiar approach set forth in the MMR – i.e., (1) baseline WEM and (2) 'with additional (and/or planned) measures' (WAM). This includes Austria, Belgium (for 2030), France, Slovakia (whereby the scenario does not reach the target), Slovenia (describes six WAM scenarios) and Spain. Finland and Portugal use WEM scenarios as a baseline, and the Portuguese strategy refers to the WEM scenario as 'off track'. The Austria strategy fits somewhat in this group. It is based on a national scenario called 'Transition 2019' (first developed in 2017 and revised in 2019) that draws heavily on WEM/WAM projections under the MMR. The Danish and Latvian strategies only describe BAU scenarios and do not include any further analysis; in Denmark, scenarios only go through 2040. As such, neither country offers valid pathways to reach the stated goal of climate neutrality by 2050 (which is the overall goal stated in each LTS).

A second group of LTSs are based on scenarios that put an emphasis on the deployment of different technologies and other structural shifts in the economy (Czechia, Italy, Finland, and Portugal). For one, the Finnish strategy details two alternative scenarios: a 'Continuous Growth' pathway based on deployment of technologies and a 'Savings' scenario based on proliferation of a circular and sharing economy as well as substantial energy efficiency gains. The Czech LTS presents eight alternative futures for 2050, of which three achieve an 80% emission reduction target, all based on different technological pathways for, e.g., nuclear, biomass and electrification. Italy uses a reference and a 'decarbonisation scenario' focussing on energy demand, energy mix and removals.

The final group of scenarios frames projections around the speed of the transformation – often distinguishing between BAU, gradual and rapid progress towards deep decarbonisation. Greece, in particular, describes four scenarios to meet the national 2050 target, two aimed at contributing to reduce warming by 1.5 degrees and two by 2.0 degrees. The scenarios also differ in terms of assumptions behind key technologies and policy priorities. Furthermore, Croatia and Hungary elaborate scenarios based on the timing of action – i.e., 'early' or 'late' transformation.

Table 25 provides an overview of the scope of analysis across these three groups. Only those countries that describe target-approaching, quantitative scenarios through 2050 are included.

Table 25: Framing of the analysis underlying national LTSs with 2050 pathways

2050 SCENARIOS FRAMED AROUND BAU, WEM/WAM	2050 SCENARIOS FRAMED AROUND TECHNOLOGY FUTURES AND SOCIO-ECONOMIC LEVERS	2050 SCENARIOS FRAMED AROUND SPEED OF TRANSFORMATION
Austria	Czechia	Croatia
France	Finland	Greece
Slovenia	Italy	Hungary
Spain	Portugal	
TOTAL: 4	**TOTAL: 4**	**TOTAL: 3**

Source: own compilation based on national LTSs.
Note: Two countries that provide information on target-approaching long-term pathways were left out of the table. First, Malta uses a unique approach based on the marginal abatement cost of different decarbonisation actions. Second, Belgium only aggregates regional pathways and does not elaborate on any national modelling.

DIFFERENT MODELS: Information about the exact modelling techniques is not always included in the LTS. Still, it is apparent that countries relied on a range of models to develop a clear picture of economic and emission pathways. Some used existing models (e.g., Czechia – UK 2050 Energy Calculator; Italy – Gdyn-E and ICES; Spain – TIMES-Sinergia), while others used tools developed for the strategy (e.g., Austria). The Belgian LTS cites modelling work conducted at a regional level and published by private research institutions, such as Climact's Pathways Explorer. Estonia employed a model adapted from the International Energy Agency (IEA) that was previously used by the government in the preparation of its NECP. Furthermore, the Polish LTS, currently in development, will be based on the EU PRIMES model and include BAU as well as decarbonisation pathways.

Many LTS scenarios were an extension of another modelling or scenario building exercise (e.g., NECP). This was the case in Latvia, where the LTS was essentially an exercise to enhance the ambition of the scenarios that underlie the country's NECP to achieve an emissions trajectory for climate neutrality by 2050. Likewise, the Slovenian and Greek LTSs are both based primarily on the government's NECP scenarios with the time horizon extended by two decades. A special case, Malta uses abatement potentials based on a Marginal Abatement Cost Curve (MACC) developed for the strategy to outline GHG emission reductions through 2050, with interim views to 2030 and 2040. Malta also used much of the sectoral modelling of the NECP as a baseline for further elaboration in the LTS. Due to an unclear accounting of removals, the projections only approach and do not fully meet the climate neutrality goal referenced in the strategy.

Other LTSs are based on scenarios developed as part of past studies commissioned by the government (i.e., Finland, Sweden) or other national plans, such as a national adaptation strategy (Czechia) or Portugal's Carbon Neutrality Roadmap (CNR2050). The Swedish LTS recycled old data detailed by the Swedish Environmental Protection Agency in 2012 as the basis for the LTS, adapting these for long-term climate planning. In France, the WAM modelling underlying the National Energy Plan was used for both the NECP and LTS and developed in advance of the LTS. Due to a lack of information, it was not always possible to determine whether the methodology was developed especially for the LTS or as part of a separate exercise.

SCIENTIFIC REVIEW AND ADVICE

The majority of LTSs submitted thus far include some mention of input by scientists, research organisations and/or academia. However, in many cases members of the scientific community were simply included in the overall participatory processes alongside other stakeholders. Consultation processes included technical workshops or online consultation platforms that allowed open comments on draft proposals. For instance, the Italian LTS mentions a special survey for experts (alongside the general public) but does not further elaborate on who was consulted. Similarly, the Latvian strategy notes consultations with 'academic staff'. In numerous countries, including France, Portugal, Slovakia, and Spain, scientific experts took part in technical working groups. Interviews with national experts in France highlighted that working groups on the latest LTS revision included representatives of national research institutes, such as Ademe, National Centre for Scientific Research. Furthermore, for the current pending revision, the National Research Institute for Agriculture, Food and Environment (INRAe, established in 2020) was added.

Somewhat unique approaches to scientific input were taken in the Netherlands and Sweden. Prior to drafting the LTS, the Dutch government asked national climate change experts to submit essays on what they considered important considerations for the long-term perspective in an effort to map diverse perspectives. The Swedish case is also unique because the initial work on what would become the long-term vision began with the Cross-Party Committee on Environmental Objectives, which included representatives of the scientific community as formal members. The committee was tasked with scoping Sweden's overarching 'climate policy framework', which would become the basis for the Swedish Climate Law and Climate Policy Council as well as Sweden's 2045 climate neutrality target. These early consultations had an impact on LTS formulation vis-à-vis a clear influence on formulating the national target (which was reiterated in the LTS).

A number of strategies lay out scientific advice and review in more concrete terms, detailing dedicated climate councils or partnerships with public and private research organisations and universities.

DEDICATED SCIENTIFIC CLIMATE ADVISORY BODIES: The number of independent, scientific advisory bodies or councils in the EU has been steadily rising as more and more countries establish their own version of the United Kingdom's prototype, the UK Climate Change Committee (CCC) (EEA, 2021b). These councils are solicited by government for expert advice on climate policy-making and are composed, in most cases, solely of scientific experts from the research community. A 2021 study identified ten such councils in EU Member States, but of these, only five were operational in time to provide input in the first LTS drafting cycle – in Denmark, Finland, Germany, Ireland (no LTS) and Sweden (Evans and Duwe, 2021).

Surprisingly, none of these five countries mention their expert council as playing a role in the strategy development phase; however, the Danish Council on Climate Change has a clear function in the development of Denmark's annual climate policy cycle and is described in the Climate Programme 2020 The Finnish strategy only states that the climate neutrality target is based on the Finnish Climate Change Panel's estimate of a national contribution to the 1.5-degree target. Only two strategies explicitly mention consultations with dedicated expert councils, and one is not exclusively a scientific body. The Belgian LTS notes that scenario-building by authorities in Flanders relied on expert advice from an independent climate panel, and in France the National Committee on Energy Transition (a stakeholder panel with scientific members) was given an opportunity to comment on the final draft of the current revision. Although it is not mentioned in the German LTS submission explicitly, the authors are aware that a Scientific Platform for Climate Protection (*Wissenschaftsplatform Klimaschutz*) was established in 2019 under the auspices of the Ministry for Environment and Ministry for Education and tasked specifically with advising on the implementation and further development of the German strategy and long-term climate action generally.

Interviewees on the French case pointed out that the High Council for Climate (HCC, established in 2019) will engage in formal consultation on future LTS revisions and provide recommendations. Indeed, one French interviewee emphasised that the expanding role for scientific advice in LTS development was driven in part by outcry within the scientific community. Representatives of national and private research institutes criticised what they saw as underrepresentation in the strategy preparation phase, which helped pave the road for the creation of the HCC as a dedicated forum for scientific input. Even still, for the first version of the French LTS, unsolicited sector-specific studies by governmental research institutions (such as Ademe) challenged some of the underlying assumptions and conclusions of the ministry. A different national expert noted that the second time around these national institutes were then given a seat at the table and included more directly in the debate (Podesta, 2022).

With the number of independent climate councils doubling since the adoption of the GovReg, it is possible that these bodies will play a more central role in future LTS revisions as in the French case. Moreover, even if they are not engaged directly in LTS development, climate councils, by way of their reputation and soft power in national climate governance, can exert an indirect influence on the vision contained in future strategy submission.

EXISTING GOVERNMENTAL AND NON-GOVERNMENTAL RESEARCH INSTITUTIONS: Several countries describe scientific review and advice occurring within the realm of national research institutes or partnerships with private, non-governmental scientific organisations and universities. These existing organisations were not developed specifically for the LTS preparation process but consulted for expert guidance and quality control. For instance, Hungary commissioned the Global Green Growth Institute to do an independent review of the government's LTS development process.

Interviews with German, Portuguese and Spanish national experts pointed to the longstanding consultancy relationship between the independent research community and governmental agencies in their country. In each case, outside research consortia played a behind-the-scenes role in LTS development, especially on technical questions and modelling, even if there was no mention of specific organisations in the LTS documents. Likewise, the Austrian Federal Environment Agency has long worked with a consortium of national scientific institutions to model GHG scenarios every two years (previously to comply with the MMR). Numerous national research agencies and independent organisations are listed along with their various contributions directly in the LTS, including inter alia the Centre of Economic Scenario Analysis and Research, Technical University Graz and the Austrian Energy Agency (p. 95). Similarly, the Dutch strategy references in numerous cases modelling work done by the government's Environmental Assessment Agency (PBL).

In the case of Czechia, the Czech Meteorological Institute was consulted on the long-term GHG projections and reviewed the chapter on adaptation and risk. Slovenia's LTS is unique because it is based on scenarios developed under an EU-funded project called ClimatePath2050. Supported by the EU LIFE Programme, the initiative is composed of a consortium of public and private entities and lead by the Jožef Stefan Institute (JSI).

Interviews also shed light on the scientific advisory processes occurring in countries that have not yet submitted a strategy. For example, the Polish national research institute, KOBiZE, is being consulted for LTS development and has already developed its own strategy based its in-house 'CAKE' model. Still, the independent think tank, WiseEuropa, has been tapped by the Polish government to spearhead the scenario development. In a similar fashion, but also due to a lack of capacity and expertise by public authorities, Bulgaria is relying on Deloitte BG to produce its first strategy.

Summary assessment

The scientific methodology underlying for an LTS is crucial to the validity of the document as a map for charting a course to a net zero emission future. Against this benchmark, over half of the already submitted strategies can be considered good practice examples, for elaborating target-approaching scenarios for 2050 based on quantitative pathways. The remaining countries fall short either by failing to describe scenarios at all or offering little indication of long-term modelling in their strategies. Still, even among those countries that elaborate robust 2050 pathways, methodologies differ significantly in their scope and the types and number of scenarios used.

As with methodology, scientific review and expert advice is also a mixed picture. On a positive note, it seems that in most cases, members of the scientific community were included in the general participatory channels, often as members of working groups or technical commissions. However, the degree to which expert advice actually influenced the final strategy (compared, e.g., to the priorities of the private sector) is hard to discern. Only a couple strategies mention the input of a dedicated national advisory body for climate policy. This is to be expected considering that many independent climate councils were only fully operational after the first round of strategies was already being developed. The Slovenian case is worth mentioning because it used the findings of an EU-funded research project, spearheaded by numerous well-established research institutes, as the basis for its scenario development. Hungary commissioned a quality review of its LTS by the Global Green Growth Initiative. The French case is also insightful as it shows that over multiple revision cycles the role for scientific experts has expanded.

3.1.3 PARTICIPATION

Relevance of the topic

Consultation between governmental institutions, stakeholders and the public is a core element of inclusive and robust long-term climate planning. By actively involving a diverse set of actors in policy-making processes, national governments can enhance the transparency of climate action and reinforce public support for mitigation measures (Duwe et al., 2017; Duwe and Evans, 2021). Moreover, considering different opinions provides not only for a more inclusive process, but also for a wider integration of available ideas and solutions. The non-binding nature of LTSs allows governments to explore these ideas more freely and consider a broader spectrum of feasible long-term scenarios (Waisman et al., 2021).

The importance of a participatory process in the creation of LTSs is also inscribed in the GovReg. The regulation stipulates that Member States 'shall set reasonable timeframes' to allow for 'early and effective' opportunities for the public to participate in the preparation of both the NECP and the LTS (Art. 10). Countries must also attach a summary of public consultations to each document. A section on public consultation is also included as an item in the LTS template in Annex IV of the GovReg. The GovReg further obliges Member States to set up a 'multilevel climate and energy dialogue' to ensure that local authorities, civil society organisations, business community, investors and other relevant stakeholders are able to give input to climate policy-making, 'including for the long-term' (Art. 11). However, the GovReg does not explicitly require Member States to use this as a participatory forum for LTS development, and only stipulates that countries 'may' use this for NECP development.

Information in the LTSs

Our analysis focused on the degree of participation of governmental and non-governmental actors in the development of each country's LTS, including inter-ministerial coordination and political support, stakeholder engagement and public participation. The main aim of the assessment was to determine whether consultations had an influence on the final text of the LTS and to measure potential buy-in by the various groups by considering the format, timing and representativeness of the various channels for involvement.

Similar to previous sections, this section obtained information on participation directly from the LTS submissions. In addition, the analysis also relied on insights gained from the eight expert interviews. In the following text, we consider first inter-ministerial coordination and political support before turning to stakeholder engagement and public participation broadly.

INTER-MINISTERIAL COORDINATION AND POLITICAL SUPPORT

The analysis of participation within governments focused on the degree to which the responsible lead ministry engaged with other ministries, or whether a clear mechanism was established to facilitate communication and coordination between governmental actors. We also attempted to answer the question whether the document received political support from higher governmental levels, such as the prime minister or the president, or from members of parliament.

Overall, information on inter-ministerial coordination was readily found in the LTS documents, but lesser so for broader political support. Of the 22 countries with submitted LTSs, Denmark, Czechia, Latvia and Portugal provide limited information on government involvement and support in their LTS submission, making further assessment difficult. A large majority of countries (16) include details on coordination between ministries and other governmental authorities. Information on political support and engagement with higher governmental officials was harder to come by but at least six countries provided some information in their LTS, often pointing to the involvement of parliament. See Table 26 for an overview.

A handful of specific cases are worth emphasising. Seven countries mention a dedicated inter-ministerial working group or commission either established for the LTS specifically or for the implementation of national climate policy-making more generally but with a role to play in LTS development (Croatia, Finland, Hungary, Italy, Luxembourg, Slovakia, Slovenia). It is possible that additional similar commissions exist in other Member States that are not mentioned explicitly in the LTS documents. The strategies in Croatia and Estonia (new 'EE2035' strategy) were adopted by parliament, and similar provisions for parliamentary oversight are in place in Portugal and Spain for future LTS iterations.

According to the French LTS, the document was co-developed under the guidance of the Ministry for an Ecological and Inclusive Transition with a number of other ministries, including the Ministry of Economy and Finance, the Ministry of Agriculture and Food and the Ministry of Research and Innovation, among others. Interviewees confirmed this but added that actual involvement varied; while some had only a minor role to play, others were deeply engaged in the preparation of the LTS. For instance, the Ministry of Agriculture and Food was heavily involved with multiple working groups as well as in the preparation of the scenarios. Notably, the French LTS is presented to parliament upon publication and will, from the 2023 update onwards, be followed by a vote of a programming law. It has also been referred to by the French President, and periodic inter-ministerial meetings with representation from all ministries were also held by the Prime Minister. Ministries also had the opportunity to provide input at a more technical level in topical working groups (Berghmans, 2022).

According to one interviewee, several ministries were involved in the preparation of the German LTS, which was ultimately adopted by a cabinet decision. Ministries' involvement took place mainly during the determination of sectoral targets for 2050 and of the scenarios for the transport and LULUCF sectors. In the end, all ministries involved had the opportunity to agree to the contents of a draft summary report.

Mentioned above under methodology, a Portuguese interviewee reiterated that the LTS is a 'copy-paste' of the government's 2050 roadmap, i.e., CNR2050. While there was no specific process to create the LTS, the preparation of the CNR2050 was discussed with all ministries and was ultimately approved by the council of ministers. The interviewee also stated that the LTS is generally regarded as Portugal's way forward for 2050 and that the document was the basis for the Portuguese Parliament to approve the country's Climate Law (Ferreira, 2022). The same applies to Denmark and Sweden. Much of the contents of the Swedish LTS are the result of a lengthy participatory process that included working groups on a wide array of topics with representatives from numerous relevant governmental ministries and agencies as well as external experts (see Section 3.1.2 on scientific review and advice above). In Denmark, the Climate Programme 2020 serves as an update to the LTS and is the primary vehicle for climate policy decisions in the country with inter-ministerial collaboration.

