EPG

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

European Climate Initiative EUKI

Recommendations for Romania's Long-Term Strategy: Pathways to climate neutrality

Mihnea Cătuți, Luciana Miu and Constantin Postoiu

Energy Policy Group

Final report

12th December 2022

A **Climate Recon** publication

ecologic · Jožef Stefan Institut · SEI · WiseEuropa

Contact

Mihnea Cătuți
Head of Research
Energy Policy Group
1, Termopile Street, 021026 Bucharest
http://www.enpg.ro
E-mail: mihnea.catuti@enpg.ro

Suggested citation

Cătuți, M., Miu, L., Postoiu, C., 2022. *Recommendations for Romania's Long-Term Strategy: Pathways to climate neutrality*. Energy Policy Group, Bucharest.

Acknowledgements

This report is part of the project **Climate Recon 2050 - Dialogue on Pathways and Policies for a climate-neutral EU.** For further details, please visit the project website.

Special thanks go to Mihai Bălan, Andrei Covatariu, and Radu Dudău for their contribution to building the scenarios and to Ana Niculicea and Corina Lazăr for their help with this report.

Appreciation for review goes to Krzysztof Kobyłka at WiseEuropa.

Executive Summary

Decarbonisation will not be achieved merely through political commitments, it also requires rigorous evidence-based planning. Romania **still needs to publish its long-term strategy** (LTS) on how decarbonisation will be achieved by 2050. Since the initial deadline of January 1st, 2020, several key events and EU-level strategies have unfolded, which should be taken into account in Romania's upcoming LTS. The European Green Deal and the Fit-for-55 package brought forth a whole new level of ambition for GHG emissions reduction, while the REPowerEU will accelerate the pace of the climate transition in the short and medium-term, following Russia's invasion of Ukraine. The Romanian LTS needs therefore to outline a plan for the rapid decarbonisation of the economy with the prospect of **reaching climate neutrality before mid-century**.

To assist in this endeavour, this report presents the results of a modelling exercise using the *2050 Pathways Explorer* developed by CLIMACT and calibrated and adapted for the Romanian case study by EPG. Three scenarios have been developed: (1) **Tech scenario,** assuming a rapid development of cutting-edge technology and rapid cost reductions, (2) **Life scenario,** assuming transformative changes in lifestyle choices and individual behaviour, as well as high levels of political buy in, and (3) **EPG scenario**, which is the recommended one, represents a more balanced approach relying on a combination of more moderate transformation when it comes to technological development and behavioural changes among the general population. All scenarios achieve climate neutrality or even net negative GHG emissions by 2050, compared to a business-as-usual scenario that **only sees a 16% decrease in emissions** compared to 2015.

Between **70% and 100%** of energy consumption from buildings, transport, and industry would need to be **sourced from renewable energy**, while **coal, fossil oil, and fossil gas** consumption would be **reduced by more than 90%** across all scenarios. **Direct electrification** and **reduction in energy consumption** are the most important decarbonisation levers, with an important role also played by **hydrogen, e-fuels, and biomass**. Romania's **natural carbon sink** contributes up to 90% to total envisaged removals, while **carbon capture technologies** play varying roles across scenarios. **Lifestyle changes** are also key – even scenarios with more relaxed assumptions on behavioural change will require heightened awareness and a mobilisation of personal investments in energy efficiency measures, electric vehicles and other low-emissions products and services.

The decarbonisation of Romania's **electricity supply** will be mainly driven by a massive increase in solar PV and wind energy sources, which will also support a significant increase in electricity demand due to electrification across sectors. According to the modelled scenarios, Romania would have in 2050 more than **17 GW of installed onshore wind, 15 GW of offshore wind, and 21 GW of solar PV**. Additional **nuclear capacity** is projected both in the EPG and Tech scenarios with an increase of 50%. In all scenarios modelled for this report, **coal must be completely phased out by 2030**. The deployment of **energy storage technologies** is necessary to ensure the flexibility needs of a future renewable-dominated electricity mix.

Two main categories of levers contribute to the decarbonisation of Romania's **buildings sector** – **energy efficiency** and **behavioural measures** to reduce energy consumption on the one hand, and the **progressive replacement of fossil fuels** for heating and cooling with renewable sources in the form of electrification and the use of as well as some continue use of biomass (albeit at half the rate of current consumption). The share of **renewable energy** in the final energy demand of the buildings sector is estimated **to rise to 85%-96% by 2050**. The deployment of **heat pumps increases by almost 5000% in most scenarios**, while **hydrogen** only accounts for **only 2.3%** of the energy demand in the entire energy sector in 2050. **Low-carbon district heating networks** continue to have an important role across scenarios. Energy demand across scenarios must be reduced between 31% and 60% despite an increase in per capita living space by 2050.

The decarbonisation of Romania's **transport sector** is mostly projected to be driven by significant **electrification** across all scenarios, as well as some use of **biofuels, e-fuels, and hydrogen**. A parallel **slash in the use of liquid fossil fuels** across all scenarios leads to emissions reductions of 87%-99% for freight transport, and 83%-99% for passenger transport, also supported by an **increase in demand for lower-emissions modes of transportation** including biking, and rail use. Under 10% of final energy demand in all scenarios comes from the direct use of hydrogen.

The main drivers for decarbonisation of **industry** are increases in **material efficiency, material substitution, switching of technologies**, including the penetration of less mature technologies such as hydrogen-DRI in steelmaking, the use of alternative fuels including electricity, renewable hydrogen, and biomass, and the use of carbon capture at an assumed capture rate of 85%. The mix of technical options for decarbonisation of Romania's industry results in a **decrease of 51%-70% of emissions by 2050**, relative to the 2015 baseline. The **use of fossil gas is eliminated** almost completely, through a mix of **direct electrification** and deployment of **hydrogen** (between 7.26 and 12.45 TWh) and **biomethane** (between 1.33 and 3.12 TWh). **Carbon capture and storage** would also need to be deployed at scale to decarbonise Romania's industry, with 1.16 $MtCO_2$ already being captured in 2030 in the recommended scenario and 3 $MtCO_2$ in 2050.

The **agriculture, forestry, and other land use sector** is also a key contributor to reaching climate neutrality, especially as a source of negative emissions – **natural carbon sinks generate negative emissions ranging from 19.9 $MtCO_2$-eq to 26.2 $MtCO_2$-eq**. The use of chemical pesticides and fertilizers based on nitrogen, phosphorus, or potash would need to be **reduced by at least 20%.**

Providing credible emissions reduction pathways is only one component of a strong Long-Term Strategy. An ambitious vision, sectoral detail, and robust governance mechanisms should all underpin the national LTSs – but the extent to which they are included varies across Member States. Romania could create a truly impactful LTS, aligned with the realities of the current policy context, launching it as a regional leader in enabling climate mitigation.

To achieve this, the Romanian LTS should firstly be centred on a **clear commitment to net zero GHG emissions by 2050** and set itself the ambition of reaching it even earlier. It should not shift the burden of emissions reductions to later decades, but focus on **higher emissions reductions in earlier years**. Secondly, the LTS should provide **sectoral targets and mitigation pathways**, using scientifically robust scenarios for sectoral and economy-wide emissions reductions. These scenarios should account for the particularities of the Romanian context, for example in terms of technology availability and applicability and behaviour change potential. Thirdly, enabling measures such as **financing and R&D** should be properly addressed, and a detailed **evaluation of the socio-economic impact** of proposed measures should be provided.

Finally, and most importantly, the Romanian LTS will not stand on its own as a document. To ensure real impact, it must be **aligned with existing plans and capable of raising ambition**. This can be further enhanced by ensuring stakeholder buy-in, by **ensuring the participation of stakeholders** in the elaboration of the LTS. It should provide **robust governance mechanisms**, including **implementation, monitoring, and evaluation** responsibilities. These recommendations look beyond the content of the LTS itself and prime it to be a centrepiece of climate mitigation action in Romania.

Contents

Executive Summary 3

List of Figures 6

List of Tables 6

1 Introduction and background 7

2 Pathways to climate neutrality by 2050 in Romania 9

Implications for policies and measures at sectoral level 14

Electricity supply 14

Buildings 20

Transport 25

Industry 29

Agriculture, forestry, and other land use 33

3 A Long-Term Strategy fit for purpose 34

Vision 34

Long-term climate targets 34

Sectoral elements 35

Technologies 36

Horizontal elements 37

Relevance 38

Preparation 38

Follow-up 39

Integration 40

4 Conclusion and recommendations 41

List of Figures

Figure 1: Total GHG emissions by sector in the business-as-usual (BAU) scenario.................... 10
Figure 2: Total GHG emissions by sector in the EPG scenario... 10
Figure 3: Evolution of fossil fuel demand in the EPG scenario 13
Figure 4: Installed renewable capacities (GW)... 14
Figure 5: Most promising areas for offshore wind based on capacity factor (%) 16
Figure 6: Evolution of total coal power plant capacity based on Law 334/2022 17
Figure 7: Installed nuclear capacity (GW) 19
Figure 8: Evolution of emissions (MtCO$_2$-eq) and final energy demand (TWh) in buildings......... 21
Figure 9: Final energy demand in buildings by vector (%) 23
Figure 10: Share of solid biomass in final energy demand in buildings (%) 24
Figure 11: Share of fossil gas in final energy demand in buildings (%) 25
Figure 12: Evolution of emissions (MtCO2-eq) and final energy demand (TWh) in transport 26
Figure 13: Share of walking, bikes, buses, and rail in passenger demand (%) 29
Figure 14: Evolution of emissions (MtCO2-eq) and final energy demand (TWh) in industry........ 30
Figure 15: Share of final energy demand in industry by vector.. 31

List of Tables

Table 1: GHG emissions by sector (MtCO2 eq.).. 11
Table 2: Final energy demand by sector (TWh)... 12
Table 3: Storage technologies and their utilization, based on response time 20
Table 4: Share of final energy demand in transport by vector (%)... 27

1 Introduction and background

Decarbonisation will not be achieved merely through political commitments, it also requires rigorous evidence-based planning. Romania still needs to set a strategy for reaching climate neutrality in line with the European Union (EU) objective to reach net-zero greenhouse gas (GHG) emissions by 2050. The authorities have not yet published the long-term strategy (LTS), as required by Regulation (EU) 2018/1999 on the Governance of the EU and Climate Action (hereinafter referred to as the Governance Regulation). The deadline was by January 1st, 2020. There is still no clear deadline assumed for its completion by the competent authority, the Ministry of Environment. As a result, the European Commission has sent a letter of formal notice opening an infringement procedure for failure to submit the plan and was given until November 29th, 2022 to notify and share the plan with the Commission.[1]

While it failed to produce an LTS, Romania submitted to the Commission in April 2020 the country's National Energy and Climate Plan (NECP) 2021-2030.[2] By-and-large aligned with the previously updated draft of the national energy strategy, the NECP set the following targets for 2030:

- 30.7% renewable energy sources (RES) from total gross energy consumption;
- 40.4% increase of energy efficiency in terms of reduction of final energy consumption, as compared to the 2007 PRIMES projection for 2030;
- 43.9% reduction of the GHG emissions under the ETS system, and a 2% reduction for those under the Effort Sharing Regulation (ESR) – both compared to the 2005 emissions levels.

These targets were set in the context of a 40% objective for GHG emissions reduction, and 32% for RES by 2030 at EU level. Despite its natural potential, Romania's RES target in the NECP is only 30.7%. In its assessment report, the Commission urged Romania to raise the latter to 34%, in line with the formula in Annex II of the governance regulation. Moreover, the Commission also flagged up that, despite outlining the intention to reach this target for the electricity, heating, and transport sectors, the plan gave no clear quantification of how the proposed measures would contribute to achieving it. The target for primary energy consumption was also deemed of low ambition, while for final energy consumption very low. Most of the Commission's recommendations were only partially addressed in the subsequent version of the NECP submitted by the Romanian authorities.

Since the adoption of the NECP, the European Green Deal[3] and the Fit-for-55 package[4] brought forth a whole new level of ambition regarding the effort for GHG emissions reduction, hence the necessity for major readjustments of the trajectories for RES, energy efficiency across sectors, decarbonisation in transports, buildings, industry, and agriculture, establishing systems of circular economy, etc. REPowerEU, with the European efforts to wean off imports of Russian fossil gas, has further accelerated the pace of the transition. All these, alongside the synergies resulting from sector coupling and the alignment with the EU's ambitions on offshore wind, clean hydrogen, methane emissions reduction etc., will have to be incorporated in a revision of the NECP, with the final revised plan due by June 30, 2024, and a draft version by June 30, 2023. Moreover, the specific measures to be taken for reaching the new targets need to be more adequately explained

---

[1] European Commission, 2022. September Infringements package: key decisions, Brussels.
[2] European Commission, 2020. The 2021-2030 Integrated National Energy and Climate Plan.
[3] European Commission, 2022. European Green Deal, Brussels.
[4] European Commission, 2020. 2021 Commission work programme-from strategy to delivery, Brussels.

and quantified, in order to understand their impact and their ability to contribute to Romania’s decarbonisation. A rigorous modelling exercise is mandatory for such an endeavour, in contrast with the methodology used for elaborating Romania’s current NECP.

Romania needs to urgently address the current shortcomings in strategic planning for the decarbonisation of its economy: an overdue LTS and an unambitious NECP. This report focuses on the former, coming with concrete recommendations on what Romania’s long-term plan should include. The remainder of the report is split in two: (1) a presentation of three decarbonisation scenarios through which Romania could reach climate neutrality could be reached by 2050, and (2) some key elements that should be included in the document based on lessons learned from best-practice examples from other Member States.

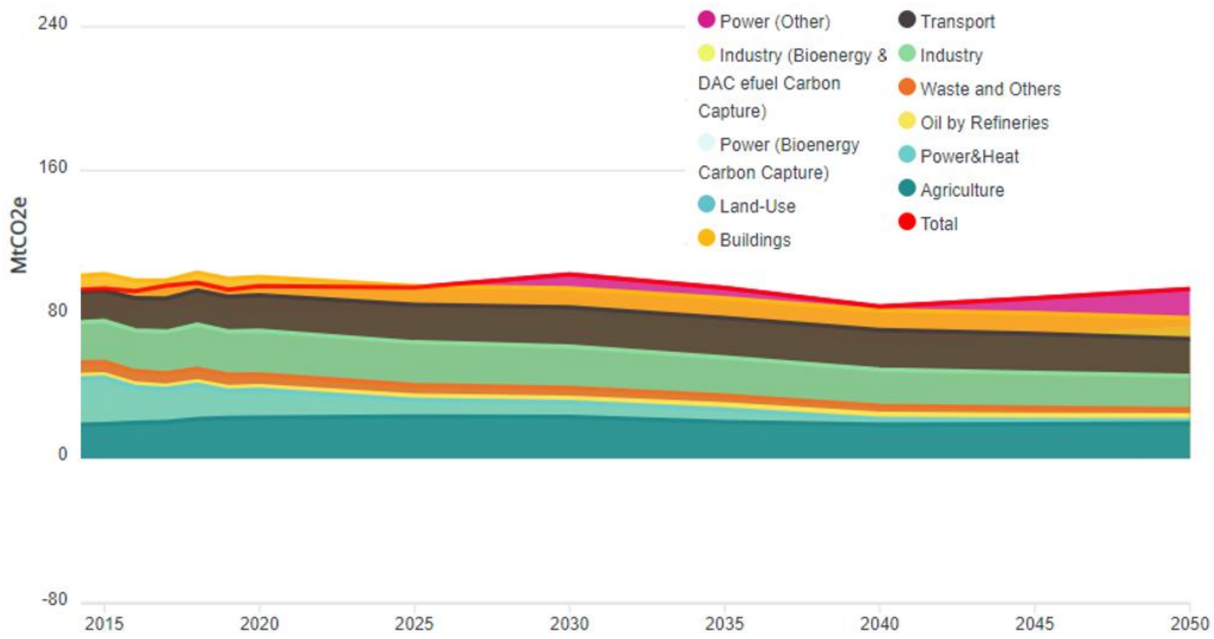
2 Pathways to climate neutrality by 2050 in Romania

The modelling for this report was done using the *2050 Pathways Explorer* developed by CLIMACT and calibrated and adapted for the Romanian case study by EPG. The Pathways Explorer is a full-fledged simulation model at the national level for all European countries. It is a fully comprehensive and dynamic model, covering all sectors of the economy emitting GHG emissions and all energy vectors, connecting the sectors dynamically between one another. The connection between sectors extends all the way to the use of products and materials. For example, it links the evolution of the fleet of cars to the materials required for their production. The choices and impacts related to diet, biomass use, and land allocation are also extensively covered. Individual and collective demand trends are adjusted through a set of indicators covering lifestyle (diet, caloric intake, personal mobility patterns, housing arrangements and waste), technological innovations (carbon capture and storage, hydrogen, storage, nuclear, electromobility), demographic developments, economic forecasts, commodity prices, as well as sector-specific levers for industry, transport, buildings, energy supply and AFOLU. The level of ambition is adjusted for each of these levers according to scenario-specific assumptions.

EPG has developed three distinct economy-wide decarbonisation scenarios. To ensure consistency with the Paris Agreement 1.5°C objective and the EU's long-term decarbonisation goals, all scenarios achieve net-zero GHG emissions before 2050, resulting in negative emissions in 2050. The assumptions underpinning the three scenarios are:

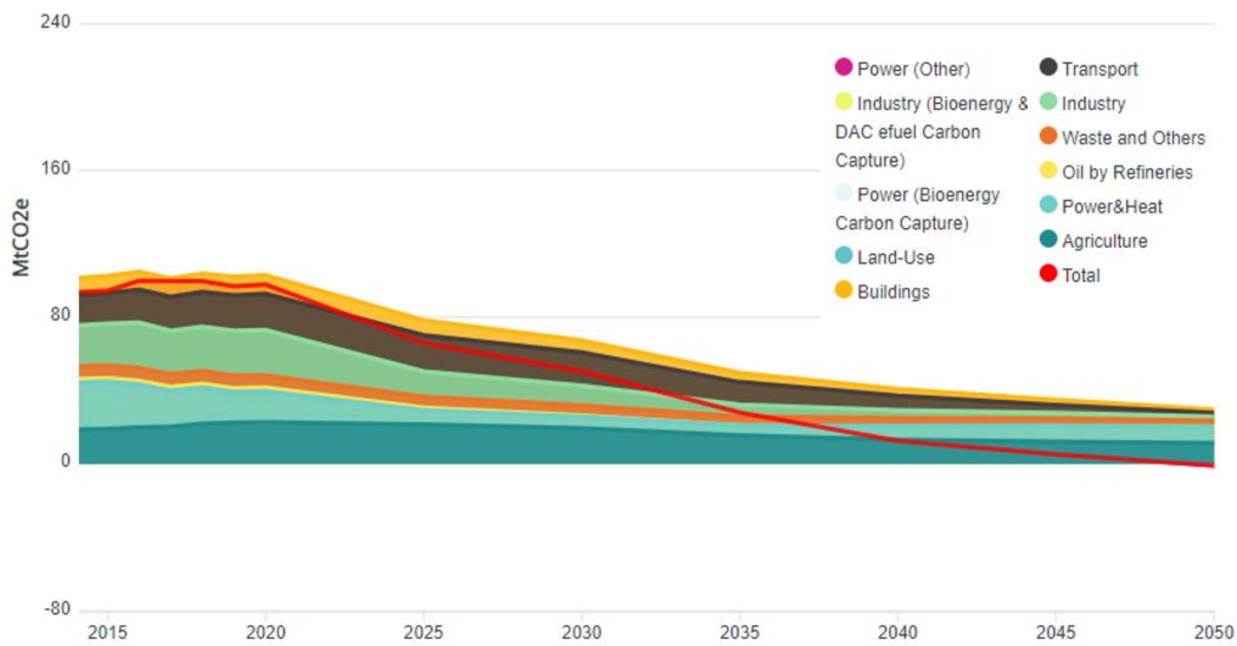
- ***Tech scenario*** assumes rapid development of cutting-edge technology together with rapid cost reductions, as well as higher, yet not fully ambitious levels of political will and support for decarbonisation from the general population. Carbon capture for industry emissions is the highest of all scenarios in 2050, and energy demand in the transport sector is met by electricity, hydrogen, and biofuels.
- ***Life scenario*** assumes full involvement of political leaders and general population in reaching net zero, together with transformative changes in lifestyle choices and individual behaviour, relying less on spectacular technological advancement and technology cost-reduction and more on the implementation of the energy sufficiency concept. Under these conditions, final energy demand in 2050 is the lowest of all scenarios, standing at 87 TWh – only a third of baseline levels.
- ***EPG scenario*** is a more balanced approach relying on a combination of more moderate transformation when it comes to technological development and behavioural changes among the general population. It entails the highest final energy demand of all scenarios (166 TWh in 2050, compared to 149 TWh in the Tech scenario and 87 TWh in the Life scenario).

Figure 1: Total GHG emissions by sector in the business-as-usual (BAU) scenario[5]



Source: Climact, 2050 Pathways Explorer, EPG calculations

Figure 2: Total GHG emissions by sector in the EPG scenario



Source: Climact, 2050 Pathways Explorer, EPG calculations

[5] The "BAU" scenario refers to a scenario where no additional measures are deployed, and the status quo relative to the baseline year is maintained.

A major differentiator between the three scenarios is the depth and breadth of assumed lifestyle changes (which may be indicative of buy-in and related feasibility of the scenario). The ***Life*** scenario assumes fundamental lifestyle changes, for example a 35% reduction of calorie consumption (held constant in the other scenarios) and a drastic decrease in meat consumption. As a result, emissions from agriculture are slashed by 85%. All scenarios also assume a significant population decline, in line with Eurostat projections for 2050 – by mid-century, the estimated Romanian population in 2050 will be 15.9 million.

Table 1: GHG emissions by sector (MtCO2 eq.)