Table 26: Inter-ministerial coordination and political support

	COORDINATION BETWEEN MINISTRIES	POLITICAL SUPPORT FROM HIGHER LEVELS IN GOVERNMENT
AT	Yes - 'relevant' ministries took part in stakeholder consultations	n/a
BE	Yes - the regional LTSs are approved at government level	Somewhat - National LTS is a combination of regional inputs; involvement of regional parliaments
HR	Yes - two 'commissions' coordinate implementation and monitoring of strategy, composed of representatives of state administration	Yes - LTS adopted by parliament
CZ	n/a	n/a; * LTS is endorsed by the government and adopted via decree
DK	n/a; * the Climate Programme 2020, serving as an update to the LTS, was developed by Ministry of Climate, Energy and Utilities, in close cooperation with the Ministry of Finance, Ministry of Taxation, Ministry of Business and ministries with responsibility for key sectors, such as transportation and agriculture	n/a; * The Climate Programme 2020 as the main vehicle for climate action in DK has received significant political attention from all levels and has been debated in parliament; it serves as an update to the LTS.

	COORDINATION BETWEEN MINISTRIES	POLITICAL SUPPORT FROM HIGHER LEVELS IN GOVERNMENT
EE	Yes - cooperation with the Ministry of Finance. Specific ministries have responsibilities for certain goals	Yes - development plans around the LTS are approved by the government; new EE2035 strategy adopted by parliament
FI	Yes - ministerial working group for climate policy discussed the LTS on several occasions, group is chaired by Minister of Environment and Climate Change	n/a
FR	Yes - the LTS was co-developed by all departments of the ministries concerned.	Yes - the LTS creation process included formal consultations carried out before adoption with the Environmental Authority and (in the future) the High Council for Climate (HCC); LTS submitted to parliament * Periodic inter-ministerial meetings held by Prime Minister; HCC uses LTS as benchmark for most communications
DE	Yes - several ministries are quoted for their initiatives, strategies, findings and forecasts.	n/a; * LTS adopted by government
EL	Yes - LTS lead by Ministry of the Environment and Energy with input by the Ministry of Finance	n/a
HU	Yes - coordination through the Inter-ministerial Working Group on Climate Change	n/a
IT	Yes - inter-ministerial 'steering committee' established for LTS	n/a
LV	n/a	n/a
LT	Yes - specific ministries have specific roles in implementation	Yes – LTS approved by government
LU	Yes - Inter-ministerial Coordination Committee for Climate Action led consultation outreach	n/a
MT	Yes - the LTS is led by several ministries.	n/a
NL	Yes - studies and policy documents of other ministries are quoted as sources for the LTS	n/a
PT	n/a; * LTS was discussed with all ministries	n/a; * LTS served as basis for parliament to approve the climate law, parliamentary oversight of future LTS development is now enshrined in the law; LTS study launch ceremony attended by Prime Minister
SK	Yes – inter-ministerial cooperation through an ad hoc working group during preparation	Yes – adopted as a strategy document by parliament
SI	(LTS mentions future establishment of an 'authority' or 'body' for inter-ministerial coordination)	n/a
ES	n/a	n/a; * LTS approved by the Council of Ministers and parliamentary oversight is enshrined in new climate law
SE	n/a	(LTS mentions a parliamentary committee, the 'Environmental Objectives Committee', established in 2010 to examine national climate policy resulting in climate law and climate neutrality target)

Source: own compilation based on national LTSs and interviews, excluding countries without an LTS (Bulgaria, Cyprus, Ireland, Poland, Romania).
Note: An asterisk indicates that the information was acquired in an interview; n/a indicates insufficient information.

STAKEHOLDER ENGAGEMENT

The degree of stakeholder participation was examined along three dimensions. First, we assessed the representativeness of the processes, considering the main stakeholder groups stipulated in the GovReg. Where information was available, we also include the format of the activity, e.g., written or in-person workshops. Finally, as the GovReg obliges Member States to assure active engagement during the preparation process of the strategies, we examined the timing of the consultations, i.e., whether these occurred in advance of a draft (e.g., as part of an initial scoping phase) or in response to a draft. Table 27 provides an overview for all submitted strategies. The final column presents an overall descriptive evaluation based on the three dimensions: (1) low, medium or high representation, (2) single or multiple format(s) and (3) single or multiple stage(s) of the LTS preparation process.

Five strategies contained insufficient information to allow for a full evaluation (Croatia, Denmark, Finland, Greece, Lithuania and Slovenia). Croatia, Finland and Slovenia, in particular, did not provide enough detail on which stakeholder groups were represented, referring vaguely to 'various stakeholders' or 'experts'. Although the Czech LTS does not mention stakeholder involvement in any detail, information was obtained via the expert interviews. The Danish update to the LTS (Climate Programme 2020) describes additional stakeholder engagement activities but not specifically for the strategy development process.

Stakeholder representation was found to be especially limited in Belgium and the Netherlands, as each LTS mentions only one stakeholder group as being consulted using a single format: discussions and essays, respectively. Nevertheless, as stated above under scientific advice, the Dutch LTS stands out for its unique approach, asking scientific experts to produce essays in an initial scoping phase 'to gather a multitude of opinions on a variety of perspectives' (MEACP, 2019, p. 17).

Nine countries consulted with stakeholders in either single or multiple formats and at various stages in the LTS preparation process (Czechia, Estonia, Germany, Hungary, Italy, Luxembourg, Slovakia, Spain and Sweden). According to the Italian LTS, many of the solutions included in the document were identified during the consultation process. In Spain, stakeholders were consulted using a targeted set of questions in open consultation in an initial stage and on the first draft; comments were then considered in the elaboration of the LTS. Nevertheless, few suggestions were incorporated in the final strategy, and while all relevant stakeholder groups were represented overall responses were limited – only 46 entities in the first round and 78 in the second, primarily from the business community. An interviewee from Spain also mentioned the use of informal meetings and dialogues that occurred behind the scenes, but these are not elaborated on in detail in the strategy. The German strategy states that the Climate Action Alliance, a dedicated stakeholder engagement body established in 2015, will be consulted for future implementation of the strategy.

A wide array of different stakeholder groups was represented in Latvia and Portugal, although either in a single format or a single stage. As such, both countries had a highly representative stakeholder engagement process compared to the aforementioned countries, but only at one phase during LTS development. In Portugal, civil society and various national institutions and experts were directly involved in the creation of the three modelling scenarios, which the national LTS is based upon. Interviewees confirmed this by stating that a lot of the challenges identified by Portuguese stakeholders where then integrated in the national LTS and that the document is largely based on different actors' advice and opinions.

According to our assessment, LTS preparation in France had the most robust stakeholder engagement process, showing both a high degree of representation across multiple formats and at various stages of the modelling and drafting process. The French LTS is also the only document, in which the impact of stakeholder consultations was evident, as the strategy specifically emphasises the stakeholder engagement process in the development of its underlying WAM model. Still, national experts had different viewpoints on the final level of impact that stakeholders had on the end product. One argued that the greatest impact came in the form of knowledge gathering to enhance the scientific validity of the strategy. Yet, another expert pointed to the fact that not much changed in the document after the final round of consultations and expressed concern about the disproportional influence of the natural gas lobby (there was a doubling of projected 2050 gas demand after consultations).

Table 27: Stakeholder engagement

	PARTICIPANTS	FORMAT	TIMING
AT	High representation	3x workshops	During preparation
BE	Low representation	Discussions	n/a
HR	Unclear	Thematic workshops	Initial scoping phase
CZ	Medium representation	n/a	* During drafting and impact assessment
EE	Medium representation	Joint consults, workshops, opinion gathering	n/a
FI	n/a	Dialogue	After a preliminary study, which the LTS scenarios are based on
FR	High representation	Discussions and seven themed work groups	Before and after the drafting and in the finalisation stage
DE	Medium representation	Three forums and working groups	Before the drafting
HU	Medium representation	Online event series and three consultation workshops	After the drafting
IT	Medium representation	Written and online consultation with questionnaires	Before the drafting
LV	High representation	Five interactive seminars	During the preparation stage of the LTS and prior to publishing
LU	Medium representation	Consultations	Prior to development of the LTS
MT	High representation	Face-to-face meetings with feedback and follow-up	Preliminary feedback
NL	Low representation	Essays	n/a
PT	High representation	Technical and sectoral workshops, thematic events, bilateral discussions and informal meetings	During the creation of the scenarios
SK	Medium representation	Working groups and consultations	During preparation
SI	n/a	Workshops	n/a
ES	High representation	Written and online consultation with questionnaires	During the preparation stage and on a first draft
SE	Medium representation	Meetings and consultations	During the proposal stage

Source: own compilation based on national LTSs and interviews, excluding countries without an LTS (Bulgaria, Cyprus, Ireland, Poland, Romania).
Note: An asterisk indicates that the information was acquired in an interview; n/a indicates insufficient information.

PUBLIC INVOLVEMENT AND CONSULTATION

Involvement of the public in LTS preparation was assessed according to the format and stage in which it took place. An overview is given in Table 28 and more information in Table A-4 in the appendices.

Five strategies did not have sufficient information to allow for an evaluation (Denmark, Estonia, Greece, Lithuania and Sweden) – this was most evident for Denmark, Lithuania and Sweden, where there was a lack of any mention of engaging the public. An interviewee representing the NGO community in Denmark stated that if citizens had been involved, the national LTS would probably have displayed a higher ambition (Belusa, 2022). Interview information from the Danish Ministry of Climate, Energy and Utilities pointed out that public engagement occurs in various fora (such as a Citizen's Assembly convened for the first time in October 2020) for the development of the annual Climate Programme, upon which future LTS iterations will be built, as well as for Danish climate policy-making generally.

The Belgian and Croatian LTSs make limited mention of public consultations. In the case of Belgium, engagement occurred in ad hoc discussions, but it is not made clear at which point during the process. Conversely, the Croatian LTS mentions public involvement during the preparation of the draft but does not provide details on the format of consultations. Most Member States who involved citizens indicated that they consulted with the public by inviting written and online comments or by convening discussion fora (Austria, Czechia, Hungary, Italy, Luxembourg, Malta and Slovakia). In Spain, public consultation took place at multiple stages within the context of overall stakeholder engagement, before and after the first draft was made publicly available. The impact of citizens' engagement was rated as high by one Spanish interviewee (Olabe, 2022), but a second interviewee stated that because the Spanish government felt pressure to deliver by the January 2020 deadline and initial comments likely influenced only the first draft of the document, impact remained altogether low (Bautista, 2022). Furthermore, the reported number of comments collected from private citizens totalled 13 across the two stages.

In Finland, Germany, Latvia and the Netherlands citizens were engaged in multiple formats but at one stage in LTS development. In the Dutch LTS, entire chapters are based on citizen feedback. For example, Chapter 2 is largely based on the Dutch Climate Agreement and the Climate Plan. The preparation of the former included broad public consultation, while public discussions and online consultations on the latter served as a basis for Chapter 3.

The strategies of France, Portugal and Slovenia describe public consultation as occurring in multiple formats at multiple stages of the process. The Portuguese government, for instance, involved public consultation on the preliminary results of the document for a period of three months. Additionally, one interviewee stated that the final LTS went through a public discussion process for final comments of the public to be integrated. A second interviewee described around ten conferences with public participation spread around the country, in which the LTS scenarios were presented and considered in respect to the regional interests where the conference took place. Moreover, according to the same expert, a public consultation after the draft was finished resulted in around 120 opinions, comments and views (Barata, 2022).

Summary assessment

There is a clear attempt to provide information about the three dimensions of participation in Member States' LTSs, albeit with a varying level of detail. Although most countries clearly name the lead ministry for the LTS process, many do not go into detail as to whether other ministries were involved and how, or if, the strategy was endorsed by higher levels of government. Estonia, France and Lithuania, as good practice examples, indicate with high specificity which governmental actors were involved.

Countries generally provided more information on their efforts to involve stakeholders – as stipulated by the GovReg. Different groups of stakeholders were involved predominantly in the drafting and preparation stages, and only three countries do not provide any information about stakeholder engagement. France stands out as a good example of highly representative and strong stakeholder engagement – engaging a wide variety of interests in multiple formats and at numerous stages of the LTS preparation process.

Table 28: Public participation

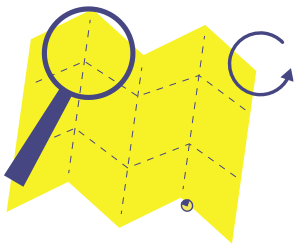
	FORMAT	TIMING
AT	Online consultation	Prior to publishing
BE	Discussions	n/a
HR	n/a	During preparation
CZ	Written comments	On draft
EE	n/a	n/a
FI	Seminar and online consultation	During preparation
FR	Consultation and public debate	Prior to revision and on the draft revised LTS
DE	Citizens' dialogue and online discussion	During preparation
EL	n/a	n/a
HU	Online consultation	During preparation
IT	Online consultations with questionnaires	Before drafting
LV	Online consultations and public debates	On draft
LU	Online comments and suggestions	On draft
MT	Public feedback on the contents of a consultation document made up of stakeholders' preliminary feedback	Prior to publishing
NL	Discussions, publications, internet consultations and through social and other media	During preparation
PT	Discussions; * Conferences	On preliminary results, after draft and on final LTS
SK	Online questionnaire	During preparation
SI	Discussions and two public presentations	During preparation and drafting
ES	Online questionnaire	Before and after drafting

Source: own compilation based on national LTSs and interviews.
Denmark, Lithuania and Sweden mention no public participation. Excluding countries without an LTS (Bulgaria, Cyprus, Ireland, Poland, Romania).
An asterisk indicates that the information was acquired in an interview; n/a indicates insufficient information.

Public involvement and consultation is the most thoroughly detailed topic, only three countries do not mention citizens' engagement at all. France, Portugal and Slovenia are notable good practice examples. As stated above, consulting the public is not only an obligation enshrined in Art. 10 of the GovReg, but it is also one of the main elements of the LTS template. This suggests that Member States regard the public as a key player in the execution of long-term ambitions and consider its contribution to be the most important.

Despite most countries providing information on governmental, stakeholder and public involvement it is often difficult to judge the degree to which the consultations actually influenced the final LTS.

3.2 FOLLOW-UP



The actual impact of a strategy becomes visible in how countries follow-through to realise the vision they outline in their LTS. Naturally, many of the measures or mitigation options presented are for the future, but it is nonetheless important to evaluate how a country plans to 'use' its strategy in the short-term.

The GovReg provides little guidance on actual implementation once a strategy is submitted. The one area in which the regulation does require some degree of LTS follow-up is with regards to monitoring and revision. Member State biennial integrated reporting on GHG policies and measures (stipulated in Article 18) must include information on 'updates relevant to [the] long-term strategies referred [...] and progress in implementing those strategies' (Annex VI, para B). The GovReg further requires countries to provide an assessment of the contributions of individual policies and measures to the achievement of the LTS (Annex VI, para C, viii). The regulation does *not* clarify the level of detail for this reporting, nor does it prescribe a national review cycle. On updating, the GovReg stipulates a ten-year cycle for new strategies and proposes an interim update every five years 'where necessary' (Art. 15.1).

In short, LTS follow-up pertains to the subsequent operationalising of the strategy once adopted – in other words 'how is strategy put to use' as a planning tool? Does the country assign roles among governmental authorities and outline concrete steps for monitoring and revision, to keep the strategy up-to-date as a dynamic tool to inform climate policy-making? Does the strategy establish a national cycle for review and possible revision that goes beyond EU obligations in terms of frequency?

The following analysis of LTSs was based on two related elements. First, we looked for some indication of implementation responsibilities, e.g., a lead ministry or committee, or new institutions created with a role in LTS implementation. Second, we searched for mention of a national monitoring process for reviewing and revising the strategy over time, especially when this goes beyond the minimal reporting required under Annex VI of the GovReg.

3.2.1 IMPLEMENTATION RESPONSIBILITIES

Relevance of topic

Assigning responsibilities is one way that governments can 'professionalize' national climate policy-making – and the same is true for long-term planning (Duwe and Evans, 2021). Clear roles enhance accountability and ownership within government because they establish who is responsible for setting the groundwork for the long-term vision in terms of tangible policies and measures (and related monitoring) in the immediate term. If the duty to follow-up on the LTS is left open or not made explicit enough, the document may have a greater risk of being forgotten as a one-off exercise every ten years.

The creation of new processes and institutions, such as a monitoring system (see next section) or advisory body or council, can also enhance government accountability surrounding the long-term vision laid forth in the strategy (Rüdinger et al., 2018). An advisory body or stakeholder platform with specific responsibilities within the context of national long-term climate planning adds transparency to the process, and with increased buy-in from external non-governmental actors might also uphold strategy relevance over time.

For the purposes of this report, we frame LTS 'implementation responsibilities' as the extent to which there is a concerted effort to translate the vision presented in the strategy into more tangible action by assigning clear roles. In the assessment below, we examine specifically who is tasked with following through on the LTS (e.g., which ministry or agency), especially if this is clearly stated and/or different than the authority that was responsible for preparing the strategy. We also looked for the establishment of new institutions or new obligations on existing ones to support the transformation towards a net zero or low emission economy. In other words, does the LTS reorganise existing governance structures and responsibilities.