		EPG	**BAU**	**EPG**	**Tech**	**Life**
	2015	2030	2050	2050	2050	2050
Agriculture	19.05	18.87	13.34	10.62	10.91	2.86
Buildings	9.4	6.51	6.91	1.88	1.15	0.29
Energy supply	41.36	10.99	29.89	5.08	-0.78	1.06
Industry	22.84	10.91	22.49	2.66	-2.13	1.33
Transport	15.72	17.07	20.41	1.79	0.02	0.52
Waste and Others	6.93	5.45	6.93	3.47	3.47	3.47
Land use	-21.93	-17.86	-21.93	-26.19	-19.6	-19.6
TOTAL	**93.37**	**51.94**	**78.63**	**-0.69**	**-7.04**	**-10.08**

Source: Climact, 2050 Pathways Explorer, EPG calculations[6]

As shown in the Table above, across all scenarios deep decreases in GHG emissions must occur in the energy and industry sectors – 36-42 Mt CO_2-eq in the energy sector (88%-101%) and 20-24 Mt CO_2-eq in the industry sector (88%-109%), relative to 2015 baseline values. This will require a substantial transformation of Romania's energy and industrial production, and in some cases the deployment of costly new investments in technologies such as bioenergy with carbon capture and storage (BECCS) to achieve negative emissions (particularly in the Tech scenario).[7]

When it comes to energy demand, it would have to be reduced by 30% in buildings and transport in the ***EPG*** scenario through a combination of deep renovation and changes in individual mobility patterns. The ***Life*** scenario achieves the lowest level of final energy demand through stringent

[6] The tables presented in this document compare 2015 figures (the last year for which the model uses input data) with the 2030 and 2050 values that can deliver net-zero GHG emissions under the EPG scenario. Values for 2050 are given for Tech and Life to provide a comparative perspective to the recommended EPG scenario.
[7] The limited availability of sustainable biomass needs to be taken into account when trying to understand its role in achieving climate neutrality. For more details see Cătuți, M., Elkerbout, M., Alessi, M., Egenhofer, C., 2020. Biomass and climate neutrality, Center for European Policy Studies, Brussels.

assumptions regarding reductions in consumption levels and increased circularity. The industrial sector would see its final energy demand reduced by at least 50% in all scenarios.

Table 2: Final energy demand by sector (TWh)

		EPG	**EPG**	**Tech**	**Life**
	2015	2030	2050	2050	2050
Buildings	107.95	103.32	74.05	69.23	44.2
Transport	64.27	72.89	45.4	39.56	15.85
Industry	88.58	57.39	41.97	32.89	25.40
Agriculture	5.02	5.01	4.28	4.81	1.74
Energy use for energy production[8]	0	7.2	133.54	45.67	49.29
Exports	41.2	26.6	5.59	42.05	58.41
TOTAL	**307.02**	**272.41**	**304.83**	**234.21**	**194.89**

Source: Climact, 2050 Pathways Explorer, EPG calculations

The energy sector will need to move rapidly towards the use of renewable sources (enough to meet between 70% and 100% of energy consumption from buildings, transport, and industry). The energy sector will also need to meet increased demand from hydrogen and e-fuels production deployed to meet net zero, which may require the rapid scaling of dedicated utility-scale solar PV and wind energy resources. In all scenarios, natural and technical CO_2 removals also play an important role in achieving net zero emissions by 2050. Romania's natural carbon sink contributes up to 90% to total envisaged removals, while carbon capture technologies play varying roles across scenarios. All scenarios will require some deployment of carbon capture, which is assumed to be permanently stored aside from CO_2 utilization to produce e-fuels in some scenarios.[9]

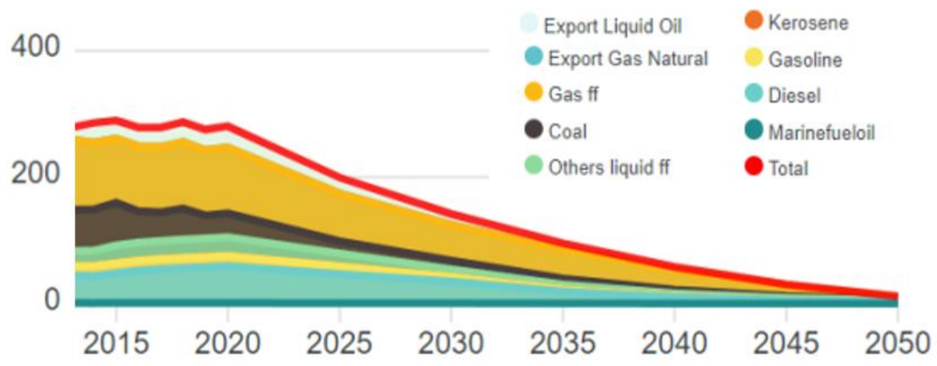
All fossil fuels are phased out near completely across scenarios. Coal is phased out in the power sector by 2030, while demand for fossil oil and liquid oil products decreases by between 88% in the ***EPG*** scenario and 97% in the ***Tech*** scenario. Meanwhile, fossil gas consumption would decrease by 90%.[10] Industrial consumption of gas would be reduced to no more than 5.9 TWh, with another 5.6 TWh consumed in the buildings sector and only 0.15 TWh in the transport sector

[8] Refers to energy used in the production of hydrogen and e-fuels.
[9] Carbon direct removal (CDR) is the process of permanently removing CO2 from the atmosphere and storing it to produce a net CO2 reduction. Importantly, not all CCS constitutes CDR as the source of the captured carbon needs to be the atmosphere rather than the combustion of fossil fuels that previously stored carbon underground. BECCS is a form of both CCS and CDR comprising capturing carbon from biomass that absorbed CO2 from the atmosphere during its lifetime. Estimating lifecycle emissions of bioenergy remains a contested topic and sustainable biomass availability is limited. If not managed properly, excessive demand for biomass could have negative impacts on natural carbon sinks, biodiversity, and air quality. See E3G (2022).
[10] Cătuți, M., Miu, L., Dudău, R., et. al., 2022. Opțiunile României pentru eliminarea dependenței de importuri de gaze naturale din Federația Rusă, Energy Policy Group, Bucharest.

according to the ***EPG*** scenario. In the more ambitious scenarios, no more than 2.5 TWh of fossil gas is consumed in 2050.

The role of fossil gas in the Romanian economy is the subject of much debate, with political sentiment tending towards the exploitation of newly discovered natural gas reserves – particularly in the wake of the revised Offshore Law, which promises to ease stagnant investments in offshore gas exploration. Any exploitation of new reserves must consider the trajectories for fossil gas use decline by 2050. Similarly, infrastructure planning needs to take into account declining consumption. An appetite for fossil gas, evinced most recently through the Romanian RRP and in response to uncertainty regarding Russian natural gas, creates a narrative around homegrown fossil gas as a hallmark of energy security and affordable heating, particularly for homes currently not connected to the gas grid. Increased gas demand has been touted as a solution to all sectors of the economy, with political declarations having been made even about increasing gas consumption in coming years. However, the scenarios presented in this report depict a different reality.

Figure 3: Evolution of fossil fuel demand in the EPG scenario



Source: Climact, 2050 Pathways Explorer, EPG calculations

To achieve climate neutrality, behavioural changes will also be crucial – they are the cornerstone of the Life scenario, which achieves the lowest net negative emissions despite projecting. Lifestyle changes also underpin the emissions reductions in the buildings and transport sectors, which slash their emissions by 7.5-9 Mt CO_2-eq (80%-96%) and 14-15.7 Mt CO_2-eq (88%-99%), respectively. Even scenarios with more relaxed assumptions on the depth of behavioural change will require heightened awareness and a mobilisation of personal investments in energy efficiency measures, electric vehicles and other low-emissions products and services.

It is evident from the presented pathways for emissions reductions that reaching climate neutrality by mid-century is possible but will require significant changes from the current policy mix. The reference scenario, which assumes no changes to the policy mix, sees only a 16% decrease in emissions from the 2015 baseline, for which the most important driver is the projected population decline (approx. 20%, based on Eurostat projections). The deployment of low-carbon technologies and instigation of ample behavioural change across Romania's population will require credible measures and policies supported by robust financing frameworks and a clear division of responsibilities for implementation, monitoring and evaluation.

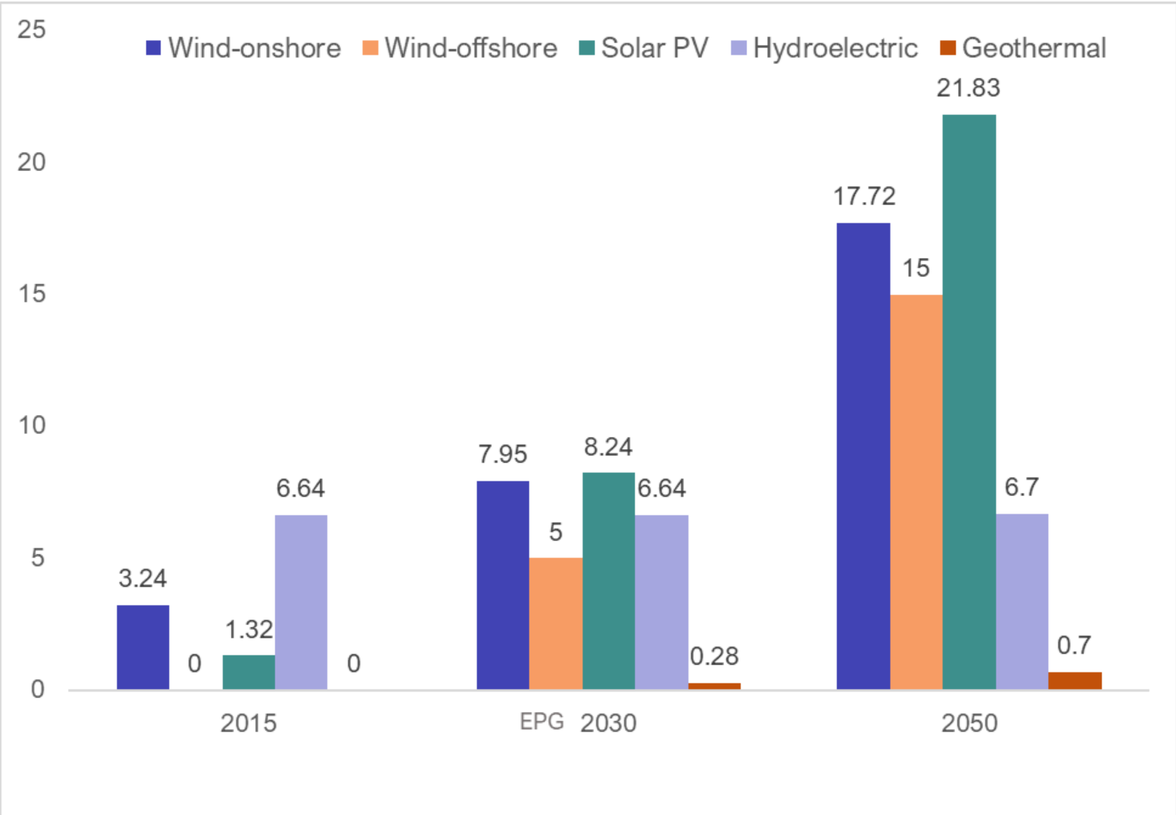
Implications for policies and measures at sectoral level

The scenarios presented above each envisage deep emissions reductions across all sectors of the Romanian economy. As Long-Term Strategies are economy-wide and should clearly address the contributions of each sector to achieving net zero, they should provide a portfolio of measures and policies for each sector, aligned under the common goal of climate neutrality. The following section presents the implications of the scenarios discussed above for decarbonisation policies and measures in each sector of the Romanian economy, including a brief review of current policies and their contribution to emissions reduction, as recommended by the Governance Regulation for inclusion in national LTSs.