Information in the LTSs

CLEAR RESPONSIBILITIES FOR IMPLEMENTATION

Overall information on this topic is scarce in the national LTS documents. It is also difficult to determine whether responsibility is simply assigned implicitly to the ministry or agency tasked with developing the strategy. For instance, in the case of Sweden responsibility to seems to fall to the Ministry for the Environment as the publisher of the strategy, but the ministry's exact role is not spelled out concretely. Only a handful of countries actually indicate concretely who is assigned to implement the LTS – and often duties are described in vague terms, making it hard to parse out what responsibility means. For example, the German LTS only mentions the 'government' regarding implementation without going into further detail or delegating to specific ministries or agencies. Still, the following cases represent good practice examples of clear implementation obligations.

In multiple countries the implementation of the LTS is assigned explicitly to the same entity that developed the strategy in the first place (i.e., Czechia, France, Lithuania, Slovakia). The Czech LTS is unique because it further states that the role of the national Hydrometeorological Institute will be strengthened to serve a coordinating function for assessing the impact of policies and measures included in the LTS. The Portuguese strategy assigns monitoring of the national climate neutrality target to the pre-existing Inter-ministerial Commission on Air, Climate Change and Circular Economy. Similarly, the Croatian strategy places dual responsibilities on two commissions, tasked specifically with cross-sectoral coordination and monitoring: the Commission for Cross-sectoral Coordination for the National System for Monitoring Greenhouse Gas Emissions and the Commission for Cross-sectoral Coordination for Policy and Actions on Climate Change Mitigation and Adaptation.

Three countries outline sectoral responsibilities in more concrete terms. The French strategy states clearly that the involvement of all departments and actors so far (under guidance from the Ministry for Ecological Transition) should be retained for implementation and monitoring phase of the LTS, including clear sector-specific competencies (p. 43). However, one interviewee from France pointed out that conflicting priorities between ministries have led to bottlenecks in the current revision process and are a limitation of this multi-ministerial configuration.

In Lithuania, although the overall LTS is deemed the responsibility of the government as a whole, the strategy more clearly establishes various roles for sector ministries and a coordinating function for the Ministry of Environment. The Estonian strategy likewise places overall responsibility vaguely on the government but spells out more specific reporting obligations for each ministry, requiring ministers to provide annual updates to parliament on a so-called 'strategy day'. Certainly, compared to the others the Estonian, French, and Lithuanian strategies assign duties in more concrete terms.

Interviews with national experts helped fill in information on some countries. For instance, in Germany, there is *no specific ministry* obliged to monitor or implement the LTS, which explains the vague mention of 'the government.' In Portugal, while the LTS is silent on who is responsible for tracking progress, the new climate law places this on the Ministry for Environment and further appoints a commission in parliament to supervise future revisions. The Danish LTS (and the national Climate Programme) is technically the responsibility of the government as a whole, but the Ministry of Climate, Energy and Utilities has a lead role, which includes tracking GHG emissions reductions progress in accordance with the Danish climate law. An interview with national experts from Spain clarified that the Ministry for Ecological Transition, established in part to develop the LTS in the first place, is also responsible for its implementation even though this is not spelled out in the document.

NEW INSTITUTIONS OR PROCESSES

Around half of the strategies submitted so far mention new institutions or processes designed to aid in the transformation. Still, of these, most refer to existing or planned institutions and processes created by a separate policy document or law. Only in some cases, were institutions created specifically for the development of the strategy or by the strategy. For example, Italy convened an inter-institutional 'steering committee' made up of representatives from various ministries for the development of the LTS. However, it is hard to tell what role this committee may have moving forward.

Existing or planned institutions and processes fall generally into two categories. The first category pertains to some form of inter-governmental coordination mechanism. As touched on above under participation, six strategies mention such a body at the national level to help assist in streamlining climate policy-making across governmental sectors (i.e., Finland, Hungary, Italy, Luxembourg, Slovenia and Slovakia). Of course, this does not mean that a similar coordinating body does not exist behind-the-scenes in other countries.

The second category pertains to scientific or stakeholder advisory bodies and panels. Germany, Slovenia, and Sweden mention such entities in their strategies as serving an expert consultancy function. As mentioned above under scientific review and advice, the development of the second LTS in France is seen by those in the policy community as having ushered in the now influential HCC. Notably, the body itself was established by the 2019 update to the French climate law. However, the participatory processes surrounding the first LTS update highlighted the need for a new institution to allow for consensus building within the scientific community, leading to a push in the policy community for the HCC (Berghmans, 2022).

Where the strategies themselves establish new processes or obligations these are most often monitoring mechanisms for the LTS itself. As previously mentioned, the Estonian strategy creates a new system in which relevant ministers are obliged to report once a year on the implementation of the medium-term scenario outlined in the LTS ('EE2035'); the LTS also describes a monitoring process by which the government reports to parliament every four years. The Croatian LTS proposes a future monitoring mechanism to account for the costs of the transformation in cross-cutting issues. As a further example, Latvia incorporates a new monitoring cycle into its strategy. However, given the importance of monitoring LTS implementation and progress overall towards the long-term transition at a national level, we consider dedicated policy-learning cycles for the LTS in the next section.

Summary assessment

Only a third of submitted LTS assign concrete implementation responsibilities, most often to a lead or coordinating ministry. Only a handful of countries assign duties in more concrete terms, stating which ministries or agencies in particular are supposed to follow-up with implementation and monitoring roles. The French, Lithuanian and Estonian strategies, in particular, assign sectoral duties to the various ministries. In exceptional cases, it seems that the strategy preparation process (i.e., the exercise itself) served as an impetus for the creation of new institutions, i.e., the HCC in France.

LTSs are otherwise silent on the creation of new processes or obligations on existing institutions. The notable exceptions described above – Croatia, Estonia, Latvia – all have to do with new long-term monitoring and reporting systems for the strategy itself and in a couple cases new monitoring tasks are given to existing institutions (e.g., Czechia, Portugal).

The GovReg does not require that Member States use their LTS to bolster their climate governance system, still the strategy is a national government document and could serve to operationalise long-term climate planning. Especially in the absence of a framework climate law, LTSs could help organise climate policy-making oriented around the long-term transformation. However, from our analysis it seems that in most Member States the LTS does not appreciably expand climate governance structures, either by assigning responsibilities or serving as a vehicle for institution creation.

3.2.2 MONITORING AND REVISING

Relevance of topic

Monitoring and revision of national planning in both the short- and long-term is central to a well-functioning climate governance system (Duwe and Iwaszuk, 2019a). To stay on course and guide the transformation national strategies should be embedded in a policy learning cycle that constitutes a regular review and subsequent updating of the strategy to account for either a lack of progress, new information (on, e.g., new technologies, economic developments and climate impacts), or both (Rüdinger et al., 2018). Still, a 2021 study showed that few national climate governance systems in Europe have in place such a monitoring system for long-term climate planning, and fewer still are enshrined in law (Evans and Duwe, 2021). An evaluation similar to the present analysis conducted in 2017 on EU Member State low-carbon development plans (LCDSs) told a similar story – monitoring 2050 ambition has long been conspicuously absent from national governance structures (Lübbeke et al., 2017).

EU regulation does not impose frequent monitoring requirements for national LTS. Unlike for the NECPs, where the EC issues country specific recommendations and obliges national follow-up, the GovReg in its current form only requires the EU to assess Member State LTSs for the 'collective achievement of the objectives and targets of the Energy Union'. Therefore, the formulation of Art. 15.1 pertaining to revision 'where necessary' leaves any modification more frequent than once a decade more or less up to Member States to decide. In the context of the integrated biennial reporting on national climate polices, Annex VI of the GovReg obliges Member States to assess the contribution of existing the policy mix to the achievement of the long-term goals outlined in the LTS. However, no further guidance is provided, and this requirement may not lead to a comprehensive check of progress towards 2050 targets. For this reason, it is important that the strategies themselves either establish or describe a national mechanism for review and revision. Furthermore, given the economy-wide and cross-cutting nature of the transformation ideally countries would pursue a robust methodology for monitoring long-term progress (such as those elaborated by Rüdinger (2018) and Velten et al. (2021)).

In the following assessment we checked Member States' LTSs for information on a dedicated monitoring process for the strategy, whether this is embedded into a policy learning cycle for review and revision and whether updating is foreseen in intervals more frequent than required by the EU (and if this is written specifically into the document itself). We also considered whether an update to the LTS already exists and if there is a process or plan in place to develop a new strategy.

Information in the LTSs

POLICY LEARNING CYCLE: LTS REVIEW AND REVISION

Roughly half of the 22 countries included in the analysis make some mention of a policy learning cycle for climate action in their LTS. However, in some cases this does not refer to monitoring of long-term progress. Both the Dutch and Swedish LTSs refer instead to the short-term Climate Plan and Climate Action Plan, respectively, aimed at 2030 – in essence each a national version of the NECP (upon which the NECP is based). The Dutch LTS specifies that the Climate Plan is updated on a five-year basis and that this has implications for long-term planning but does not specify a revision cycle for the LTS as a result (p. 1). The Estonian strategy describes a sectoral annual reporting cycle for the government's 2035 scenario, which serves as the basis for the LTS (albeit a four-year revision cycle for the plan as a whole is also mentioned).

Four countries – Austria, Denmark, Hungary, and Luxembourg – describe a monitoring and updating cycle for their LTS in vague terms, suggesting that the strategy should be reviewed and updated with some regularity but provide no concrete indication of timing or process. The Danish submission to the EU in December 2019 states that the strategy should be seen as an 'evolving document' and foresees updates more often than the 5–10-year interval set forth in the GovReg (p. 6). It also refers to an annual policy cycle, with reporting on overall emissions reduction progress; although the time horizon of updating the LTS on the basis of the annual cycles is unclear from the strategy itself. Expert interviews clarified that a revision of the LTS depends on whether the government changes long-term targets under the Danish Climate Act (Belusa, 2022; Rasmussen, 2022). Belgium, Hungary and Luxembourg more or less copy in the language from the GovReg on the suggested five-yearly revision; Luxembourg expands also on the benefits of regular revisions. However, the wording in these strategies seems to stop short of prescribing five years as a minimum frequency.

A bit of a unique case, the Slovenian LTS mentions the future establishment of a comprehensive monitoring system for climate policy implementation, including for both the NECP and LTS, by a 'suitable act', presumably a climate framework law or similar piece of legislation. However, it does not go into detail on the format or timing of the mechanism aside from calling for an annual reporting process for NECP implementation.

Other countries provide a more concrete picture of how the strategy will be revised. For one, Lithuania explicitly states in its LTS that the strategy will be updated every ten years unless there is a change in regulation. The Latvian LTS mentions a ten-year review cycle, with the option for more frequent reporting where necessary but does not clarify if these ad hoc reviews could trigger an update. Interviews with country experts in Portugal suggested that the government plans to operate on the proposed five-year cycle for LTS revisions even though a ten-year cycle is described in the current LTS submission. In Germany, the 2016 strategy states that a five-year review and revision cycle should be implemented, following the rhythm of the Paris Agreement. However, establishing this five-year update cycle directly as mandatory in the national climate law of 2019 proved politically difficult. A respective paragraph on the national LTS was struck from an earlier draft of the law (Duwe and Evans, 2020). As such, updates are expected to happen on a 'need to' basis (currently the next is foreseen by 2023) if more frequent than the EU's ten-year cycle. The Finnish climate law from 2022 foresees a 10-year cycle for long-term planning, thereby enshrining the mandatory EU timing in national law.

The strategies in Czechia, France, Spain and Slovakia establish the EU's suggested five-year cycle for review/revision of the LTS as a national process. In France, this cycle is enshrined in the country's climate law (passed in 2019). The French policy learning cycle for the LTS further includes a robust indicator-based assessment with input from an expert climate council (i.e., the aforementioned HCC) to track LTS implementation. Taking a step further, Malta and Estonia both describe a *four-year* cycle for review and possible revision (in Malta this is enshrined in the country's framework climate law). Although there is little information in the Spanish LTS; two interviewees pointed to the fact that the country's new climate law enshrines the five-year review and update of the LTS.

In sum, at least nine countries *seem* to call for more frequent updates than the ten-year requirement in the GovReg (Czechia, Denmark, Estonia, France, Germany, Luxembourg, Malta, Slovakia and Spain). Still, in countries like Denmark, Germany and Luxembourg this reads more like a soft promise, especially compared to the more robust monitoring systems in place in France, Estonia, and Malta. Nonetheless, the majority of EU countries do not elaborate a dedicated monitoring and review cycle for their LTS. Of course, this does not necessarily preclude a cycle from being developed in the future or that frequent updating will not occur (e.g., Slovenia). And as we look at next, many countries have already revised their strategy to account for developments in EU and national policy.

LTS REVISION STATUS AND PROSPECTS FOR UPDATING

Three current LTS submissions are already updates from a previous, now outdated, strategy (France, Hungary and Lithuania). In the French case, an update was deemed necessary to incorporate the government's climate neutrality target and update the carbon budgets accordingly. The Lithuanian strategy was also updated to account for an upwards revision to the national climate objectives.

Currently, there is a process in place in at least three countries to update their LTS, including Croatia, Czechia and France. In all three cases the update is being pursued in order to align the strategy with the current level of national ambition or, in the case of Czechia, outline further measures to achieve 2030 and 2050 goals. While it is not mentioned directly in the Portuguese LTS, expert interviews pointed to how the country's new climate law *could* trigger a review of the LTS to anticipate an earlier date for climate neutrality. However, it is not clear if this entails a new revision cycle or simply a one-off update.

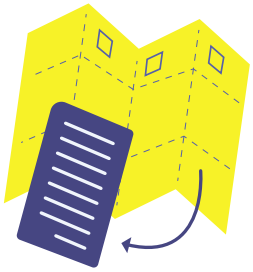
Summary assessment

As mentioned, the GovReg establishes two benchmarks for the revision of national strategies – a ten-year required cycle for new strategies and a five-year suggested update. It further stipulates some reporting on LTS implementation within the context of the integrated biennial reporting on national climate policies and measures. However, in order to ensure continued alignment with the NECPs (which are on a five-year cycle), Member States at a minimum should strive to implement the EU's proposed more frequent revision. While revisions should occur at least every five years, monitoring would ideally be done more frequently in order to fill gaps in ambition and streamline short-term policy-making by anticipating future challenges or bottlenecks.

Across all EU Member States there is a clear lack of national processes for monitoring LTS implementation and progress towards long-term goals – a finding that has been highlighted in other studies (see, e.g., Ross et al., 2021). Only a third of assessed countries state concretely their plans to follow at least the five-year revision cycle. Others provide a vague plan for monitoring and updating on the basis of these evaluations but do not describe clear methodologies or timelines. France stands out as a good practice example for enshrining a five-year policy learning cycle in national law that is based on a dynamic evaluation rubric and expert consultation. In addition to a four-year reporting cycle, the Estonian LTS proposes a new system of annual reporting to parliament by sectoral competencies, but this is only through the near-term. Likewise, Malta foresees a four-year policy learning cycle complete with review and revision.

Important also to note is that a revision may not always include a comprehensive monitoring of progress (although a valid update would take interim progress into account and amend all projections accordingly). While a handful of countries point to a review/revision cycle for their LTS, fewer still elaborate a strong and continuous system for monitoring progress towards the long-term goals outlined therein.

INTEGRATION



The relevance of an LTS depends largely on the degree to which it is embedded in broader national climate governance structures. Is the strategy referenced by other planning documents; does it factor into a framework climate law? Is it aligned with short-term actions at a national level on climate and other key policy processes? In sum: is it seen as integral to national climate governance or is it a one-off, box checking exercise to comply with EU regulation? The extent to which an LTS is embedded in existing governance systems is associated with the overall relevance of the strategy and the low-emission vision it contains.

Apart from alignment with the NECP, the GovReg does not place further requirements on Member States pertaining to LTS integration (Duwe, 2022). In other words, EU countries are not required by EU regulation to organize national climate policy around their LTS or link it to other planning tools or laws (although some mention of linkages falls under mandatory content, see Section 3.1.1). In recent years, more and more EU countries have adopted framework climate laws, often with the intent to engrain the EU minimum governance standards at a national level (Evans and Duwe, 2021). However, in and outside of the EU, these laws do not always contain long-term planning (World Bank, 2020).

The following analysis of LTS integration was based on the strategy's position and function in national climate governance and its coherence with other key planning tools. Importantly, as with LTS follow-up above, integration pertains not only to national ownership but crucially also national *integration* of the LTS as a 'living' document and iterative planning tool. Therefore, for the analysis of integration we touch on elements previously mentioned, such as participatory processes, ministerial oversight and responsibility, and underlying methodology.

Information in this section was often difficult to infer directly from the LTS submissions themselves and relied heavily on interview insights for a select group of countries. The analysis is thus limited in most cases to a description of what information *is* included in detail with some assessment of what this can tell us about LTS integration into broader national governance structures.