Electricity supply

The decarbonisation of Romania's electricity supply will be mainly driven by a massive increase in solar PV and wind energy capacity, which will also support a significant increase in electricity demand due to electrification across sectors. According to the modelled scenarios, Romania would have in 2050 more than 17 GW of installed onshore wind, 15 GW of offshore wind, and 21 GW of solar PV. Additional nuclear capacity is projected both in the EPG and Tech scenarios, with an increase of 50%. Hydropower will remain constant, and some amounts of geothermal energy are projected to be developed (0.7 GW in ***EPG*** and ***Life*** Scenarios, compared to 2.1 GW in the ***Tech*** scenario). Romania has significant untapped geothermal potential suitable both for electricity and heat production.

Figure 4: Installed renewable capacities (GW)



Source: Climact, 2050 Pathways Explorer, EPG calculations

The modelled scenarios foresee a relatively constant year-on-year increase in renewable energy capacity – however, the years to 2030 will be crucial, particularly for renewable energy technologies, for which political and administrative barriers still exist (e.g., large-scale solar PV – see below), or have not yet been deployed (e.g., offshore wind[11]). The foremost implication of transforming Romania's energy mix is thus the need for a strong enabling policy and investment environment for renewable energy deployment. This is twofold: building off the success in addressing certain legal and administrative barriers to renewable energy deployment (Romania having some of the shortest permitting periods in the EU) and tackling the remaining barriers that are holding back renewable energy projects, including the lack of coherent governance, the slow pace of grid modernisation and the lack of attention paid to workforce development and building out the manufacturing value chain.[12]

The impact of Romania's long-standing key barriers to renewable energy deployment, such as limited administrative capacity, lack of transparency from authorities and highly fragmented administrative procedures, has recently been partially alleviated by several important policy changes. The most notable of these was lifting the ban on power purchasing agreements (PPAs), as well as the quantitative compensation for rooftop solar PV prosumers.[13] In combination with a first call for 900 MW of renewable energy capacity under the Modernisation Fund and green investments put forward in the National Recovery and Resilience Plan (RRP), these changes have given more clarity and visibility to investors and generally a more positive environment for developing renewable energy in Romania.

However, the remaining and newly emerged barriers must be addressed if Romania is to reach the required renewable energy capacity for achieving climate neutrality. For example, an important legislative barrier to the development of large-scale renewable projects can hamper progress towards the installed capacity needed to achieve climate neutrality, according to the modelled scenarios. This barrier originates in the interpretation of a legislative change to the Land Use Law by the authority responsible for issuing permits for larger renewable energy projects, and effectively entails that solar PV projects larger than 42 MW cannot be developed in Romania. Other legislative barriers have emerged in the wake of Romania's handling of the energy price crisis, which culminated in November 2022 with the effective re-establishment of a regulated energy market until 2025.[14] The uncertainty and investment aversion caused by legislative changes is certainly not unique to Romania, but is underpinned by a long-standing lack of coherent and ambitious governance of the energy sector, which has led to the heightened EU-level ambitions for renewables deployment not filtering down to key strategic plans, such as the TSO's Ten-Year Network Development Plan. Grid expansion, similarly, represents an in important barrier that needs to be urgently addressed to support the large-scale renewable deployment that is needed.

Importantly, all scenarios see some 15 GW of offshore wind capacities developed in the Black Sea by 2050, with 5 GW already installed by 2030. In all scenarios, offshore wind becomes the largest

---

[11] Romania has no legally binding Maritime Spatial Plan and has not yet submitted one to the European Commission. This is an essential piece of legislation for enabling offshore wind power capacity. European Commission, 2022. MSP in the EU – Romania.

[12] Bălan, M., Chiriță, A., 2022. What's holding back large-scale renewable deployment in Romania? Energy Policy Group, Bucharest.

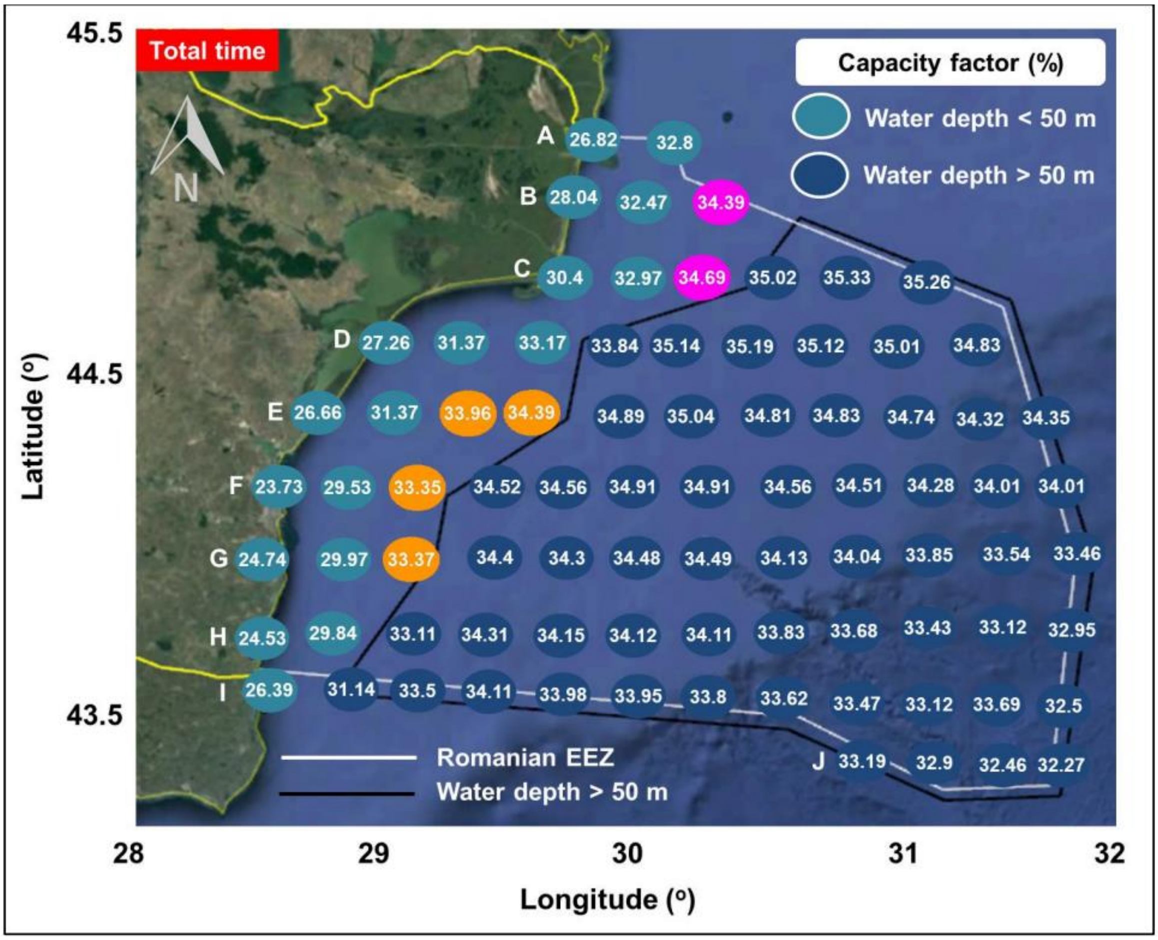
[13] However, there still seem to be some hurdles in the secondary legislation that renders full quantitative compensation difficult, as pointed out in a recent petition by AMPEER, the Romanian Association of Small Power Producers -- https://www.petitieonline.com/energie_regenerabil_-_problemele_prosumatorilor

[14]Although current and future renewable energy generators are exempted from the centralized purchasing mechanism, this is the latest in a series of major changes, passed with little or no public consultation, creating further uncertainty and aversion to investing in new renewable capacities in Romania.

source of electricity production by 2050. Given the scale of renewable uptake that Romania needs to accomplish, tapping into the offshore wind potential is of utmost importance. A previous study by EPG has indicated that the natural and technical potential of Romania's offshore wind sector is of an estimated total potential natural capacity of 94 GW, out of which 22 GW could be installed as fixed turbines, leading to a total Annual Energy Production (AEP) of 239 TWh, with 54.4 TWh from fixed turbines.[15] The EPG study identified two potential clusters with most favourable conditions for a first stage of offshore wind development, based on fixed turbines, as it can be seen in the figure bellow.

Once again, to develop its wind potential in the Black Sea, Romania needs to address several key issues, the most significant being overcoming grid challenges. Any new offshore wind farm developed in Romanian waters will have to be connected to the grid in Dobrogea, where a large part of the country's power generation assets are already located, and additional renewables are planned to be developed, alongside two new nuclear units at Cernavodă, to the effect of almost doubling the installed capacity in an area with quite limited local energy demand.

Figure 5: Most promising areas for offshore wind based on capacity factor (%)

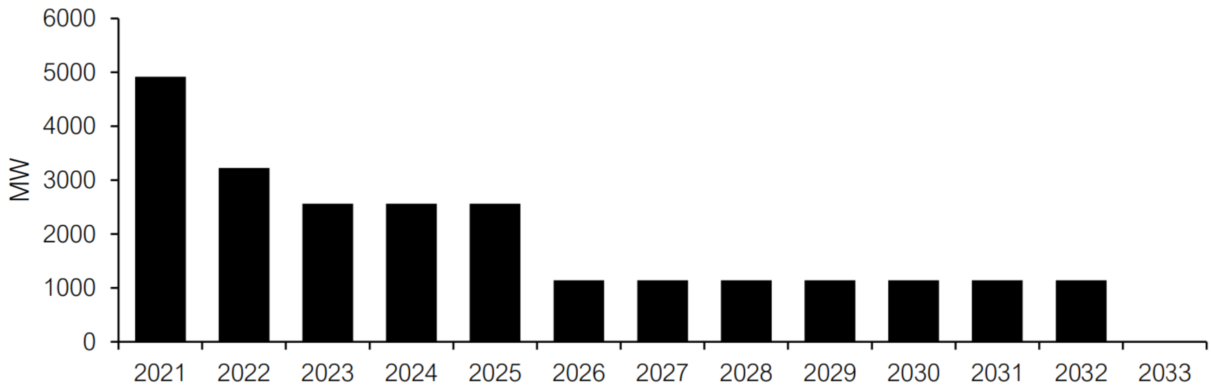


Source: Bălan et al. (2020)

[15] Bălan, M., Dudău, R., Cătuți, M. et al., 2020. Romania's Offshore Wind Energy Resources: Natural potential, regulatory framework, and development prospects, Energy Policy Group, Bucharest.