3.3.1 POSITION OF LTS IN NATIONAL CLIMATE GOVERNANCE LANDSCAPE

Relevance of topic

An LTS with a strong position within government will serve as the overriding benchmark across numerous policy fields. For example, should a sectoral policy be at odds with the vision presented in the country's LTS, the LTS will take precedence. Sometimes the preparation process of the LTS might be indicative of its position within the governance system – a more comprehensive process for public and stakeholder participation could lead to a strategy with more weight on climate policy-making decisions.

At the time of writing, over half of EU Member States have adopted some form of a framework climate law. These laws help boost national ownership of the EU's 2050 climate ambition by *inter alia* enshrining national targets and operationalizing the NECP – and less commonly – LTS planning cycles dictated by the GovReg (Duwe and Evans, 2020). Robust climate laws are situated at the core of national governance systems and provide the infrastructure for organizing policy, while simultaneously sending a strong signal to relevant actors within and outside of government (Averchenkova, 2019). Although they are not the product of legislation and often more technical in nature, LTSs and the processes surrounding them could in principle serve a similar role in lieu of a law.

Below we check for how the LTS fits into national climate policy-making overall, whether it features in a national climate law, and how it stands in relation to other governmental planning processes? In many cases the information was not found directly in the document itself and thus we are able to present a more nuanced picture for the eight interview countries.

Information in the LTSs

ROLE IN NATIONAL GOVERNANCE AND LEGAL STATUS

The role of the LTS in national policy making, including its legal status, was difficult to infer from the submissions themselves in many cases. Over a third of the countries assessed provided little or no information on this topic while others offered only a basic description of the document's legal form. Where information was available the LTS was described either as a governmental 'strategy document' (e.g., Croatia) or 'resolution' (e.g., Portugal and Slovenia). The Finnish strategy, in particular, notes that the LTS is *not* legally binding on Finland and its climate policy-making processes.

In Germany, the LTS was deemed by a national expert as too out-of-date to be a pillar of current national climate policy, but that once updated it would have more weight. At the time of its publication in 2016, the German LTS was a national document, a roadmap for long-term climate action, but many changes have occurred both at EU and national level since then. As for immediate impact at the time, the process of developing the strategy prompted the Germany's Climate Action Programme 2030 as a follow-up (although this is not explicitly laid forth in the strategy) as well as the coal commission, which was tasked with exploratory work on the German coal phase out. Additionally, the sectoral targets in the German climate law were taken directly from the LTS. This serves as the basis for sectoral division of responsibility, a core element of the German law.

On a similar note, a Danish NGO interviewee mentioned that the country's climate law takes precedence over the initial submission of the LTS and that the latter is simply not relevant for policy-making in its current form (Belusa, 2022). Interview information from the Danish Ministry of Climate, Energy and Utilities clarified that the Climate Programme 2020, a core element of the Danish Climate Act, serves as an update to the LTS and was submitted as such to the UNFCCC (Rasmussen, 2022). The initial 2019 LTS submission seems to play less of a role in Danish national climate policy-making compared to the law and annual cycle, and although the Climate Programme 2020 is seen as an update, it is focused primarily on 2030 and is not officially available on the Commission's repository.

The LTSs of Croatia and Estonia both mention that the document was debated and adopted in parliament – and moving forward this will also be the case in Spain as dictated by the new law. One Portuguese interviewee noted that as in Spain the Portuguese parliament will have a similar oversight role supervising LTS development in the future. In Estonia, the LTS stipulates that the strategy should be seen as *the* coordinating document with implementing measures and programmes outlined in other documents – if this role is realised in practice the Estonian LTS could function somewhat like a climate framework law. Moreover, the target set in the Estonian LTS is seen as legally binding.

Other strategies include similar language to this effect – positioning the LTS as a key guidance document for the main fields of action and strategic measures (e.g., Lithuania, Luxembourg). This is perhaps most pronounced in Latvia where the LTS is described as a compilation of numerous sectoral and other governmental plans, however, it is not clear what this means for the weight of the strategy in broader national governance. In Poland, the NECP took precedence over the LTS in large part because of the perceived importance that the Commission placed on the NECP (i.e., more concrete guidance, clearer monitoring, etc.). Interviews with experts in Czechia painted a split picture. On the one side, the document is considered by some to outline an overarching strategic vision. Still, another expert took the position that it has somewhat less weight, pointing to two cases in which legislative proposals arising from the LTS did not make it through parliament (Polanecky, 2022).

The Swedish strategy was born out of a sweeping overhaul of the country's climate governance system in 2017. The so-called 'National Climate Policy Framework' is composed of Sweden's long-term climate neutrality target, climate law, and expert council – however, it is not clear where exactly the strategy fits into this overarching structure. Similarly, the Dutch LTS built on a consolidation and restructuring of national climate policy that led to the country's Climate Act, Climate Plan and broader Climate Agreement, which included input from over 100 civil society groups.

Other countries seem to embed their strategies more consequentially in existing climate governance structures. The Spanish LTS, for one, is described as fitting within an integrated short- and long-term policy learning cycle for reaching climate neutrality, embedded in a national climate law. The LTS is seen to complement other core processes, such as the NECP, National Adaptation Plan, Just Transition Strategy, which together form a coherent policy framework at a national level, with more or less uniform monitoring and scientific input processes (Olabe, 2022).

In France, the LTS is a national document (not only an EU submission) and makes up one of two components of national climate policy, alongside the National Climate Change Adaptation Plan. Furthermore, the HCC tends to frame not only its annual reporting but also most of its communication and recommendations around the LTS, lending weight to the strategy in a national context (Berghmans, 2022). In interviews, experts suggested that the importance of the French LTS has increased substantially over time, while also criticising that a lack of sectoral detail has undermined the strategy in some instances. The need for separate sectoral plans that align with and feed into future LTS revisions as well as further enhancement of inter-ministerial and stakeholder engagement was highlighted by one interviewee (Berghmans, 2022). In both, France and Spain, the LTS features prominently within each country's national climate law, as discussed next.

FEATURED IN A FRAMEWORK CLIMATE LAW?

Only a handful of strategies explicitly mention a national framework law when discussing the country's climate governance system. These include Austria (Climate Protection Law from 2017), Croatia (*Climate Change and Ozone Layer Protection Act from 2019*), Finland (*Climate Change Act from 2015*), and Malta (*Climate Action Act from 2020*), the Netherlands (*Climate Act from 2019*) and Spain (*Climate Change and Energy Transition Act from 2020*).

In the case of Austria and Croatia it is not made clear how the LTS relates to the law, albeit in Croatia the law is said to be implemented via the LTS along with other national planning documents. Although France's 2019 *Law 2019-1147 relating to energy and climate* is not described in the LTS from expert interviews we know that the LTS is incorporated as *the* long-term planning tool running on a five-year cycle. The French law also requires robust monitoring of the strategy. The case is similar in Malta except that here the LTS works on a four-year cycle. An expert noted that the Portuguese climate law also refers to the LTS as the long-term planning instrument, requiring government to submit this to parliament. Moreover, the figures and GHG projections included in the law were taken directly from the LTS. In fact, in Portugal, the LTS was seen by one expert as instrumental in the lead up to the climate law with an impact on the final legal text as adopted (Ferreira, 2022). Like the French law, the Finnish climate law, revised in 2022, requires the government to produce a long-term climate plan with a 30-year time horizon. One key difference is that this strategic planning cycle in the Finnish law operates on a ten-year schedule.

Notably, at the time of writing a total of 15 countries have climate laws and at least another three are considering or in the process of developing legislation. Therefore, it is somewhat surprising that the relation of the LTS to an overarching framework law is not further elaborated in strategies. In some cases, this can be explained by the age of the submission – in Germany the strategy pre-dates the law, for instance.

RELATION TO OTHER PLANNING PROCESSES

A handful of countries delineate their strategy in relation to other planning documents. For example, some contain language to suggest that the LTS overrides other sectoral policies and measures – if these are found to fall outside of the emission reduction pathways elaborated in the strategy (i.e., Czechia, Hungary). In the Czech strategy this manifests as a new measure requiring all sectoral strategies, policies and programs submitted to the government to be assessed in terms of an impact on the GHG emissions pathways detailed in the LTS (p. 97). The Hungarian strategy simply states that all sectoral policies must be harmonised with the contents of the strategy without going into further detail.

Unsurprisingly, many strategies include some reference to coherence with the NECP (see next section) but also with other national planning documents, such as a national energy strategy (Croatia), long-term renovation strategy (Malta), the bio-economy strategy and transport planning (Austria). The Croatian LTS features a lengthy list of planned actions in an annex as well as how they tie into over ten different existing planning processes and national strategies. Numerous strategies mention alignment with regional or sub-national sustainable development (e.g., Portugal, France). For a non-exhaustive list of LTS references to other national planning processes by country see Table 29.

The Latvian strategy is worth highlighting because it includes a dedicated section on integration within the governance system, stating that due to a historical lack of climate planning and the disjointed nature of previous policies the LTS should not only compile but supplement all past planning processes (p. 19). Likewise, the Austrian LTS requires coherence with short-term action plans and states that the 'lock-in effects of technologies and regulations that contradict the strategy are to be timely identified and corrected'. This wording implies a relatively strong position for the LTS within government in both Latvia and Austria, but of course much relies on actual implementation. Given the importance of regional and local levels of governance in Spain, the LTS specifically states that regional plans must be aligned with the national strategy but references the need for additional coordination to ensure this in practice.

Summary assessment

A long-term vision as laid forth in an LTS can best guide national climate action if embedded in and allowed to shape existing governance processes. The role and relative importance of each LTS in national policy-making seems to vary by country; though it is not always possible to discern this from the strategies themselves.

In many cases, the LTS is a non-binding government document or strategy, more or less a compliance exercise. In some countries parliament was given a role in adopting the strategy, suggesting a stronger anchor in national governance overall. Other countries seem to use their LTS as a means to compile all current and planned climate actions – Czechia, Hungary and Latvia, for example, all describe, in varying detail, how their respective strategies relate to other sectoral or national planning processes. Good practice can be found in Finland, France, Malta, Portugal and Spain, where the LTS features concretely in a national climate framework law as the key long-term planning process.

In an effort to gauge expert perceptions, interviewees from eight countries were asked to judge the overall importance of their national strategy for policy-making on a five-point scale. The results, summarised in Table 30, paint a mixed picture.

Table 29: National planning processes mentioned directly in the LTS

	REFERENCES IN LTS TO NATIONAL PLANNING DOCUMENTS (OTHER THAN THE NECP OR OTHER NATIONAL CLIMATE PLANS)
AT	Bio-economy Strategy, Transport planning, Forestry Strategy 2020+, Digitalisation Strategy
BE	(Various subnational plans mentioned)
HR	Energy Strategy, National Energy Efficiency Action Plan, National Education System Development Plan, National Green Public Procurement Action Plan, Circular Economy Action Plan, Ten Year Plan for Gas Transmission System Development, State Spatial Plan, National Plan for the Development of Coastal Lined Maritime Transport, Advanced Biofuels Market Development Plan, Food Waste Prevention and Reduction Plan 2019-2022, Waste Management Plan
CZ	State Environmental Policy, Transport Policy (2014-2020), Biomass Action Plan, Smart Grids Action Plan, Clean Mobility Action Plan, Biogas Action Plan, Waste Management Plan (2015-2024), Assorted national research plans, National Strategy for the Development of Cycling Transport for 2013-2020
DK	Green Mobility Plan, various planned strategies for circular economy, sustainable construction
FI	National Forest Strategy
FR	Regional land-use plans, Regional sustainable development plans (SRADDET), Urban planning, Multi-annual Energy Plan
DE	Energy Efficiency in Buildings Strategy, Affordable Housing Strategy, National Buildings Strategy, Food Waste Strategy, Moor Conservation Strategy, Mobility and Fuel Strategy (2013), Sustainability Strategy (2002)
HU	National Forest Strategy
IT	Long-term Renovation Strategy, National Housing Stock (STREPIN)
LV	Sustainable Development Strategy 2030, Bio-economy Strategy 2030, Technology Development Innovation Guidelines 2014-2020, Circular Economy Strategy, Regional Guidelines 2021-202, national sectoral plans for, e.g., waste, industry, transport, energy, land use, environmental policy generally
LT	National Progress Plan, State Progress Strategy, National Energy Independence Strategy, National Security Strategy
LU	National Sustainable Development Plan, National Land-Use Plan
MT	Long-Term Renovation Strategy (LTRS)
NL	National Spatial Planning Strategy
PT	National Spatial Planning Policy Program
SK	Environmental Strategy, National Adaptation Strategy and Action Plan, National Renewable Energy Action Plan, National Forest Programme, Sectoral Strategy Paper on the Rural Development Programme
SI	Heating and Cooling Strategy, District Heating Strategy, Transport Development Strategy, Energy Renovation of National Building Stock Strategy, Circular Economy Action Plan, CAP Strategic Plan, Spatial Development Strategy, Smart Specialisation Strategy
ES	National Energy Poverty Strategy
SE	Clean Air Strategy

Source: own compilation based on national LTSs, excluding countries without an LTS (Bulgaria, Cyprus, Ireland, Poland, Romania).

Table 30: Expert perceptions of LTS relevance on a five-point scale

	LTS RELEVANCE FOR NATIONAL CLIMATE POLICY-MAKING JUDGED ON A FIVE-POINT SCALE
DE	1 (4-5 in year of initial publication)
BG	5 (but not final)
CZ	4
DK	1-5
FR	4 (first iteration was 2-3, next revision will be 5)
PL	3
PT	4.5
ES	3-4

Source: Own compilation based on expert interviews (sample of eight countries).
Note: 1 = not relevant at all; 5 = very relevant.

Notably, the age of the strategy seems to be a key factor – experts from Germany mentioned how the relevance of the document has faded over time due to developments in national policy. For one, the provisions of the revised German climate law render the current strategy, and the targets it contains, irrelevant. Still, at the time, the process of producing the initial climate protection plan for 2050, served as the impulse for elements of German climate governance today (e.g., the sectoral target breakout). Spanish experts compared the relevance of their country's NECP, independently claiming that the NECP would be closer to a five on the scale. While this is only anecdotal evidence it nonetheless underscores the different importance attached to strategies in some countries compared to others.

3.3.2 REFERENCE TO AND COHERENCE WITH NECPS

Relevance of topic

The alignment of short-term actions with long-term objectives is fundamental to good planning. For climate governance, in particular, coherence over time is crucial to avoid lock-ins and closing doors on later policy options – that is, actions now dictate what can be done later. For instance, ensuring policy consistency can be a key added-value of framework laws, which in most cases incorporate regular action cycles towards a long-term goal (Duwe and Evans, 2020; World Bank, 2020). Recital 36 and Article 15.6 of the GovReg take note of this, requiring Member States to ensure their short-term planning cycles (detailed in the NECPs) are aligned with national long-term ambitions (displayed in the LTSs). Nonetheless, the regulation does not go into detail on *how* Member States should ensure consistency, and it is not yet clear how the EC will check this in its aggregate assessment of the LTSs or in its new evaluation of policy consistency at a national level as required under the ECL.

A comprehensive analysis of consistency between the pathways outlined in the NECPs and LTSs was beyond the scope of analysis in this report. However, in place of a quantitative exercise, information across four criteria pulled from the LTS documents themselves allowed us to infer some degree of short- and long-term coherence between the planning documents. These were: (1) the timing of submission of each, (2) methodological consistency to ensure target alignment for 2030 and 2050, (3) the number of direct references to the NECPs in the LTSs, and (4) common ministerial oversight, i.e., was the same institution or institutions responsible for both the LTS and NECP?

Information in the LTSs

Table 31 presents a descriptive overview of countries. Overall, nine countries seem to have either 'coherent' or 'mostly coherent' LTSs based on the four criteria. Still, in many cases information was either missing or unclear (especially on scientific methodology) and therefore the overall assessment offered in the last column should be taken with a grain of salt. On LTS/NECP coherence, Austria, Greece and Spain stand out as good practice examples.

Table 31: LTS/NECP coherence inferred from four criteria

	TIMING OF SUBMISSION	METHODOLOGICAL CONSISTENCY	CROSS-REFERENCING	COMMON INSTITUTIONAL RESPONSIBILITIES	OVERALL ASSESSMENT
AT	Yes	Yes	Yes	Yes	Coherent
BE	Yes	Somewhat		n/a	Not coherent
HR		n/a	Yes	Yes	Somewhat coherent
CZ		n/a		Yes	Not coherent
DK	Yes	n/a		Yes	Somewhat coherent
EE	Yes	n/a			Not coherent
FI	Yes	Somewhat		Yes	Somewhat coherent
FR	Yes	Yes		Yes	Mostly coherent
DE		n/a			Not coherent
EL	Yes	Yes	Yes	Yes	Coherent
HU		Yes		Yes	Somewhat coherent
IT	Somewhat	Yes	Yes	Yes	Mostly coherent
LV	Yes	Yes		Yes	Mostly coherent
LT	Yes	n/a	Yes	Yes	Mostly coherent
LU		n/a	Yes		Not coherent
MT		Yes	Yes		Somewhat coherent
NL	Yes	n/a	Yes	Yes	Mostly coherent
PT	Yes	Yes	Yes		Mostly coherent
SK	Yes	n/a	Yes		Somewhat coherent
SI		Yes	Yes		Somewhat coherent
ES	Yes	Yes	Yes	Yes	Coherent
SE	Yes	n/a	Yes		Somewhat coherent

Source: own compilation based on national LTSs and interviews, excluding countries without an LTS (Bulgaria, Cyprus, Ireland, Poland, Romania).
Note: Overall assessment on a four-point scale based on fulfilment of four criteria: 'not coherent' (no more than 1/4 criteria), 'somewhat coherent' (at least 2/4 criteria), 'mostly coherent' (at least 3/4 criteria), and 'coherent' (all criteria); n/a indicates unclear or insufficient information.

SUBMISSION TIMING

The timing of when NECPs and LTSs were developed and submitted has implications for policy consistency over time. The GovReg set the submission deadline for NECPs a day before the LTS, i.e., the initial deadline was 31 December 2019 (for more information on submission status see Section 3.1.1 on compliance above). This means that for the first iteration of their NECPs and LTSs Member States had to prepare these more or less simultaneously. Pursuing both in parallel could in theory help ensure consistency between the medium-term actions and long-term vision – insofar as there is feedback and interaction between the two processes. On the other hand, because the LTS should serve as a blueprint then ideally it would be developed first, with short-term actions dictated by the strategic vision.

Submission timing for the LTSs and NECPs paints a mixed picture of consistency (see Table 31). Overall, Member States were largely on time with their NECPs, but six countries submitted their LTSs significantly later (over a year) and another five strategies are still overdue. One interviewee from Poland expressed concern over the lack of cohesion due to the late LTS as a major problem for climate planning in the country – so much time has passed that the methodologies and basic economic assumptions are out of touch with market realities and must be fundamentally revised (Kobyłka, 2022). The missing overlap in development is a sign that in these 11 countries the LTS did not inform the contents of the NECP. Conversely, an additional two countries (Germany and Czechia) submitted strategies that are based on national documents pre-dating the GovReg, which means that these LTSs likely need to be updated to align better with the respective NECP (a process is currently underway in Czechia).

The remaining 14 strategies were developed either in tandem or slightly before the 2030 plans, presumably allowing the discussions on the LTS to inform the NECP and vice versa. Still, interviews with country experts in Spain and Poland shed light on the practical problems that arose with developing the NECP and LTS simultaneously. In both cases, the LTS took a back seat to the NECP, because the latter was deemed more pressing in policy circles and therefore given substantially more attention. It is possible a similar dynamic was in play in other countries, due not only to the quick turnaround required for both documents following the adoption of the GovReg in 2018 but also a lack of capacity for long-term scenario development.

As such, the timing of policy documents alone cannot ensure consistency – while an out-of-date or late LTS is less likely to have adequately defined the pathways for 2030 in the NECP, developing both in the same time period does not necessarily ensure policy coherence over time. Still, an LTS developed much later or earlier than the NECP cannot effectively serve as guidance for policy decisions for the near-term.

METHODOLOGICAL CONSISTENCY AND TARGET ALIGNMENT

Due to a lack of detail provided in the strategies, it was not possible to gauge from the documents themselves whether the underlying pathways were consistent between the short- and long-term planning processes. Indeed, nearly one third of submitted strategies do not offer any information on methodological consistency. Another group of countries – including Croatia and Luxembourg – state vaguely in their LTS that the pathways elaborated are in line with medium-term planning but provide little by way of an explanation. The Netherlands' LTS simply states the long-term target is aligned and refers for any detail to the NECP without adding any further information.

The strategies that do provide detail on long- and short-term coherence generally refer to the alignment of long-term targets and pathways. As described above in section 3.1.2 on scientific basis, numerous strategies are based on an extrapolation of the same modelling used for the NECP development. For instance, the Greek 'NECP 2050' scenario – as well as pathways defined in Hungary, Italy, Malta, Latvia, Slovenia, Spain – more or less extend the time horizon of the NECP scenario(s) based on the same underlying methodologies. Interviews with representatives from Bulgaria noted that the analytical framework is consistent between the NECP and the upcoming LTS despite the delay.

In other countries the modelling itself is new for the LTS but employs similar techniques

and assumptions (e.g., Portugal). In France, a National Energy Plan and its methodologies served as the basis for both the NECP and the LTS. Moreover, we learned from expert interviews that in France the stakeholder engagement processes were well-aligned between the two planning time horizons, with participants providing input to both processes simultaneously in an integrated manner (Berghmans, 2022; Podesta, 2022). An expert from Poland noted that while the LTS is based on modelling developed specifically for the purpose, it is supposed to reference the foundations and information elaborated in the NECP (and the national PEP2040 document upon which the NECP is based). However, due to already unrealistic assumptions in the NECP and the time that has elapsed, it has proven challenging to maintain cohesion with the medium-term plan while also producing a realistic LTS for the country (Kobyłka, 2022).

Methodological consistency between the two planning cycles is an important pre-requisite for alignment but it does not always lead to target-conform scenarios. Speaking with an expert in France highlighted that a robust back-casting exercise was missing from some aspects of the NECP/LTS development process despite the two being otherwise methodologically aligned, such as for transport where current trends were simply fit onto a net zero projection. In the strategy of Sweden, no emission pathways are provided for climate neutrality, which is the long-term goal. In Lithuania, in particular, the 2030 target presented in the LTS actually supersedes that of the NECP, suggesting that the Lithuanian NECP is less ambitious than the LTS. This is due to the LTS having been revised already since its first submission.

NECP/LTS CROSS-REFERENCING

The degree of cross-referencing between the two EU climate planning documents is a concrete indication of alignment, or suggests that, at a minimum, they draw on the same information. In our assessment we only considered references to the NECP in the LTSs as well as whether any information taken directly from the NECP and incorporated.

Aside from the descriptions of methodologies and scenarios within the context of target alignment outlined above, we did not find many instances of direct crossover (naturally this was to be expected for countries that submitted their LTS before their NECP). Still, a few cases stand out as worthy of being mentioned.

In Slovakia, data on renewable energy, energy efficiency and biomass is mentioned as having been taken over directly from the NECP. In a unique approach, the Slovenian LTS includes a sub-chapter for each main section that covers policies and measures in the short-term, i.e., those elaborated in the country's NECP. The Dutch NECP and LTS were developed around the same time and also include cross-referencing in key areas – such as sectoral detail and short-term measures. Information on socio-economic impacts was taken from the NECP in the Lithuanian LTS. A handful of countries (France, Portugal, Italy) also described the NECP preparation process in some detail as the foundation for the work on the LTS, listing the institutions involved.

MINISTERIAL RESPONSIBILITIES FOR LTS/NECP DEVELOPMENT

Coherence may be easier to achieve if a single governmental entity, ministry or agency, is responsible for coordinating both the development of the NECP and the LTS. Different sectoral competencies may have conflicting priorities or views on optimal climate policy, or they may emphasize one element over another. For example, a ministry responsible for energy and economy might have the expertise to focus on decarbonisation in the energy sector but fail to account for emissions reductions in other sectors. That being said, silo-thinking and misaligned priorities within government can be countered through inter-ministerial engagement and coordination, such as in the form of a governmental commission (see section 3.1.3 on participation).

Table 32 outlines differences in ministerial oversight for NECP and LTS development in EU Member States. Overall, we found that countries can be organised into one of three groups. Only half of the strategies (11) submitted so far were developed by the same ministry or governmental agency also responsible for producing the NECP. As a rule, this was a lead ministry in a coordinating role also tasked with drafting the submission. Of course, this arrangement did not preclude the involvement of other ministries.

In two countries (Czechia and Italy) the LTS/NECP development fell to a mix of ministries and/or governmental agencies. However, in both cases, the environment ministry played a central, guiding role. In Czechia, the LTS process was led by the Ministry of the Environment in close cooperation with the Ministry for Industry and Trade – whereas for the NECP the Ministry for Industry and Trade took a less central role. In Italy the LTS was developed building on the work of the NECP by an inter-institutional, steering committee' consisting of several ministries.

Table 32: Ministerial responsibilities for LTS and NECP development

SAME INSTITUTION IN COORDINATING ROLE	AT LEAST ONE INSTITUTION IS INVOLVED IN BOTH NECP AND LTS DEVELOPMENT	DIFFERENT INSTITUTION IN COORDINATING ROLE
Austria	Czechia	Estonia
Croatia	Italy	Germany (1)
Denmark		Luxembourg
Finland		Malta
France		Portugal
Greece		Slovakia
Hungary		Slovenia
Latvia		Sweden
Lithuania		
Netherlands		
Spain		
TOTAL: 11	**TOTAL: 2**	**TOTAL: 8**

Source: own compilation based on national LTSs and interviews, excluding countries without an LTS (Bulgaria, Cyprus, Ireland, Poland, Romania).

Note: It is not fully clear from the document which institution was responsible for drafting the Belgian LTS. As such, it was left out of the table.
(1) The two ministries in Germany have since been merged following the elections in 2021 with possible implications for future LTS revisions.

The remaining eight countries noted a different institution responsible for the NECP than for the LTS. In Germany, for example, the LTS was drawn up by the Federal Environment Ministry while the NECP drafting process was led by the Federal Economic Ministry, which is also responsible for energy – however, this will be different moving forward due to the change in government. The division of responsibilities between ministries for environment and development, economy and/or energy was a common trend – similar arrangements were found in Luxembourg, Malta, Portugal, and Slovakia. In Slovenia and Sweden, the Environment Ministry was likewise responsible for the LTS, but each country's ministry for infrastructure took over the NECP preparation. Although it is still in development, the Polish LTS is being prepared by the Ministry for Development, whereas the NECP was produced by the Ministry for Climate and Environment (Kobyłka, 2022).

Summary assessment

Although many EU Member States insist in their strategies that these are consistent with the near-term NECPs, a comprehensive (and quantitative) evaluation is needed to determine whether this is true across all countries. Assessing coherence between the two key planning tools is a difficult task – even if the medium-term targets are in line with long-term ambition the respective pathways may be out of sync due to, e.g., a lack of emphasis on key infrastructure in the intermediate term or over-reliance on untested technologies in the long-term.

Still, it is possible to infer some degree of LTS/NECP coherence based on four criteria (see Table 31 for an overview). Within this analytical framework three countries – Austria, Greece and Spain – display some degree of coherence between short- and long-term planning cycles. However, an additional six countries showed signs of 'mostly coherent' LTS/NECPs, either failing to fulfil or provide information on just one of the four criteria. Perhaps unsurprisingly, of the 14 Member States that submitted their LTS shortly before or around the same time as their NECP (i.e., alignment in the timing of submission), eight describe a common methodology underpinning both planning exercises and nine were developed with involvement of the same ministry, either in a coordinating role or as part of an inter-ministerial taskforce.

4

KEY INSIGHTS FROM THE ANALYSIS

The comparative analysis of the existing national LTSs in this report has covered a long list of items on both content and processes. This section summarises the essential insights across the two main parts "long-term vision" and "relevance in the national context" as a basis for specific lessons to derive from them. It includes two tables which summarise good practice examples across the topics addressed here (see Table 33 for vision and Table 34 for relevance).

4.1 TECHNICAL SUBSTANCE OF LTSs: NOT ENOUGH ACTIONABLE LONG-TERM VISION

The degree to which LTSs provide a vision for 2050 varies significantly among the countries and for the different elements considered in this analysis. In this section, we outline the key findings on the vision including an overview on good practice examples (Table 33).

National long-term targets are being aligned with the EU objective, but underlying emission reductions and removals remain partly unclear

The **EU goal of climate neutrality has largely been translated into corresponding national targets** – at least on paper (with some of the national commitments preceding the adoption at EU level). More than two thirds of EU Member States (20/27) have adopted a climate neutrality goal in some form (or very close to it, e.g., the Netherlands) and a majority of all Member States has codified the goal in a climate framework law or a similar legal act. Some have even set target years before 2050 such as Finland, Austria, Germany and Sweden.

However, when it comes to showing a credible pathway and a landing point in the LTSs, with details on the underlying emission reductions and removals, the picture is less clear. The **envisioned emission reductions are likely insufficient** under the assumption that on average emission reductions must be higher than 90% (EC, 2018). Only two Member States, the Netherlands and Hungary, state that emissions must fall by 95% in 2050 compared to 1990; while Greece specifies a range of 85-95%. Ten countries aim at a 90% or lower emission reductions by the target year – several provide no info at all. Moreover, **GHG removals are projected in only ten LTSs**. Of those, five Member States assume more than a doubling of removals compared to 2019 – mainly through natural sinks and/or BECCS. An additional five countries assume stable CO_2 removals from natural sinks through 2050. The other half of the countries with an LTS are lacking a quantitative figure for removals.

Without this information available, **it is impossible to assess at this stage if countries' objectives and underlying assumptions on emission reductions and removals aggregate to the net zero emissions by 2050.**

Energy consumption declines, renewables take over while there seems to be some flexibility with respect to agricultural emission reductions, use of CCS and sinks

In general, **not even half of all countries provided sufficient information on sectoral emission reductions with even varying detail per sector**. This being said, it can be noted that all countries providing a quantification of sectoral GHG emissions in their LTS outline that energy generation and demand patterns will need to change significantly. This includes a reduction of overall energy consumption in the order of 30-50% between 2005 and 2050 and an outstanding shift to 90- 100% of renewables for energy generation by 2050 outlined in most of the countries providing a quantification. The by far largest emission reductions – ranging for most countries to close to 100% – is expected to take place in electricity generation. Austria, Portugal and Spain aim at supplying all electricity using renewables. Most other countries outline that they will phase-out coal power generation. Portugal highlights its phase-out targets for coal and natural gas power generation and mineral oil use in energy generation in the LTS (see also Table 33). Finland and Greece aim at a carbon or climate neutral energy mix outlining that they will still have natural gas and mineral oil products in their energy mix, but that related emissions will be captured and stored or balanced using BECCS. Czechia includes one scenario with large deployment of CCS in combination with coal and natural gas power generation to reach their overall 80%-emission reduction target.

In **transport and buildings, emission reductions are closely linked to efficiency improvements and fuels switch** in particular to electricity and synthetic fuels. Most countries also see emission reductions to come from changes in behaviour e.g., through a shift in transport modes or less heating in buildings. In industry, emission reductions are closely linked to efficiency improvement. Some countries, including France, Greece and Italy, specify that **industrial emissions will be partly captured and stored** reducing emissions to 80-100%. Also, Croatia, Luxembourg and Sweden consider using CCS for capturing emissions.

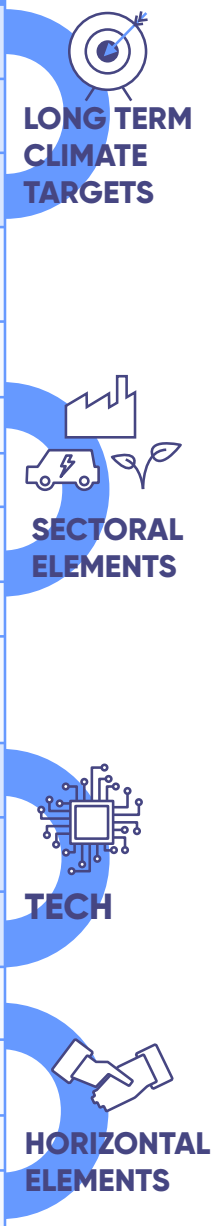
Overall, hydrogen, biomass and CCUS are considered to play a vital role to achieve climate neutrality in almost all LTS. However, their potential is limited which is hardly addressed by any of the LTSs in terms of numbers (for good practice see Table 33). And it remains **unclear from many LTSs how much hydrogen and biomass can sustainably generated in the country, which amount is needed and what this means for imports.** An exemption is Czechia which has an own scenario allowing for a specific amount of biomass and electricity imports. Similarly, **there is hardly any country discussing limited storing capacity for CO_2 emissions.** In particular Italy plans to capture and store a large amount of CO_2 without clearly identifying where such emissions end up. Greece outlines a rather large use of industrial CO_2 emissions for synthetic fuel generation, but it remains unclear where related emissions (released within a very short timeframe) appear in their sectoral split.

Countries expect to realise **comparably lower emission reductions in agriculture** mainly in the order of 30-60% besides Hungary that outlines an emission reduction of 79% – Hungary is also one of the countries with the largest total emission reduction to be realised by 2050 and here agricultural emission reductions might be the key factor for achieving more. Other countries with high overall emission reductions are the Netherlands which however do not provide any sectoral information and Greece which achieves the reduction via capturing and storing emissions.

The role of land use and forestry is generally not discussed in combination with agriculture but considered as the carbon dioxide removal option compensating the hard-to-abate emissions from several sectors. The **expected role of natural sinks differs** with ten countries providing numbers on natural sinks. Here, five countries assume a stable natural sink function and five countries assume a doubling or even higher increases; two of them (Austria and Finland), however, also outline a rather limited natural removal in another scenario with high wood harvesting rates which is then compensated by using BECCS in the same order of magnitude. Next to the two countries, only four other countries also consider technical removal with only Greece considering DACCS in one of the scenario sets.