Beyond the investment and governance aspects of deploying renewables at pace and scale in Romania, long-term planning will also need to incorporate the phase-out of fossil fuels and the associated transformation of local economies and employment looming on the horizon. Romania has committed to phasing out its coal-fired power production by the end 2032, by passing Law 334/2022, and issued a timetable for closure of coal power plants and mines. However, in all scenarios modelled for this report, coal must be completely phased out by 2030.

Figure 6: Evolution of total coal power plant capacity based on Law 334/2022



Source: Niculicea et al. (2022)

Previous research by EPG and partners[16] has emphasized that a faster phaseout in Romania by 2027 could simultaneously lower the need for granting additional state aid for maintaining unprofitable power plants operational (including compensation for the ETS allowances), while also avoiding sudden spikes in wholesale electricity prices. The modelling results showed that, after 2026, no lignite power plant in Romania will be economically viable, while a 2025 phaseout date would result in sudden increases in electricity prices. EU-level modelling conducted by Agora Energiewende and enervis[17] has similarly shown that an accelerated coal phaseout calendar could ensure an exit from coal before 2030 in all member states. However, these analyses were conducted before this year's spike in wholesale electricity prices, which has enabled Romanian coal companies to make significant windfall profits. Therefore, the economic situation of coal power plants has drastically improved in 2022, as fossil gas-based power generation has become the costlier alternative in the merit order. To reflect the current market conditions, dedicated modelling for Romania should explore if a faster coal phase-out deadline, such as that of 2030 is still feasible.[18]

This phase-out is a complex process with significant social impact, which can be proactively mitigated by cushioning financial impact in the short term, and by enabling structural change and economic diversification at the regional level, particularly in Romania's Just Transition regions, in the long-term.[19] These deep long-term changes can be encouraged by expanding renewable

[16] Dudău, R., Cătuți, M., Covatariu, A., et al., 2020. Accelerated lignite exit in Bulgaria, Romania and Greece.
[17] Agora Energiewende and enervis 2022 Agora Energiewende and enervis, 2021. Phasing out coal in the EU's power system by 2030. A policy action plan, s.l.: Agora Energiewende
[18] Niculicea, A.M., Chiriță, A., Cătuți, M., 2022. Phasing out coal in Romania: An assessment of the governance framework, Energy Policy Group, Bucharest.
[19] Cătuți, M., Bălan, M., Postoiu, C., et al., 2021. The sustainable transition of Gorj County. Greenpeace, Bucharest.

energy and investing in transport, digitalisation and local research, development, and innovation – solutions meant to be encapsulated in the Operational and Territorial Just Transition Plans (JTP) of Member States. Measures addressing reskilling and economic revitalisation of Just Transition areas are addressed in Romania's submitted Just Transition Plans,[20] and more broadly in the NRRP which places significant emphasis on developing and strengthening SME environment, a key component of Romania's economy responsible for over half of national added value and 65% of jobs.[21] Particular attention should be given to leveraging state aid to attract segments of the value chains of renewable technologies, electrolysers, electric vehicles, and batteries.

In the context of the coal phase-out, it is important to highlight the associated risks with the overwhelming reliance in the decarbonisation plans of all these companies on investing in fossil gas power plants as a transition solution for replacing coal capacities.[22] While it is true that phasing out coal power plants will be difficult without some level of switching to new gas-fired capacities, the risk of overinvestment seems to be significant. CCGTs could smooth out the replacement of more polluting capacities, but in the context of decarbonisation by mid-century many of these investments would likely not be able to stay operational for their entire lifetime and definitely not at high-capacity factors. With the potential development of the Black Sea offshore wind resources, as well as other RES, the need for baseload power production will gradually decrease. In fact, other modelling results show that the load factor of new CCGT units in Romania will experience a quick drop in load factor, averaging values of under 40% by 2030.[23]

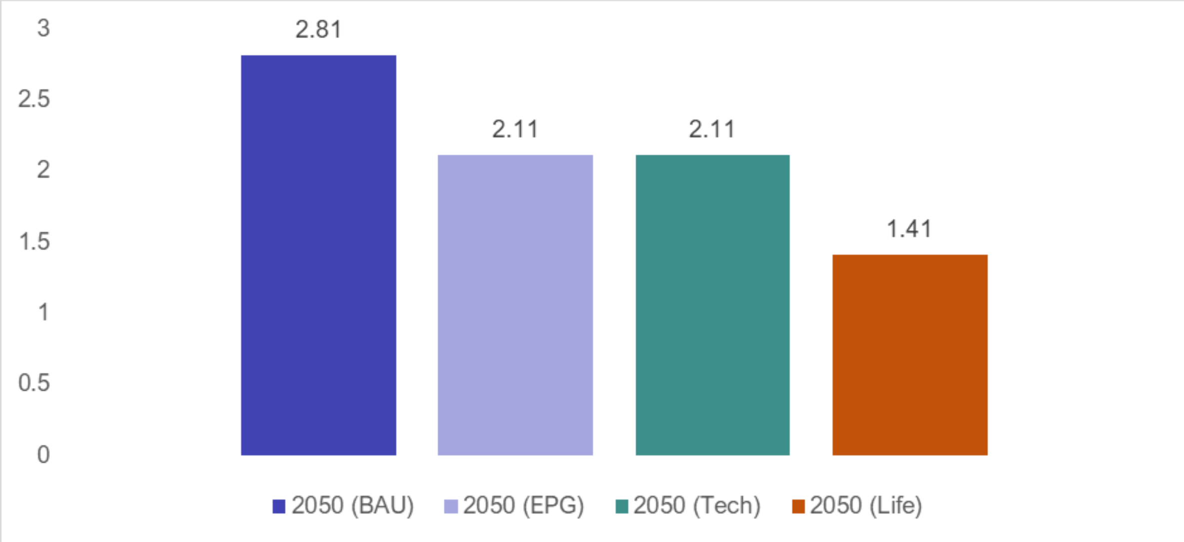
As the power sector will approach climate neutrality, gas-fired power plants will rather be needed as peaker capacities. Moreover, the development of alternative means of storage, such as batteries or pumped hydro, as well as an increased level of interconnection, could also reduce the need for peaker power plants. Therefore, the likely capacity factor at which new CCGTs will operate throughout the coming years needs to be factored in the investment decision. It should also be mentioned that despite a lower emissions intensity compared to coal, the combustion of fossil gas still generates CO_2 emissions, on top of the methane leakage present throughout the supply chain. Investments in gas capacities should be sized according to the needs of a future electricity mix dominated by renewable energy and considering the imperative of avoiding the creation of stranded assets and crowding out investments in cleaner energy sources. The high gas prices and depleting gas reserves of Romania should also be considered when betting on gas as a transition fuel.

While nuclear capacities are maintained or increased in all scenarios, nuclear-based electricity production is only foreseen in the ***EPG*** scenario in 2050. In the other scenarios, because of the overall lower energy demand, this would be met exclusively from cheaper non-nuclear electricity production sources. In other words, in 2050 both ***Life*** and ***Tech*** scenarios have installed nuclear capacities, but their usage rate is zero. Romania's current plans are to install two additional units of conventional nuclear power at the Cernavodă power station, as well as invest in Small Modular Reactors (SMRs). Such investments need to be based on rigorous cost estimations.

---

[20] Ministry of Investments and European Projects, 2022. Just Transition Programme.
[21] Frankfurt School of Finance and Management, 2021. Report on the Transition Process Towards Climate Neutrality for Romania (Final).
[22] Niculicea, A.M., Chiriță, A., Cătuți, M., 2022. Phasing out coal in Romania: An assessment of the governance framework, Energy Policy Group, Bucharest.
[23] Poseidon, K., 2020. EU Climate Goals Accelerate Eastern European Decarbonisation, BloombergNEF.

Figure 7: Installed nuclear capacity (GW)



Source: Climact, 2050 Pathways Explorer, EPG calculations

Last but not least, the further uptake and integration of wind and solar energy requires flexibility of the rest of the system, which includes fast-responding generation sources on the supply side, storage and demand response. A more decentralised power system dominated by renewables also relies on smarter and more flexible energy infrastructure. While the modelling done for this report does not go into details on specific technologies, around 33.8 TWh of flexibility would be needed by 2050 in the ***EPG*** scenario. Based on response time and capacity, there are multiple storage technologies that can be considered for ensuring the flexibility needs of a renewable-dominated power system, as it can be seen in the table bellow.

Therefore, given the need for a significant uptake of renewable energy sources in the electricity mix over the following decades, Romania must also develop a deployment strategy for the energy storage technologies.[24] Taking into consideration both the current poor adequacy level of the Romanian power grids and the need to scale up renewable power generation in the years to come, the energy sector needs to find technical and investment opportunities for storage technologies and services. To this end, a proper regulatory framework – which will not only create the legislative environment for different storage technologies deployment, but will also set up a proper remuneration system for investors – needs to be urgently identified and put into force.

[24] Covatariu, A., Bălan, M., Cătuți, M., et al., 2020. Romania's Energy Storage: Demand and Potential, Energy Policy Group, Bucharest.

Table 3: Storage technologies and their utilization, based on response time

	Instant response (adequacy response)			**Reserve (flexibility response)**		
	Seconds	Minutes	Hours	Days	Weeks	Seasons
Utility scale batteries	Suitable/indicated	Suitable/indicated	Suitable/indicated	Less suitable/indicated	Not suitable/indicated	Not suitable/indicated
Pumped Hydro	Not suitable/indicated	Suitable/indicated	Suitable/indicated	Not suitable/indicated	Not suitable/indicated	Not suitable/indicated
Big hydro (capacity reservoirs)	Less suitable/indicated	Suitable/indicated	Suitable/indicated	Suitable/indicated	Suitable/indicated	Suitable/indicated
Hydrogen	Less suitable/indicated	Less suitable/indicated	Less suitable/indicated	Suitable/indicated	Suitable/indicated	Suitable/indicated
Electric thermal energy storage (ETES)	Not suitable/indicated	Less suitable/indicated	Suitable/indicated	Suitable/indicated	Not suitable/indicated	Not suitable/indicated
Small-scale battery storage	Less suitable/indicated	Suitable/indicated	Suitable/indicated	Not suitable/indicated	Not suitable/indicated	Not suitable/indicated
Vehicle-to-grid	Suitable/indicated	Suitable/indicated	Less suitable/indicated	Not suitable/indicated	Not suitable/indicated	Not suitable/indicated