Table 33: Selected good practice on LTS vision

VISION: GOOD PRACTICE EXAMPLES	
NET ZERO EMISSIONS	**FI, AT:** clear info and with net zero targets in 2035 and 2040; **SE:** mentions that it wants to achieve net negative emissions.
EMISSION REDUCTIONS	**NL:** clear info with target of 95% emission reduction (2050 vs. 1990) enshrined in law; **HU, GR:** clear info from scenarios with 95% and 85-95% emission reduction (2050 vs. 1990).
GHG REDUCTION PATHWAYS	**LV:** clear info with interim target for 2040 of 85% (vs. 1990); **FI:** Early action in at least one of the scenarios; **MT:** clear info with 10-year data points.
ENERGY SUPPLY	**LU, ES:** clear target setting with highest share of renewables in 2050; **PT:** clear energy mix and target setting with phase-out of coal power in 2030 (enshrined in law), gas-fired power and mineral oils use in 2040.
ENERGY DEMAND	**LT:** with 2050 target of ≥ 2.4 times a reduction of energy demand; **HR, FI, PT, ES:** clear info including pathways.
TRANSPORT	**BE, IT:** outline an emission reduction of 100% by 2050; **FR:** clear and detailed info.
BUILDINGS	**IT, LT, ES:** outline an emission reduction of 100% by 2050; **EL:** clear and detailed info.
INDUSTRY	**HU:** outlines an emission reduction of 98% by 2050; **LT:** sets target of reducing GHG emission by 100% by 2050 and phasing out fossil fuel use in ETS-industries by 2045.
AGRICULTURE	**HU:** outlines an emission reduction of 79% by 2050; **FR, IT, ES, PT:** clear and detailed info.
GHG REMOVAL	**AT, FI:** clearly outline interlinkages between natural and technical (BECCS) sinks and include land cover; **ES, IT:** consider a set of measures for natural sinks including sustainable soil management and wetland restoration; **EL:** detailed info on technical sinks.
HYDROGEN	**EL:** considers green H_2 and rules out blue hydrogen due to restrictions on CO_2 storage; **LU:** only considers green H_2 and plans to pursue H_2 certification.
BIOMASS	**CZ:** provides a comparison of biomass import dependencies for different scenarios and cap domestic biomass generation based on potential.
CCUS	**EL:** provides most specificity including capture and stored emissions; **AT:** provides domestic storage capacity.
BEHAVIOUR CHANGE	**LT:** includes various targets for behaviour change; **FR:** provides detailed info with some quantifications.
FINANCE	**PT:** identifies total and additional investment needs including sectoral split; **ES:** indicates specific shares for public and private sector investment.
JUST TRANSITION	**LU:** provides detailed info on various aspects including specific measures.
CLIMATE ADAPTATION	**MT:** with good vulnerability assessment including adverse effects on vulnerable groups; **LU:** with catalogue of measures; **FR, MT, LT, SL:** highlight importance of nature for adaptation and mitigation.



Source: own compilation based on national LTSs, excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).

Changes in behaviour and technologies supported by additional investments lead to a transition which is overall beneficial for the EU countries.

Almost all countries acknowledge the rising threat from climate change impacts with particularly Malta defining affected vulnerable groups and sectors. Although many countries reference their national adaptation strategy, half of the LTSs lack a clear presentation of envisioned adaptation actions and do not provide information on funding for these actions. **Almost all countries with information on adaptation have some reference to the beneficial role of nature** when it comes to adapting to the impacts of climate change but also see a synergy with mitigation. In this context, some countries see the transition as an opportunity to preserve natural areas and wild species.

Climate mitigation comes with a change in technologies (as highlighted above) as well as lifestyle changes in the fields of mobility, diet, heating and circular economy, to differing extents but generally as descriptive information. Thus, it remains unclear how far lifestyle change should contribute to the reduction of emissions, but most countries propose actions, and some also include targets. Lithuania and France stand out as the countries outlining required changes also in numbers. Thus, almost all **countries need and expect that their population changes their behaviour and routines** reducing in particular energy needs and the consumption of animal products.

The transition will need additional investment which also gets clear in the national LTSs that acknowledge the necessity of mobilising both public and private money. Only Spain mentions a clear split which is that 20% of total investment will come from public and 80% from private investment. Numbers on total investment are limited to a few countries and these countries use different forms of presenting the numbers. However, **the additional investment need up to 2050 is in the order of 1-2% of GDP** except for Hungary and Slovakia expecting rather the double value. The few countries with sectoral split show that highest investments will have to happen in the transport sector.

The expected changes in technology and lifestyle and related additional investments will be a challenge but generally beneficial for the countries. Impacts on the economy and employment provided by half of the countries show **growth in GDP** but a mixed picture for job creation. However, **most countries addressing employment qualitatively assume job creation overall** with some countries expecting a job decline in specific (fossil fuel-based) sectors. **Negative side-effects are expected to arise from additional costs and their distribution as investments have to be refinanced.** Here, countries highlight that they are aware and want to take appropriate counter-measures. For example, Italy outlines that it will ensure equity in the distribution of costs, Luxembourg mentions subsidies and cash transfers, and Slovenia wants to support a just transition with respective taxation policies.

Countries also highlight that the **transition to clean technologies leads to reduced air pollution and related respiratory diseases.** Czechia outlines that cost of controlling traditional air pollutants will fall and that improved air quality results in health care expenditure savings. The benefits for human health are supported by many countries while some countries additionally outlining the health benefits from lifestyle change, such as switching to cycling.

Every country has its own LTS recipe, making comparison and aggregation at EU level difficult

Strategies differ in structure (1), content (2) and methodological base (3) – this is the theme that runs through this assessment:

1) Information was found at different places in the document. Despite the existing (albeit voluntary) template in Annex IV of the GovReg, **only five countries largely followed the structure** (see Table 23), 12 countries seemed to have used the template more as general guidance and five did not use it at all (in some cases because these strategies were published before the GovReg was adopted).

2) The content differs in terms of availability and format. When it comes to the mandatory content outlined in the GovReg, the current LTS submissions are mostly compliant; the same goes for the required time horizon of 30 years (see also Table 22). At the same time, the GovReg does *not* specify the type of information or format of presentation for content. As a result, the **level of detail varies substantially for the mandatory as well as for the voluntary content**. Often only qualitative descriptions are offered where more quantitative figures would be warranted, e.g., on sectoral GHG pathways, energy carrier use, generation and imports, or economic and societal impacts. Furthermore, the same indicator across countries is often presented with different units, base years or base periods. For any comparative assessment, the numbers must be recalculated and standardised across all countries (as was done in this study but only to set 1990 as the base year for GHG emission reductions and removals). As a general observation, the current submitted strategies set different thematic focus areas, and as such, detail on specific indicators may be limited or missing entirely. However, it is notable that information on the horizontal elements made it into almost all LTSs – although mainly qualitatively.

3) In general, the strategies can be categories into scenario-based approaches and qualitative approaches. A robust scientific basis is clearly a strength overall (even though some are weaker than others); and this is especially the case for those countries providing **climate neutrality-conforming scenario(s) with information on a (sub)sectoral level and expected impacts**. However, this is only the case for France, Hungary, Portugal, Slovenia and Spain, although France misses detailed information on its future energy mix. The Austrian LTS lacks information on some sectors and the energy mix. The Finnish LTS outlines very different pathways and provides no emission reduction on buildings. The Italian lacks sectoral pathways and information on impacts of the transition, and the Greek LTS information on natural sinks and transition impacts.

Overall, **15 countries use some form of scenario development.** Of these, the LTSs of Denmark, Latvia and Slovakia deliver no scenario that reaches climate neutrality in the respective target year. Croatia has no climate neutrality target which is reflected in the scenarios. Malta does not clearly fit into this category, but the country uses the abatement potential to outline emission reductions by 2030, 2040 and 2050 (including sectoral information but without providing a base to calculate emission reductions).

The **other seven LTSs are mainly descriptive documents** which offer only qualitative descriptions of their long-term vision. This is particularly true for Germany and Luxembourg. Sweden only refers to another study on reaching net zero emissions by 2050 used as a basis for the qualitative information provided in the LTS. The Netherlands almost entirely refers the reader to their NECP. Estonia delivers targets for the national level but do not provide a clear indication of which emission reductions are envisioned in which sector. Lithuania provides emission reductions to be achieved on national and sectoral level but does not provide any underlying scenario. Belgium's strategy consists of separate statements from regional strategies on non-ETS emissions but lacks a comprehensive and integrative national scenario.

As a result, finding information was difficult and detail on specific indicators is limited or missing entirely. **The lack of quantitative, standardised data makes it exceedingly challenging to compare countries and did not allow for generating a comprehensive picture for the EU as a whole.**

4.2 INTEGRATION IN NATIONAL PROCESSES: MEMBER STATES UNDERUTILISE LTSs IN POLICY-MAKING

The integration of LTSs as a tool for managing long-term climate ambition and their relevance in wider national governance differ significantly by country. This was found to be the case when looking at strategy preparation as well as the LTSs' immediate implications for short-term policy via concrete decision points on responsibilities, monitoring and weight relative to other governmental strategies and plans. In this section, we outline five key insights from the assessment of LTS relevance and present a table of good practice examples (Table 3).

Developing an LTS adds value to national climate governance even though in some cases it was a box-checking exercise

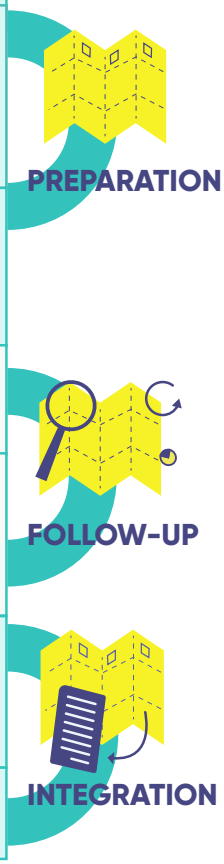
Across EU Member States LTSs' position in overall national governance ranges from constituting one pillar of an overarching framework to little more than a required regulatory exercise with at best a weak anchor in national decision-making. Late and missing submissions (now at the time of writing almost two and a half years overdue) are a further indication that, compared to the NECPs, many Member States did not take the long-term planning exercise very seriously. Nevertheless, **the process of preparing a strategy with a 30-year time horizon can have far-reaching implications for national climate policy**, regardless of the importance of the final document. In many cases, LTS development forced relevant actors to think (possibly for the first time) about a long-term transformation and climate neutrality. In other countries, structured discourse and analysis of a 2050 future served to further debate on impending key decisions, such as coal phase out (Germany), institutionalising scientific advice (France) or pursuing framework legislation (Spain, Portugal).

Table 34 lists a handful of cases where the LTS seems to have been given comparatively more weight in national climate governance. On compliance, a handful of LTSs are particularly noteworthy for the level of detail on key (and in many cases, mandatory) elements (Austria, France, Italy, Portugal, Slovenia and Spain). In terms of prominence in overall national climate governance, Finland, France, Malta, Portugal and Spain stand out for embedding their strategy in national policy-making as one element of a coherent climate governance framework, in all five cases featuring the LTS in a framework law. National parliaments played a role in LTS development in at least four countries (Croatia, Estonia, Portugal and Spain); and six countries describe new review and revision cycles for the LTS in line with the *proposed* five-year cycle in the GovReg (Czechia, Estonia, France, Malta, Slovakia, Spain). Finally, as a sign of political attention to the LTS process, three countries have already updated their strategies to account for higher ambition and national policy developments (France, Hungary, Lithuania).

While few **Member States map the EU LTS cycle concretely into national structures**, this does not necessarily mean the lack of a robust climate governance system. A comparison of the French and Danish cases provides an illustration of how differently LTSs are used national policy-making. Notably, two countries with longstanding and robust climate governance structures (Evans and Duwe, 2021). In France, LTS development is a core provision in a national framework law that further requires a review every five years based on a concrete set of indicators to track progress towards the long-term goal. Now in the midst of a *third* update (where some countries have yet to submit their first), expert interviewees pointed to how the French LTS has slowly risen to become a prominent blueprint for policy and is frequently referenced by high-level politicians and the French HCC, the latter of which often uses it as a benchmark to measure the fitness of pending policy decisions.

Table 34: Selected good practices on LTS relevance

RELEVANCE: GOOD PRACTICE EXAMPLES	
COMPLIANCE	**AT, DK, EE, EL, LT, LI, NL, PT, SE:** timely submission; **IT, HU, PT, ES, SL:** provide quantitative GHG data through 2050 for economy-wide reductions, removals and all mandatory sectors.
SCIENTIFIC BASIS	**AT, HR, CZ, FI, FR, EL, HU, IT, MT, PT, SL, ES:** clearly defined long-term scenarios for 2050; **NL:** dedicated scoping phase for researchers to provide long-term perspectives; **HU:** commissioned a quality review of strategy; **FR:** national research institutes represented in technical working groups; **AT, DE, PT, ES, SE:** consulted independent research institutes for technical advice; **SL:** scenario-building via EU-funded project spearheaded by reputable national research organisation.
PARTICIPATION	**FI, HU, IT, LU, SK:** inter-ministerial coordination for LTS development via dedicated working committee; **HR, EE; PT, (ES):** parliament given role in (future) strategy development (in PT enshrined in climate law); **FR:** highly representative stakeholder engagement process with various formats before and after initial draft, clear signs of impact (participation has expanded over time).
IMPLEMENTATION RESPONSIBILITIES	**CZ, EE, FR, LI, SK:** implementation responsibilities clearly assigned; **FR, LT, EE:** sectoral responsibilities outlined in strategy; **HR, CZ, EE, PT:** new monitoring responsibilities assigned to existing institutions.
MONITORING AND REVISION	**CZ, DK, EE, FR, DE, LT, LU, LV, MT, SK, ES:** outline concrete revision cycles; **CZ, EE, FR, MT, SK, ES:** at least a five-year revision cycle established either in strategy or climate law; **EE:** annual monitoring cycle for sectoral emissions established in strategy (for 2035 scenario); **FR:** robust monitoring with indicators; **(EE), FR, HU, LI:** already updated LTS since initial submission (EE not yet submitted officially).
POSITION IN NATIONAL GOVERNANCE	**LV:** diagram presenting position of strategy in relation to other current governance processes, plans and strategies; **CZ:** all sectoral strategies, policies and measures must be checked against LTS; **FI, FR, MT, PT, ES:** strategy viewed as prominent element of a coherent framework embedded in a climate law.
NECP COHERENCE	**AT, EL, ES:** high LTS-NECP coherence indicated by timing of submission, methodological consistency and common institutional responsibilities.



Source: own compilation based on national LTSs and interviews, excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland and Romania).

In Denmark, climate governance is framed by the Danish Climate Act (adopted in 2020). This includes two national cycles: an annual Climate Programme for short-term action and a national Climate Plan updated every five years with a ten-year perspective. Both must consider the long-term goal of climate neutrality by 2050 at the latest set forth by the Danish Climate Act. A national planning cycle with a 30-year perspective is limited to the long-term targets and principles set out in the Climate Act. The first Danish LTS submission to the European Commission in December 2019 reflects the national governance structures that existed before the adoption of the new framework climate law in June 2020. Indeed, the new LTS submitted to the UNFCCC in December 2020 (and to the EU in March 2021) contains more information on policy decisions at a national level and better reflects the current system.

Nevertheless, the role of the LTS in national policy-making is not immediately clear from the document itself, and Danish experts were split on the importance of the strategy as such. Our analysis suggests that compared to other countries, such as France, where the LTS is *used* as a national planning document and embedded in national governance structures, the Danish LTS is not given as much weight and long-term planning seems to be covered by other governance elements. Moreover, while an update to Denmark's climate target could trigger a revision of the strategy (within the context of the annual Climate Programme), there is no separate national requirement to revise the LTS although the Danish Climate Act requires national progress monitoring of GHG reductions for the 2050 goal.

The Danish case is akin to the situation in Sweden and elsewhere and speaks to the general weakness of long-term planning in national climate governance structures, even in those countries with otherwise robust frameworks in place for climate action. Aside from the LTS neither country has a planning cycle with a 30-year time horizon. **The EU's effort to bolster strategic planning with the LTS cycle will prove most effective if Member States take national ownership** over the plans they create. At least in this first round of LTSs a strong sign of national ownership seems to be missing in many cases.

Participation enhances buy-in to long-term planning but could be further utilised

Engagement with stakeholders, the scientific community and the public during strategy development seems to have improved the documents although actual impact is difficult to infer. Those **countries with stronger participatory processes, and as a result greater buy-in from public and private actors, may feel emboldened to use their LTS as guidance for short- and medium-term decisions.** Where engagement was limited in the government and beyond, there is arguably less of an anchor in on-the-ground challenges.

Although over half of the LTS submitted mention some degree of inter-ministerial involvement it is hard to tease out the depth and impact of these consultations. As highlighted in Table 34, good practices include the strategies of Finland, Hungary, Luxembourg, Italy and Slovakia, which mention the creation of dedicated working committees to enhance engagement among relevant governmental institutions. The French strategy, in particular, states that the same ministries should be involved for all future iterations, cementing inter-ministerial coordination as a cornerstone of the process. The French LTS is also a good practice example as having been developed and updated within the context of a wide-reaching (and expanding) participation process, involving members of the scientific community, business associations, civil society at numerous stages of preparation and in multiple formats.

Many Member States did not provide ample information in their LTS to facilitate a full assessment of participation – indeed, consultations may have occurred behind the scenes with greater impact than alluded to in the documents themselves. Still, based on the information contained in the strategies it seems that aside from a handful of good practice examples, most **public and stakeholder engagement processes were relegated to a single point in time in one format.** Furthermore, many countries did not proactively seek out a diversity of interests, which resulted in limited or disproportional representation from some groups. Especially, in the numerous cases where consultation occurred exclusively after a fleshed-out draft was already available it is less likely that recommendations and concerns were taken on board.