Suitable/indicated **Less suitable/indicated** **Not suitable/indicated**

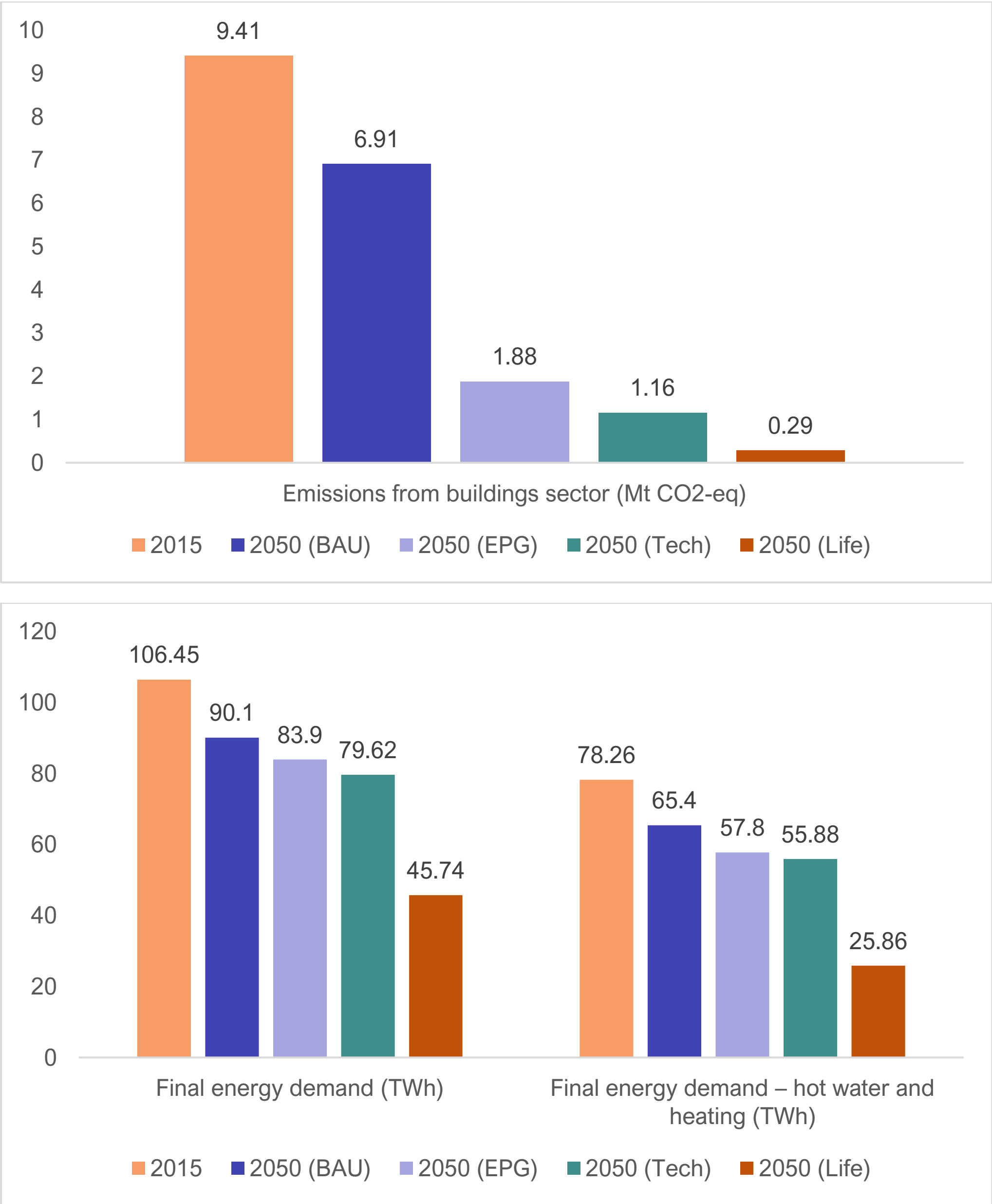
Source: Covatariu et al. (2020)

Overall, the required massive increase in renewable energy, coupled with a drastic phase-out or phase-down of fossil fuels, require a reform Romania's legislative environment, improved governance, and capitalised economic opportunities to ensure a successful Just Transition, going beyond short-term compensation and improving economic competitiveness. These have implications for energy policy, but also the industrial (e.g., the creation of new manufacturing value chains to enable renewable energy) and the labour policy (e.g., the retraining and reskilling effort needed in Just Transition regions). The changes and reforms in these policy areas must be enacted quickly, and all legislative barriers to developing renewable energy must be removed in the next several years, to enable high-impact large-scale renewable energy projects such as offshore wind and solar PV.

Buildings

By 2050, the modelled scenarios envisage a significant reduction in energy demand and related emissions from Romania's buildings: 31%-60% and 80%-90%, respectively. This points to two main categories of levers for decarbonising Romania's buildings sector – energy efficiency and behavioural changes to reduce energy consumption on the one hand, and the progressive replacement of fossil fuels for heating and cooling with renewable sources, such as heat pumps, on the other hand. Both categories will have significant implications for the policy mix and investments in buildings and their governing strategies, including the National Energy and Climate Plan (NECP) and Long-Term Renovation Strategy (LTRS).

Figure 8: Evolution of emissions ($MtCO_2$-eq) and final energy demand (TWh) in buildings



Source: Climact, 2050 Pathways Explorer, EPG calculations

Importantly, when it comes to housing, Romania has the highest overcrowding rate in EU (45.8% in 2019). Therefore, all scenarios take into account an increase in the per capita living space by 2050. The highest is in the EPG scenario, of 40%, as living space reaches 32m^2/capita. The EPG scenario also assumes that 60% of residential buildings are equipped with cooling systems in 2050.

Nonetheless, as in most temperate-climate countries, the largest share of energy demand and related emissions from Romanian buildings is for heating and hot water consumption, a trend maintained to 2050. However, in all modelled scenarios the absolute energy demand from heating and hot water is projected to decrease drastically (25%-67%), alongside associated emissions that drop by 77%-96% compared to 2015 levels. Emissions from cooking, representing approx. 8% in the baseline year, are projected to decrease to negligible shares by 2050 in all scenarios (even zero in the Life scenario). The share of renewable energy in the final energy demand of the buildings sector is estimated to rise to 85%-96% by 2050, compared to 50% in 2015.

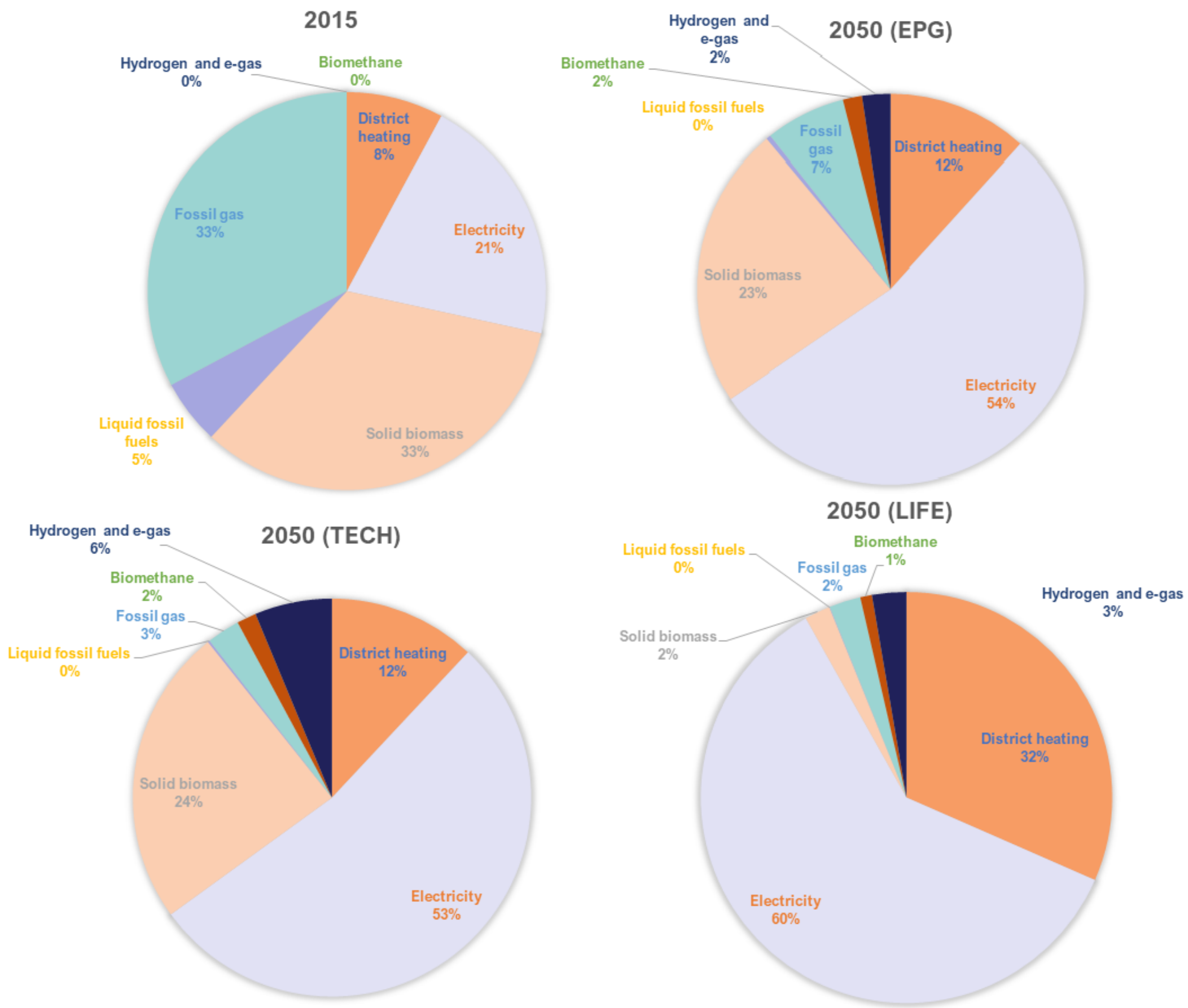
The decrease in energy demand has significant implications for the policy environment underpinning building renovation in Romania, which is not on track to achieve required emissions reductions. The ***Life*** scenario, which shows the most significant reductions in the buildings sector, assumes, *inter alia*, a renovation rate double that from other scenarios (3%, compared to 1.5% in the other scenarios), as well as increased depth of renovation (80% of buildings are assumed to undergo deep renovation, compared to 27% in the other scenarios). For comparison, current rates of renovation in Romania are only 0.5%, and only 6% of all buildings' floorspace had been renovated by 2020.[25] Current renovation rates are much lower than the requirements set by forthcoming EU legislation, including the Energy Efficiency Directive and the Energy Performance of Buildings Directive, and the targets set in Romania's NECP fall short of the expected contribution to the collective achievement of the EU's objectives for energy efficiency, even in the short-term. Thus, in the long-term Romania's building-related policies and investments will face increasing pressure to speed up building renovations, underpinned by higher policy ambitions – and the administrative burden of legislating these ambitions should not be discounted, particularly given that Romania is still transposing the current obligations of the Energy Efficiency Directive into national law.

The second important lever for decarbonisation of the buildings sector is **fuel switching for heating and cooling**. The required drastic change in the balance of fossil fuels and renewable energy for heating and hot water provision (as well as emerging cooling needs) has implications both for individual heating sources and for centralised (district) heating systems. The main vector for decarbonisation is electrification, through which individual fossil gas boilers are replaced with heat pumps. In some scenarios, particularly ***Life***, decarbonisation is also driven by removing individual heating solutions and replacing them with connections to low-emissions district heat networks, and in other scenarios by some use of e-fuels, biogas, and hydrogen.

The deployment of heat pumps increases by almost 5000% in the ***EPG*** and ***Tech*** scenarios. Romania does not currently have any requirements for the replacement of individual gas boilers, nor an official information campaign for popularising heat pumps or other renewable heating solutions. The deployment of heat pumps will require a massive mobilisation of investments as well as a sustained increase in available renewable energy capacity to provide zero-emissions electricity (see **Electricity supply** section). Meanwhile, hydrogen and e-gases only account for only 2.3% of the energy demand in the entire energy sector in 2050. Direct electrification of heating using heat pumps is far more efficient, which explains the low penetration of hydrogen as a decarbonisation solution for the buildings sector.

[25] Ministry of Public Works, Development and Administration, 2020. National Long-Term Renovation Strategy, Bucharest.

Figure 9: Final energy demand in buildings by vector (%)



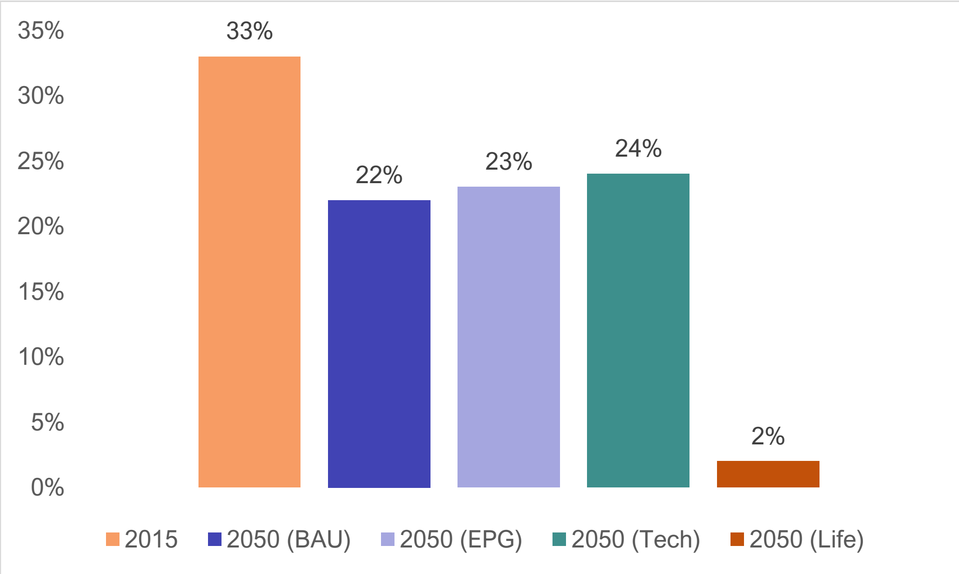
Source: Climact, 2050 Pathways Explorer, EPG calculations

Meanwhile, enabling new connections to low-emissions district heating (DH) networks (as projected in the ***Life*** scenario) is dependent on significant modernisation and upgrading of existing heating grids. Currently, these contribute ca. 23% to the total heat demand of the residential sector and are potentially important components of reducing residential sector emissions, given their superior efficiency and ability to incorporate renewable energy sources. However, they are generally legacy systems, mostly using fossil gas, and in dire need of repair and upgrading to reduce the currently significant thermal losses in many municipalities, including Bucharest. A national programme for financing investments in the modernisation, refurbishment and expansion of DH systems is currently being implemented over the 2019-2027 period by the Ministry of Development, Public Works and Administration,[26] and in October 2022 the Ministry of Energy launched a state aid scheme for modernising and repairing district heat networks, using funding through the Modernisation Fund. However, little or no provision is made for the enabling of fuel switching from fossil gas to renewable energy sources in existing district heat networks.[27]

[26] Author, 2020. National Energy and Climate Plan 2021-2030.
[27] Ministry of Energy, 2022. State aid scheme to support the modernisation/rehabilitation of the smart district heating network from the Modernisation Fund, Bucharest.

While individual gas boilers and connections to district heat networks are mostly restricted to urban areas, long-term decarbonisation of the buildings sector will also incorporate rural households, the majority of which use wood-burning stoves (i.e., traditional biomass) for heating and hot water provision (70% of single-family homes) and cooking (42% of single-family homes). In the ***EPG*** and ***Tech*** scenarios, the use of firewood (solid biomass) for these purposes is expected to continue in 2050, albeit at half the rate of the baseline year in absolute terms (approx. 19 TWh/year, compared to 35.5 TWh/year).

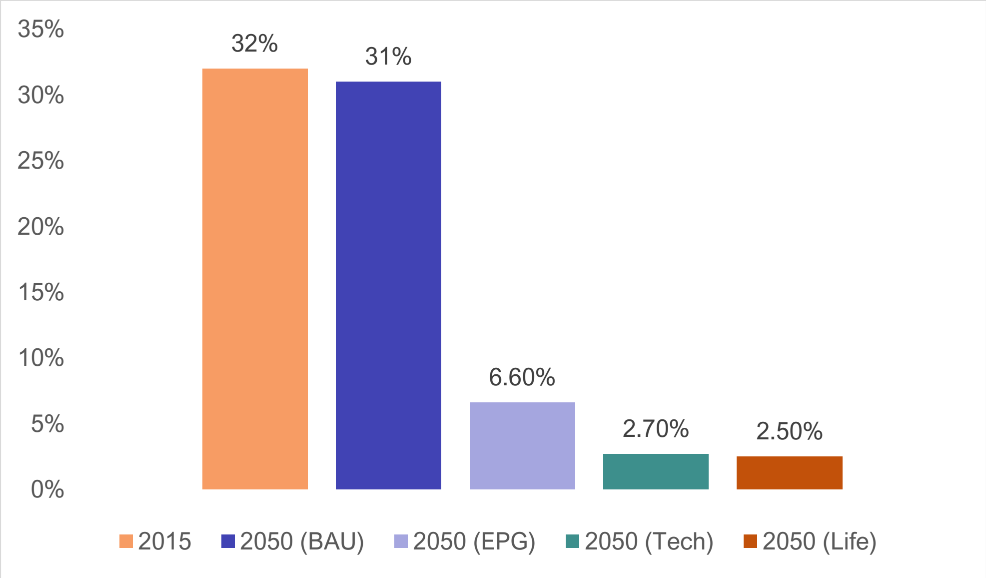
Figure 10: Share of solid biomass in final energy demand in buildings (%)



Source: Climact, 2050 Pathways Explorer, EPG calculations

The narrative around gasification of rural households currently reliant on traditional biomass that has gained traction in Romania is not feasible under any of the modelled scenarios. On the contrary, fossil gas represents no more than 6% in all scenarios. Therefore, the plans part of the Romanian RRP of building at least 1,870 km of gas distribution network in Oltenia region, to carry at least 20% of renewable hydrogen (by volume) when commissioned by 30 June 2026, and 100% renewable hydrogen and/or other renewable gases in 2030, is not in line with any of the decarbonisation scenarios. There is a very high risk that such an investment would quickly turn into stranded assets and can create captive consumers whose decarbonisation will be more difficult in the future. Meanwhile, a switch to renewable hydrogen for heating would be an incredibly wasteful use of valuable molecules.

Figure 11: Share of fossil gas in final energy demand in buildings (%)



Source: Climact, 2050 Pathways Explorer, EPG calculations

One final aspect worthy of attention is the incentivisation of behaviour change to enable decarbonisation of the buildings sector. The significantly lower energy consumption of the ***Life*** scenario is primarily due to an embracing of "austerity" on the part of consumers, leading to reduced appliance ownership and appliance use time, as well as a higher tolerance for cooler indoor temperatures in the winter season and hotter ones in the summer. On the other hand, the ***EPG*** and ***Tech*** scenarios foresee an increase in the proportion of residential buildings equipped with cooling systems, increased appliance ownership and increased time of use of appliances. In the ***EPG*** scenario, households are heated heat their homes to 23°C and cooled to 19°C. Underpinned by an increase in per capita living space in the decades to come, this is projected to lead to higher energy demand and emissions from the building sector in these two scenarios.

Although reaching economy-wide climate neutrality is possible even without the deep behavioural changes of ***Life*** leading to minimal emissions from the buildings sector, coherent communication, and awareness-raising campaigns to incentivise a change in energy consumption behaviour will be key to maintaining a firm reduction in energy demand. This is particularly relevant in the current energy price crisis, an element picked up on by the European Commission, for example through the "Playing my part" campaign.[28] Over the course of 2022, Romanian policymakers missed key opportunities to incentivise energy savings from residential consumers, as part of their consumer protection programmes, for example by linking favourable price caps to energy savings enacted by consumers.

Transport

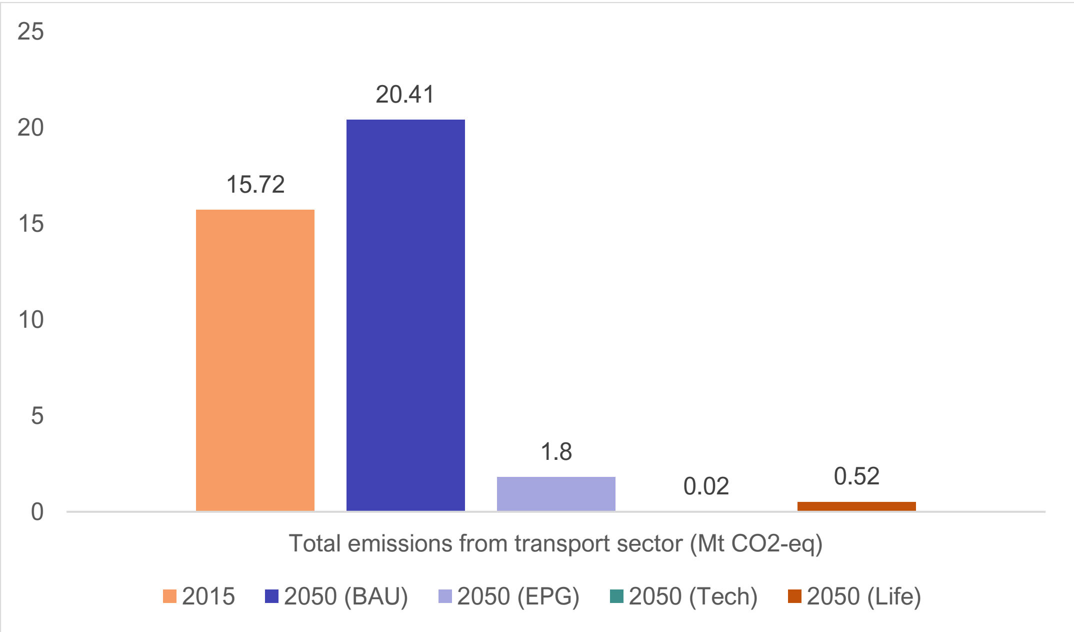
The decarbonisation of Romania's transport sector is mostly projected to be driven by significant electrification across all scenarios, as well as some use of biofuels, e-fuels, and hydrogen. A parallel slash in the use of liquid fossil fuels across all scenarios leads to emissions reductions of 87%-99% for freight transport, and 83%-99% for passenger transport, also supported by an increase in