Post-submission blues? Little detail on national monitoring and institutional responsibilities for follow-up

The GovReg provides little to no guidance on actual implementation of the LTSs at national level. The ECL has introduced assessments of consistency with the climate neutrality goal for both EU level policies and national ones, but this is to be carried out by the European Commission itself. Overall, information on monitoring and institutional responsibilities for LTS follow-up is scarce in the documents themselves. Still, our assessment suggests that **LTSs are *not* used by EU Member States to enhance their climate governance systems, either by assigning new roles within government or creating new institutions and processes** for making sure that the strategies are actively translated into policies, or to monitor the structural changes implied.

Only a third of the strategies evaluated provide an indication of who is responsible for LTS implementation. Often duties are described in vague terms, making it hard to parse out what responsibility in this context actually means. The few notable exceptions included in Table 34 below pertain to concrete mention of inter-ministerial engagement in both development and implementation or new monitoring tasks given to existing institutions (Croatia, Czechia, Estonia, Portugal). For instance, the Lithuanian and Estonian strategy both set out clear sectoral responsibilities for climate action. In a few cases parliament is given an oversight role in future LTS revision (Spain, Portugal).

Nonetheless, our analysis suggests that most strategies were submitted with little actionable consideration of follow-up. That is, of how the strategy could be *used* as a blueprint for policy-making. The general absence of concrete decision points on processes for LTS monitoring and who is responsible for managing the long-term transformation reveals a missed opportunity for improving national climate governance systems, especially in the roughly third of EU countries without a dedicated climate law.

LTS updating and progress monitoring not a priority; effective policy learning for the long-term transformation is limited to a few countries

The regular and parallel (re)submission and updating of LTSs is necessary to keep up with changes in policy and technological developments. Moreover, it can facilitate a similar pace of transformation between countries and a certain degree of coordination inside the EU.

Several Member States have already revised their strategies once (e.g., France, Lithuania and Portugal) after an upwards adjustment of national climate ambition. Others are currently carrying out review processes (e.g., Austria, Czechia, Germany) to account for similar target changes and other updating needs. Since some strategies were submitted, the headline EU climate targets have changed, and negotiations on the 'Fit for 55' package are underway at the time writing. Similarly, policy changes related to energy security have been triggered in reaction to the war in Ukraine. These developments serve as a further impulse for revising national planning sooner than initially envisioned – and certainly justify an update to the EU LTS as well.

On monitoring and revision, France stands out as a good practice example for enshrining a five-year policy learning cycle in national law that is based on a dynamic, indicator-based evaluation and expert consultation. Czechia, Estonia, Malta, Slovakia and Spain also foresee concrete national policy learning cycles for their strategies. In all cases, at least a five-year updating cycle (four years for Malta and Estonia) is established in either by the strategy itself or a climate framework law, which may also set core responsibilities for implementation.

Still, across all EU Member States only these few examples indicate robust monitoring and revision cycles for their strategies that are at *least* in line with the five-year cycle for updates 'where necessary' as proposed in the GovReg. This implies that the majority plan to update their strategy only every ten-years to comply with current EU regulation, although it is not always made clear. Given the speed and scope of policy change in the last half decade a five-year cycle should be seen as the bare minimum. Ideally, Member States would reconsider the basic assumptions in their LTS on a more frequent basis, in order to make sure the five-year required updates to national short-term planning (detailed in the NECPs) are aligned with the most up-to-date projections and assumptions about the long-term transformation.

The lack of concrete plans for monitoring progress and updating accordingly points again to a lack of national ownership of the LTS process and long-term climate planning more generally.

LTS and NECP alignment exists on paper, verification pending

The LTSs seem to show coherence with NECPs although the order of preparation and publication varies from country to country. Some countries argue alignment because they view their LTS as an extension of their NECP through 2050, making use of the same or similar underlying methodologies and participatory workshops and forums. Taking a different perspective, other countries contend that they first developed their long-term vision and then used the NECP to define the short- and medium-term actions in coherence with the long-term planning. Nonetheless, because most of the LTSs included in this analysis are missing inputs of crucial importance to the NECPs, any promise of alignment contained in the strategies themselves should not be assumed reliable.

A comprehensive assessment of coherence between Member States' NECPs and LTSs was beyond the scope of this study. However, a simple assessment built on four criteria – timing of submission, methodological consistency, cross-referencing and common ministerial oversight – allowed us to gauge some degree of alignment. As highlighted in Table 34, Austria, Greece and Spain, in particular, show the most coherence between their short- and long-term climate planning processes. Of course, this is only a rough rubric, and a comprehensive analysis of both planning documents is needed to obtain a fuller picture.

5 CONCLUSIONS AND RECOMMENDATIONS

GOOD PRACTICES EXIST.

Three LTSs stand out as good practice examples, delivering on both vision and relevance; they are the strategies from France, Portugal and Spain. All three of these LTSs plus that of Hungary provide good information on their long-term vision, including details on total and sectoral GHG emission reductions, and at least to some extent on the use of hydrogen, biomass, CCUS and sinks. Aside from France, they also provide the future energy mix including the share of renewables and the role of conventional energy carrier. The strategies also cover information about the horizontal elements although Portugal has no information on adaptation to climate change. France, Portugal and Spain built their strategies on clearly defined long-term pathways for 2050, with concrete input from the scientific community. In terms of relevance, all three good practice cases embed their LTS as the long-term planning element of a national climate framework law, with regular cycles of review. France and Portugal further provide a description of a participatory process with input on initial LTS scenario elaboration; France especially has expanded stakeholder and expert consultations over time. Many other countries showed good practice on one or more underlying elements of the analysis, such as the level of detail on specific sectors, participation processes and monitoring cycles for the strategy (see selected good practices in Table 33 and Table 34).

Many LTSs do not provide enough information to guide policy-making now requiring more detail and interpretation of results.

A core function of LTSs is to chart a pathway to the future so that decisions on policies in the near-term can consider the investigated changes. Not all of the existing LTSs currently are able to do so. At least descriptive documents generally miss an indication of the role and timing of specific technologies and practices or changes in lifestyle and corresponding requirements. This is also the case for strategies with scenarios that do not reach the long-term climate target. In addition, most strategies outlining different scenarios do not provide a preference or timing of deciding on which path to follow. Finally, not all strategies provide enough sectoral data to show changes in the energy mix or in agricultural practices nor quantified impacts of the different pathways.

In essence, this means that **most LTSs do not clarify the required changes and underlying enablers in sufficient detail,** nor do they identify decision points on enabling conditions, e.g., when specific technologies need to have achieved market readiness, what infrastructure needs to be in place when, etc. These LTSs thus cannot provide clear strategic guidance for the near-term.

To ensure that future strategies can fulfil this function, **more harmonisation and mandatory information on detailed pathways and decision points** are required. Accordingly, the GovReg should be amended to include a mandatory template for LTSs to streamline the content of the documents.

The template should require the inclusion of:

- an **overview of long-term and interim climate and energy targets** as well as of any other relevant targets with an in/direct impact on GHG emissions.
- specific **indicators with harmonised base and units, and ten-year steps for at least 30 years for economy-wide and sector specific information** beyond GHG reduction data; indicators that can be relevant are outlined in the NECP template or also in other studies such as Velten et al. (2021);
- the obligation to develop and include data from at least **one target-conforming scenario and details on underlying assumptions** such as potentials of domestic energy source, on imports, or price estimates for specific energy sources; and
- where diverging scenarios reach the long-term climate target, **clarification on the preferred path or at least an indication on how and when to decide** on this (and when a decision may be needed).

In addition, it needs a section on the **interpretation of the data included for national policies**, which sheds light on the preferred pathway, important enablers and potential risks that might have an impact on the transition and which pinpoints specific actions and decision points to be considered.

LTSs are partly outdated and do not necessarily serve as the basis for NECP development which highlights the need for regular updates and better alignment

LTSs should guide short- to medium-term actions. While many Member States have their own respective policy-making cycles, the vehicle introduced as mandatory for all countries to summarise and communicate them are the NECPs. Alignment between the two processes is thus crucial, including the right sequence. However, it seems that **in practice not all governments are equally ensuring the consistency of their respective LTS and NECP** despite a legal requirement to do so. This is indicated primarily by the timing of the two documents (a problem created in the GovReg to some extent) and by who was involved (a decision at national level).

Another problem in this context is the validity of the information in the LTSs. Changes in technology, scientific evidence, public opinion, and the policy landscape can make strategies obsolete or partially outdated. **Some national LTSs have already been revised**, e.g., due to a decision to revise the long-term target. As a consequence, new pathways need to be simulated, and the speed of change has to be accelerated in the actual policies afterwards.

External shocks can also force strategy adjustment. An obvious example is the policy change on natural gas following the Russian invasion of Ukraine. Many LTSs included natural gas as a form of bridging technology or even a low-carbon energy carrier with a relevant share in the log-term energy mix. This assumption is now out of date – energy policy is being revised and LTSs need to be updated, too, to stay relevant.

These examples underline the importance of **regular updates of the LTSs** so that the documents remain or become relevant for decisions on short- and medium-term action (incl. via the NECPs). The same goes for policies, and for the NECPs. The updating of both planning processes needs to be happening in an integrated fashion that happens in the right sequence (long-term before short-term).

Therefore, the GovReg should be amended to:

- include **mandatory LTS updates every five years**; this should also apply to the EU LTS,
- require that the **LTS is developed or revised *alongside* or rather *before* the NECP** so that it can guide the respective scenario building and related short- and medium-term actions elaborated in the NECP, and
- require a **harmonisation of the overarching GHG emission pathway across the NECPs and LTSs** to ensure coherence between the two planning horizons.

Opportunity to get buy-in: a participatory process can enhance transparency and support for climate action

Consultation within the government and with the scientific community, local authorities, companies, civil society, and the public must be a core element of inclusive and robust long-term climate planning. However, the analysis reveals that **most governments underutilise the potential of participation in the development** of their LTSs in many ways. Many governments limit public and stakeholder engagement to a single point in time, often once a draft is already finished, and do not actively seek out representation from a diversity of interests.

By actively involving various actors in the policy planning process, national governments can **enhance the transparency and reinforce public support for climate action and offer additional certainty for businesses and private citizens** when taking decisions.

Therefore, amendments to the GovReg would push Member States to be more proactive when it comes to the LTS participation and provide a fuller picture of the process. These include:

- A **mandatory two-stage process** with opportunities for input both in an initial scoping phase and on a draft
- A **highly representative stakeholder engagement process** with active seeking of different interests from, e.g., business, public, civil society, and local governments.
- A separate **process on engaging scientific expertise** drawing on an existing advisory body in the country
- Requirement to provide **a more detailed description** of the participatory process including details on who is involved and at what periods.

Many countries would benefit from anchoring the LTS cycle more concretely in national policy-making, ideally in a climate framework law

An integrated system for long-term planning is central to an effective climate governance system; **good decisions in the short-term must be based on a concrete and regularly updated long-term vision**. EU Member States do not always provide detail on how their strategy fits into the national governance context, but our assessment found a lack of clear responsibilities and national processes for regular monitoring and revision.

It is important to reiterate that many countries have their own national processes and more or less explain what they are doing at a national level in their LTS and NECP submissions. Still, the **few good practice examples explain in concrete terms how their strategy is embedded in a broader climate governance framework**, often but not necessarily codified in a climate law, alongside binding long-term targets, regular monitoring of the LTS and dedicated institutions for realising the 2050 vision (i.e., Finland, France, Malta, Spain plus Portugal although this is not described in the LTS). As such, these countries take over national ownership of the LTS as a tool to guide and consolidate policy making for the long-term transformation. France, in particular, assigns clear implementation responsibilities for future LTS revisions.

Governments should **anchor their LTS in national policy-making by clearly assigning a responsible authority to oversee its implementation and establishing a five-year policy learning cycle for the strategy**, either via a national framework law or other means. The learning cycle should include a regular review and revision schedule for the strategy that tracks progress towards the long-term goals, accounting for the latest scientific evidence as well as socio-economic and technological developments.

LTS development and updates need technical support and intra-EU communication and experience sharing

There are some good practice examples for LTS vision and relevance but most LTSs need improvement. Support and experience sharing could help national governments in developing better information and implementing better preparation and follow-up processes.

Therefore, the **EC should build upon on their active role** for the development of NECPs and support NECP *and* LTS development in an integrated way. This can take the form of **technical working groups and capacity support and making available a common toolbox** for joint assumptions to harmonise the methodological basis. Thus, the EC could help to ensure that LTSs are developed before of NECPs as well as their coherence and timely completion.

Next to this, the EC could provide **a forum for good practice experience sharing** on technical and governance aspects and for encouraging integrated planning processes across borders. The **Czech presidency could help to initiate and raise political attention** for long-term planning in the context of their own ongoing LTS updating process. **Sweden and Spain could continue by sharing their own experiences** to promote good practice in LTS development and use, particularly in 2023 as the review mechanisms of the EU Climate Law are first implemented.

The creation of a common EU vision for climate neutrality can guide EU and Member State's policy making

Providing information across national LTSs helps to understand if and how Member States on aggregate plan to achieve climate neutrality. However, **there is no assessment of the EC so far and even if, such assessment would possibly face same or similar problems of varying and non-existing information** making any aggregation difficult and for specific elements even impossible as there basically just six LTSs with enough visible information on the elements covered in this study.

There is clear need for a new bottom-up long-term vision for the EU as a whole. This is because the EU LTS is outdated and lacks Member State specific information. Therefore, the EC should **create a vision for climate neutrality in the EU based on the national LTSs and integrating this into future updates of the EU LTS**. In this context, the EC must assess the alignment of aggregated national planning with the EU goal of reaching climate neutrality by 2050, and the EC should pinpoint the role of important enablers to consider these in near-term decision making. However, for such an assessment the EU should enforce compliance with the requirements for LTSs in the Governance Regulation, requesting the submission of all missing LTSs and updates to all LTSs without sufficient detail.

This opens the grounds for exchange and coordination among the national governments and the EU and it would be **a good basis for strategic decisions by the EU as well as for Member States** for the short-term and medium-term to help develop and implement identified key enablers across the EU. Indeed, this is of crucial importance as the EU LTS is already outdated and when produced did not outline any Member State specific developments. Such assessment would then also provide a basis for further analysis by others and serve as a source for information, e.g., for companies and private citizens and their investment decisions. Therefore, the EU **must request the submission of all LTSs** not submitted thus far and the **updating of all LTSs without sufficient information** on relevant enablers.

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6.3 ABBREVIATIONS

ACRONYM	FULL PHRASE
Art	Article
BAU	Business-as-usual
BECCS	Bioenergy with carbon capture and storage
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CCUS	Carbon capture, utilisation and storage
COP	Conference of the Parties
CO2e	Carbon dioxide equivalents
DAC	Direct Air Capture
DACCS	Direct Air Carbon Capture and Sequestration
EC	European Commission
ECF	European Climate Foundation
ECL	European Climate Law; Regulation (EU) 2021/1119
GHG	Greenhouse gas
GovReg	Governance Regulation; Regulation 2018/1999
LCDS	Low-Carbon Development Strategies
LTS	Long-Term Strategy
LT-LEDS	Long-Term Low Greenhouse Gas Emission Development Strategies
LUILUCF	Land use, land use change and forestry
MMR	Monitoring Mechanism Regulation; Regulation (EU) No 525/2013
Mt	Million tonnes
NDC	Nationally Determined Contributions
NECP	National Energy and Climate Plan
t	tonne
WAM	With additional measures
WEM	With existing measures
UNFCCC	United Nations Framework Convention on Climate Change

7 LITERATURE

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APPENDICES

Table A-1: Information on countries selected for interviews with national experts

INDICATORS COUNTRIES	GDP/CAPITA		GHG / CAPITA		LOCATION IN EUROPE	STATUS OF LTS SUBMISSION (*)
	EUR/ 1000 CAPITA	RANK	T CO2E / CAPITA	RANK		
Bulgaria	6.6	27.	8.1	13.	South-East	not submitted yet
Czechia	17.3	16.	11.5	3.	Central-East	Mar 2017
Denmark	48.1	3.	7.6	15.	North	Dec 2019
France	30.6	10.	6.5	21.	West	Mar 2020
Germany	34.3	8.	9.7	9.	Central	Nov 2019
Poland	12.7	22.	10.3	6.	Central-East	not submitted yet
Portugal	17.1	17.	6.2	22.	South	Jun 2019
Spain	22.4	13.	6.6	19.	South	Nov 2020

Source: own compilation based on indicator databases (EEA, 2021c; Eurostat, 2021a, 2021b) and national LTSs
GDP/capita here as chain linked volumes based on 2010.
Abbreviations: t CO_2e = tonnes of carbon dioxide equivalents.

Table A-2: Sectoral emission reductions (2050 vs.1990) and GHG removal across countries providing quantitative information

	POWER	TRANSPORT	BUILDINGS	INDUSTRY	AGRICULTURE	GHG REDUCTION PATHWAYS	NATURAL SINKS	TECHNICAL SINKS
AT	~24-73% (energy incl. transport, buildings) (*)			~83-84% (*)	~39-50% (*)	Linear, delayed in industry	17.0 / 3.9 / 0 Mt	0 / 8.8 / 18.7 Mt
BE	100%	100%	88-90%	~94-95% (*)	55-59%			
HR	61-93%	28-55 %	55-74% (1)	64-83%	51-56%	Delayed in transport		
FI	~80-98 % (*)	~68-97% (*)		~56-90% (*)	~32-60% (*)	Linear	25-28 / 16.4 Mt	0 / 14.0 Mt
FR	97%	97%	95%	81%	46%	Linear	67 Mt	10 Mt
EL	~97-101% (*)	88 %/-99.5%	90-100%	48-106%	55% (2)	Linear		0-4.8 / 0.9-8.5
HU	98%	~78 % (*)	~100% (*)	98%	79%	Linear where available	4.5 - 5 Mt	Non-quantified BECCS uptake
IT	88%	100%	100%	84%	33%		45 Mt	
LT	100%	90%	100%	100%				8.6 Mt (natural and technical sinks)
PT	~98% (*)	84-85% / 98%	~96-97% (*)	~67-68% (*)	~26-52% (*)	Linear	9 / 11.8 / 13.4 Mt	
SI (3)	99 %	99 %	95%	87%	22%	Linear, delayed in transport, industry	2.5 Mt	
ES	~100% (*)	97.7%	100%	~91% (*)	~57% (*)	Linear	37.0 Mt	
SE (4)	~60% (*)	25% (*)		61% (*)	~37% (*)			

Source: own compilation and calculation based on national LTSs, Ricardo-AEA (2019) and EEA (2021c).
(*) = percentages based on own calculation from absolute values. (1) = includes fuel combustion in agriculture, forestry and fishing. (2) = all non-CO_2 emissions. (3) = against 2005 values. (4) = data for 2045. Excluding Denmark, Latvia and Slovakia which do not provide data until 2050 or in line with the target, excluding Malta which provides only the abatement potential and excluding countries which do not provide an emission reduction figure, or those without LTS (Bulgaria, Cyprus, Ireland, Poland, and Romania).

Table A-3: LTS compliance with mandatory content in Articles 15.1 and 15.4 of GovReg – full detail

	ARTICLE 15.1	ARTICLE 15.4					ASSESSMENT
	AT LEAST A 30 YEAR PERSPECTIVE (I.E., 2050)	(A) TOTAL GHG REDUCTIONS AND REMOVALS	(B) SECTORAL GHG EMISSION REDUCTIONS	(C) PROGRESS ON TRANSITION: R&D AND INVESTMENTS	(D) SOCIO-ECONOMIC, HEALTH, AND ENVIRONMENTAL IMPACT	(E) LINKS TO OTHER NATIONAL OBJECTIVES, STRATEGIES, AND PLANS	
AT	Yes	Yes, quant./ qual. info on reductions and removals	Partly, quant./qual. info on all sectors (industry, transport and buildings included within aggregate 'energy' sector)	Yes, qual. info on investments	Yes, qual. info on socio-economic, health, environmental impact	Yes	COMPLIANT
BE	Yes	Partly, quant./ qual. info on reductions; no info on removals	Partly, quant. information on most sectors; qual. info on electricity; no info on LULUCF	Yes, qual. info on investments	No, no info provided	No	MOSTLY NON-COMPLIANT
HR	Yes, goes to 2030 with a 'look' at 2050 but does include GHG data for 2050	Yes, quant./ qual. info on reductions; qual. info on removals	Yes, quant./qual. info for most sectors; only qual. info on LULUCF	Yes, quant./ qual. info on investments	Yes, qual. info on socio-economic, health, environmental impact	Yes	COMPLIANT
CZ	Yes	Partly, quant. info on reductions; no info on removals	Partly, no info on buildings, electricity, industry, LULUCF; only qual. on transport	Yes, quant./ qual. info on investments	No, no info provided	Yes	MOSTLY COMPLIANT
DK	Partly, GHG data reported through 2040	Partly, missing significant detail (GHG data reported through 2040)	Partly, missing significant detail (GHG data reported through 2040)	No, no info provided	No, no info provided	Partly	MOSTYLY NON-COMPLIANT
EE	Yes	Yes, quant./ qual. info on reductions; qual. info on removals	Partly, no info on buildings; only qual. info on LULUCF	No, no info provided	Partly, no info on socio-economic, health impact; qual. info on environmental impact	Partly	MOSTLY COMPLIANT
FI	Yes	Yes, quant./ qual. info on reductions and removals	Yes, quant./qual. info on most sectors; qual. info on buildings	Yes, quant./ qual. info on investments	Yes, qual. info on socio-economic, health, environmental impact	Partly	COMPLIANT
FR	Yes	Yes, quant./ qual. info on reductions and removals	Yes, quant./qual. info on all sectors	Yes, quant./ qual. info on investments	Yes, qual. info on socio-economic, health, environmental impact	Yes	COMPLIANT
DE	Partly, GHG data reported through 2030	Yes, qual. info on reductions and removals (no data for 2050)	Yes, qual. info on all sectors (no data for 2050)	Yes, qual. info on investments	Partly, qual. info on socio-economic impact; no info on health, environmental impact	Partly	MOSTLY COMPLIANT

	ARTICLE 15.1	ARTICLE 15.4					ASSESSMENT
	AT LEAST A 30 YEAR PERSPECTIVE (I.E., 2050)	(A) TOTAL GHG REDUCTIONS AND REMOVALS	(B) SECTORAL GHG EMISSION REDUCTIONS	(C) PROGRESS ON TRANSITION: R&D AND INVESTMENTS	(D) SOCIO-ECONOMIC, HEALTH, AND ENVIRONMEN-TAL IMPACT	(E) LINKS TO OTHER NATIONAL OBJEC-TIVES, STRATE-GIES, AND PLANS	
EL	Yes	Yes, quant./ qual. info on reductions and removals (missing detail on natural sinks)	Partly, quant./qual. information for most sectors; no info on LULUCF	Yes, quant./ qual. info on investments	Partly, qual. info on socio-economic impact; no info on health, environmental impact	No	MOSTLY COMPLIANT
HU	Yes	Yes, quant./ qual. info on reductions and removals (qual. info on technical removals)	Yes, quant./qual. information for all sectors	Yes, quant./ qual. info on investments	Yes, qual. info on socio-economic, health, environmental impact	Partly	COMPLIANT
IT	Yes	Yes, quant./ qual. info on reductions and removals	Yes, quant./qual. info on all sectors	Yes, qual. info on investments	Yes, quant./ qual. info on socio-economic impact; qual. info on health, environmental impact	Partly	COMPLIANT
LV	Yes	Yes, quant./ qual. info on reductions and removals	Yes, qual. info on buildings; qual./ quant. info on all other sectors (LULUCF indicated in graph)	Yes, quant./ qual. info on investments	Yes, qual./ quant. info on socio-economic impact; qual. info on health, environmental impact	Yes	COMPLIANT
LT	Yes	Yes, quant./ qual. info on reductions and removals	Yes, qual. info on all sectors; quant. info on transport	Partly, qual./ quant. info on investments through 2040, no info provided for 2050	Partly, quant. info on socio-economic impact; qual. info on health all based on NECP through 2040; no info on environmental impact	Yes	COMPLIANT
LU	Yes	Partly, no info on reductions; qual. info on removals	Yes, qual. info on all sectors	Yes, qual. info on investments	Yes, qual. info on socio-economic, health, environmental impact	Partly	COMPLIANT
MT	Yes	Yes, quant./ qual. info on reductions; qual. info on removals	Yes, quant./qual. info on most sectors; qual. info on electricity	Yes, quant./ qual. info on investments	Yes, qual. info on socio-economic, health, environmental impact	Partly	COMPLIANT

	ARTICLE 15.1	ARTICLE 15.4					ASSESSMENT
	AT LEAST A 30 YEAR PERSPECTIVE (I.E., 2050)	(A) TOTAL GHG REDUCTIONS AND REMOVALS	(B) SECTORAL GHG EMISSION REDUCTIONS	(C) PROGRESS ON TRANSITION: R&D AND INVESTMENTS	(D) SOCIO-ECONOMIC, HEALTH, AND ENVIRONMEN-TAL IMPACT	(E) LINKS TO OTHER NATIONAL OBJECTIVES, STRATEGIES, AND PLANS	
NL	Partly, GHG data reported through 2030	Yes, qual. info on reductions and removals (no data for 2050)	Partly, no info on electricity, qual. info on all other sectors (no data for 2050)	No, no info provided	No, no info provided	Partly	MOSTLY NON-COMPLIANT
PT	Yes	Yes, quant./ qual. info on reductions and removals	Yes, quant./qual. info on all sectors	Yes, quant./ qual. info on investments	Yes, quant./ qual. info on socio-economic impact, qual. info on health and environmental impact	Partly	COMPLIANT
SK	Partly, sectoral GHG data through 2040	Yes, quant./ qual. info on reductions and removals	Partly, no info on buildings; quant./ qual. info on most sectors (only through 2040)	Yes, quant./ qual. info on investments	Partly, quant./ qual. info on socio-economic impact; no info on health impact; qual. info on environmental impact	Yes	MOSTLY COMPLIANT
SI	Yes	Yes, quant./ qual. info on reductions and removals	Yes, quant./qual. info on all sectors	Yes, quant./ qual. info on investments	Partly, qual. info on socio-economic impact (quant. only through 2030); no info on health, environmental impact	Yes	COMPLIANT
ES	Yes	Yes, quant./ qual. info on reductions and removals	Yes, quant./qual. info on all sectors	Yes, quant./ qual. info on investments	Yes, quant./ qual. info on socio-economic impact, health, qual. info on environmental impact	Yes	COMPLIANT
SE	No, 2045 because this is the date for Sweden's net-zero target	Yes, quant./ qual. info on reductions; qual. info on removals	Yes, quant./qual. info most sectors; qual. info on buildings	Yes, qual. info on investments	Partly, qual. info on socio-economic impact; no info on health, environmental impact	Yes	MOSTLY COMPLIANT

Source: own assessment based on the information provided in national LTSs; Ricardo-AEA (2019).
Excluding countries which do not provide an emission reduction figure, and excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland and Romania).
Note on methodology: Countries were assessed overall as being (1) 'compliant,' (2) 'mostly compliant,," (3) 'mostly non-compliant' and (4) 'non-compliant'. A two-step point system was used to determine the varying degrees of Member State compliance with the obligations in Article 15 of the GovReg pertaining to mandatory content and time horizon. First, Member State strategies were judged as follows across six components derived from Articles 15.1 and 15.4: 'yes' – information provided (1 point); 'partly' – some information missing (e.g., sector omitted) (1/2 point); 'no' – information not provided (0 points). Based on this, strategies were then evaluated overall along a four-point scale: 'compliant' – >= 5 points (but no 'no'); 'mostly compliant' – 3.5-4.5 points; 'mostly non-compliant' – 2-3 points; 'non-compliant' – <= 1.5 points.
Links to other national objectives, strategies and plans was assessed primarily for the number of instances of reference to other governmental documents in the LTS submission itself.

Table A-4: Stakeholder engagement

	PARTICIPANTS					FORMAT	TIMING	ASSESSMENT
	LOCAL OFFICIALS	CIVIL SOCIETY	BUSINESS	INVESTORS	OTHER			
AT	Yes, federal ministries, federal provinces, cities and municipalities	Yes, social partners and civil society	Yes, the Federation of Austrian Industries		Yes, federal ministries, federal provinces, cities and municipalities	Dialogue; three workshops	During preparation	High representation, single format, single stage
BE					Yes, "stakeholders" and experts; Advisory climate panel of independent experts in Flanders.			
HR					Yes, sectors and ministries	Dialogue; thematic workshops	Initial scoping phase	Single format, single stage Representation unclear
CZ		* Yes	* Yes				* During drafting and impact assessment	Medium representation, multiple stages Format unclear
DK	Insufficient information for evaluation							
EE		Yes, non-governmental partners	Yes, entrepreneurs		Yes, politicians, officials, researchers and experts	Dialogue: joint discussions, analyses, workshops and opinion gathering		Medium representation, multiple formats Timing unclear
FI					'a wide variety of stakeholders'	Dialogue	After the preliminary results of the study, which the LTS scenarios are based on	Single format, single stage Representation unclear
FR	Yes, local authorities	Yes, NGOs, trade unions, consumer representatives	Yes, businesses		Yes, MPs, National Energy Transition Council, National Committee on Energy Transition	Dialogue; discussions and seven themed work groups	Before and after the drafting and in the finalisation stage	High representation, multiple formats, multiple stages
DE	Yes, federal states, municipalities		Yes, industry		Yes, associations	Dialogue; three forums and working groups	Before the drafting	Medium representation, multiple formats, multiple stages
EL	Insufficient information for evaluation							

Source: own assessment based on the information provided in national LTSs; Ricardo-AEA (2019).
Excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland and Romania).
Note: An asterisk indicates that the information was acquired in an interview.

Table A-4: Stakeholder engagement

	PARTICIPANTS					FORMAT	TIMING	ASSESSMENT
	LOCAL OFFICIALS	CIVIL SOCIETY	BUSINESS	INVESTORS	OTHER			
AT	Yes, federal ministries, federal provinces, cities and municipalities	Yes, social partners and civil society	Yes, the Federation of Austrian Industries		Yes, federal ministries, federal provinces, cities and municipalities	Dialogue; three workshops	During preparation	High representation, single format, single stage
BE					Yes, "stakeholders" and experts; Advisory climate panel of independent experts in Flanders.			
HR					Yes, sectors and ministries	Dialogue; thematic workshops	Initial scoping phase	Single format, single stage Representation unclear
CZ		* Yes	* Yes				* During drafting and impact assessment	Medium representation, multiple stages Format unclear
DK	Insufficient information for evaluation							
EE		Yes, non-governmental partners	Yes, entrepreneurs		Yes, politicians, officials, researchers and experts	Dialogue: joint discussions, analyses, workshops and opinion gathering		Medium representation, multiple formats Timing unclear
FI					'a wide variety of stakeholders'	Dialogue	After the preliminary results of the study, which the LTS scenarios are based on	Single format, single stage Representation unclear
FR	Yes, local authorities	Yes, NGOs, trade unions, consumer representatives	Yes, businesses		Yes, MPs, National Energy Transition Council, National Committee on Energy Transition	Dialogue; discussions and seven themed work groups	Before and after the drafting and in the finalisation stage	High representation, multiple formats, multiple stages
DE	Yes, federal states, municipalities		Yes, industry		Yes, associations	Dialogue; three forums and working groups	Before the drafting	Medium representation, multiple formats, multiple stages
EL	Insufficient information for evaluation							

	PARTICIPANTS					FORMAT	TIMING	ASSESSMENT
	LOCAL OFFICIALS	CIVIL SOCIETY	BUSINESS	INVESTORS	OTHER			
HU		Yes, civil society groups including youth organizations		Yes, financial institutions	Yes, private sector and academia	Dialogue; online event series and three consultation workshops	After the drafting	Medium representation, multiple formats, single stage
IT		Yes, civil society and experts	Yes, companies and associations (from industry, transport, agriculture)			Dialogue and written consultation; online consultations with questionnaires filled in by experts	Before the drafting	Medium representation, multiple formats, single stage
LV	Yes, local governments, regional branches of state institutions, leaders of local public groups	Yes, social partners	Yes, industry associations		Yes, academic staff	Dialogue; five interactive seminars	During the preparation stage of the LTS and prior to publishing	High representation, single format, multiple stages
LT	Insufficient information for evaluation							
LU		Yes, civil society	Yes, industry		Yes, public authorities and science	Dialogue; consultations	Prior to the development of the LTS	Medium representation, single format, single stage
MT	Yes, representatives of regional committees and local councils	Yes, members of the civil society	Yes, business representatives		Yes, ministries, government entities, agencies, authorities and academics	Dialogue; face-to-face meetings with feedback and follow-up	Preliminary feedback	High representation, single format, single stage
NL					Yes, scientists	Written consultation; essays	Preliminary scoping	Low representation, single format, single stage
PT	Yes, town councils	Yes, civil society, trade unions and NGOs	Yes, industry		Yes, national institutions and experts	Dialogue; technical and sectoral workshops, thematic events, bilateral discussions and informal meetings	During the creation of the modelling scenarios	High representation, multiple formats, single stage
SK			Yes, employers' associations		Yes, academia and representatives of relevant sections and organisations within the remit of the Ministry of Environmen	Dialogue; working groups and consultations	During preparation	Medium representation, multiple formats, single stage
SI					"several stakeholders"	Dialogue; workshops		Single format Representation and timing unclear

	PARTICIPANTS					FORMAT	TIMING	ASSESSMENT
	LOCAL OFFICIALS	CIVIL SOCIETY	BUSINESS	INVESTORS	OTHER			
ES	Yes	Yes, NGOs and trade unions	Yes, businesses, associations and industry		Yes, scientific-academic entities, governmental administrations	Dialogue; meetings	During the drafting	High representation, single format, single stage
SE		Yes, representatives from the civil society, researchers, environmental organisations and unions, NGOs, think tanks	Yes, representatives from the business community and industry organisations		Yes, government agencies, experts in political science, law and climate economics, representatives from academia	Dialogue; meetings and consultations	During the proposal stage	Medium representation, multiple formats, single stage

Source: own assessment based on the information provided in national LTSs; Ricardo-AEA (2019).
Excluding countries without LTS (Bulgaria, Cyprus, Ireland, Poland and Romania).
Note: An asterisk indicates that the information was acquired in an interview.

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NET ZERO 2050

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