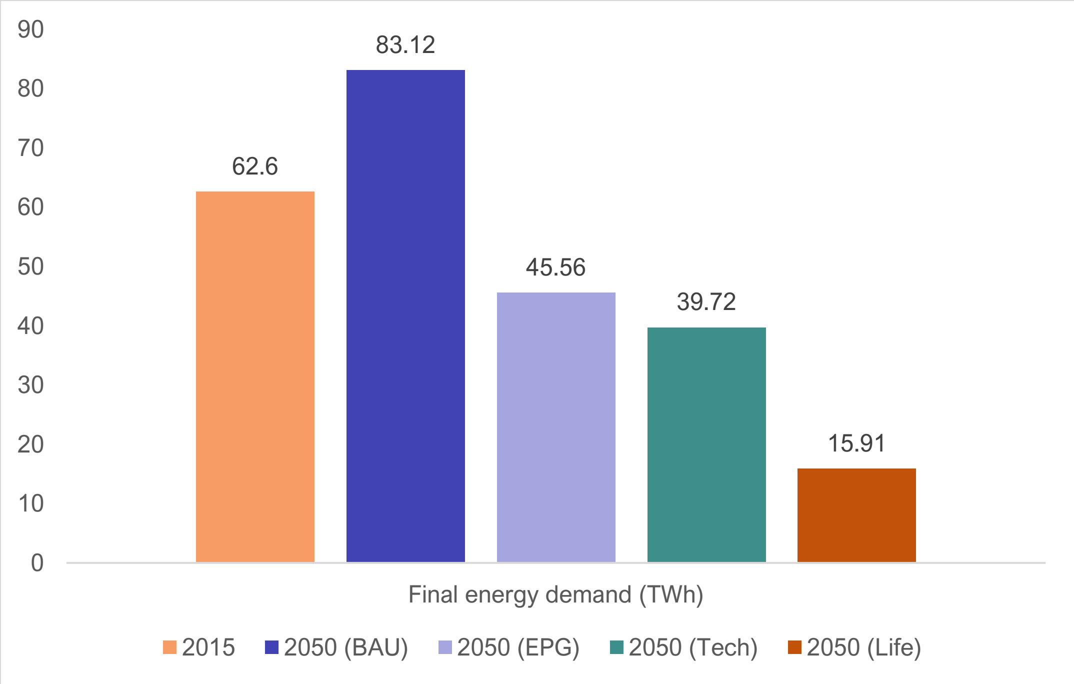
[28] European Commission, 2022. Playing my part: Key energy saving actions, Brussels.

demand for lower-emissions modes of transportation including biking, and rail use (which increases across all scenarios). Both the ***EPG*** and ***Tech*** scenarios assume an increase in the distance travelled by passenger cars and other inland modes, based on the current low levels of motorisation and advanced age of the Romanian car fleet. Romania has the lowest motorisation rate in the EU: in 2019 on average there were 357 cars per 1,000 inhabitants, while the EU average was 540. Therefore, the EPG scenario assumes that passenger distance will increase by 35%. freight demand also increases by 12% in 2050 compared to 2015 level. Demand for aviation is projected to remain relatively constant, aside from the ***Life*** scenario where passenger demand falls by approx. 36% by 2050.

Overall emissions of the transport sector are lowest in the ***Tech*** scenario, due to substantial fuel switching to electricity and biofuels in both freight and passenger transport, 100% sales of zero-emissions vehicles for new truck and car sales, and an increase in the share of autonomous vehicles to 50%. Emissions reductions in the ***Life*** scenario, where sectoral emissions are the second lowest in 2050 of all scenarios, are more driven by a major modal shift from car to bike and bus (in urban areas) and from car to rail and bus (in non-urban areas), as well as an overall reduction of average distance travelled, in line with the increased “austerity” of this scenario compared to the others. Final energy consumption needs to drastically decrease across all scenarios, with the lowest of 15.91 TWh in the ***Life*** scenario and the highest of 45.56 TWh in the ***EPG*** scenario. This decrease in consumption is in part the result of direct electrification of passenger cars, as electric vehicles can be up to two times more efficient than ICE vehicles.

Figure 12: Evolution of emissions (MtCO2-eq) and final energy demand (TWh) in transport





Source: Climact, 2050 Pathways Explorer, EPG calculations

When it comes to fuel types, these vary greatly among scenarios, with the ***EPG*** scenario relying the heaviest on e-fuels derived from hydrogen, while the ***Tech*** scenario relies overwhelmingly on advanced biofuels. Under 10% of final energy demand in all scenarios comes from the direct use of hydrogen, while the use of liquid fossil fuels decreases by at least 85%. Gas is only used in marginal quantities. Electrification is key driver of the decarbonisation of passenger cars across all scenarios, with a tenfold increase in electricity demand in the ***EPG*** scenario. Once again, electrification contributes not just to displacing the use of liquid fossil fuels from ICE vehicles, but it also halves the energy consumption for a car, given the superior efficiency of electric vehicles.

Table 4: Share of final energy demand in transport by vector (%)

	2015	2050 (BAU)	2050 (EPG)	2050 (Tech)	2050 (Life)
Electricity	1.67	1.8	25	20.85	34.8
Biofuels	3.77	6.72	4.61	69.97	3.57
E-fuels	0	0	49.17	0	40.18
Hydrogen	0	0	6.32	9.17	9.32
Liquid fossil fuels	94.5	91.3	14.49	0	11.45

Source: Climact, 2050 Pathways Explorer, EPG calculations

Passenger cars and vans in Romania were responsible for half of transportation emissions in 2015, with trucks contributing an additional 35%. One of the major challenges for decarbonising this sector is the advanced age of the car fleet (averaging 16 years for passenger cars, and 15 years for heavy-duty vehicles). This accompanies an overall significant growth in car sales (primarily re-selling of used cars) and advancement of air transportation at the expense of a declining rail transport sector.[29] This has led to urban congestion and air quality issues, reinforced by the lack of implementation of zero-emission zones in cities, and low availability of good-quality cycling or walking infrastructure. The challenge of an aging car fleet has been acknowledged in Romania's NECP, which sets the renewal of the existing car fleet as an objective for 2030. This is proposed to be achieved through the continued *Rabla* voucher programme, whereby car owners turning in older vehicles are subsidized to purchase lower-emission, plug-in hybrid, or fully electric cars.[30] According to the Romanian RRP, the *Rabla* programme has led to 26,000 older vehicles being taken off the road since 2005.[31]

Across all modelled scenarios, fuel switching remains a major driver for emissions reduction in Romania's transport sector. However, despite the advances in renewing Romania's car fleet discussed above, the carbon intensity of road transportation remains high. An increase in fuel consumption for road transportation between 2010 and 2020 was mostly driven by an increase in diesel and bio-diesel consumption, with lower taxation rates for diesel than petrol. The Romanian RRP committed to installing 30,000 new electric charging points by 2026, a welcome sign for advancing electric car ownership but with its decarbonisation impact dependent on the penetration of large amounts of renewable electricity to the Romanian grid, with the associated challenges detailed in the **Electricity supply** section. The decarbonisation of heavy-duty vehicles, foreseen to occur through fuel switching in the ***EPG*** and ***Tech*** scenarios, may be supported through the eventual application of specific emissions taxes as targeted through the national RRP – however, significant resistance should be expected in the introduction of "polluter pays" taxes such as this.

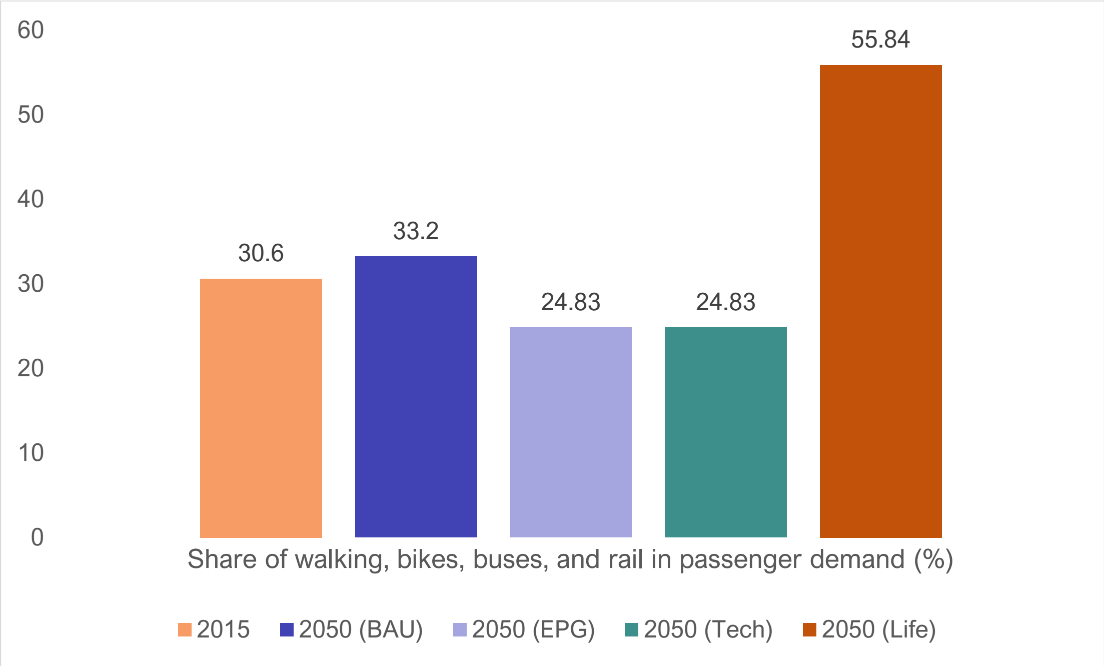
Moreover, the discussion around sustainable road transportation in Romania may be frequently overshadowed by that on the improvement of road infrastructure, one of the main foci of the RRP and the subject of some controversy upon receipt by the European Commission. To advance alternative road transportation fuels, plans for the expansion of roads and motorways must be accompanied by clear targets on infrastructure for alternative fuels. In its assessment of Romania's National Policy Framework (NPF) under Directive 2014/94/EU on alternative fuels infrastructure, the European Commission found a lack of concrete targets for electric vehicle and hydrogen refuelling infrastructure.[32] Under the Fit for 55 package, the planned revision of Directive 2014/94/EU will introduce additional requirements for the placement and frequency of electric charging and hydrogen refuelling points.

Aside from fuel switching, modal shift is also an important driver for passenger transport decarbonisation and is reliant on the improvement of public transport and low-emissions transportation modes such as walking and cycling, particularly in the ***Life*** scenario. Modal shift is also a driver for decarbonising freight transportation in the ***Life*** scenario, with long-distance rail transportation and last-mile bike usage penetrating the sector to drive emissions reductions. Romania has one of the lowest rates of rail electrification in the EU as well as an old rolling stock (average age of 30 years), and the national RRP allocated a whopping €3.48 billion to the modernisation and electrification of national railways, over half of its entire budget allocation for transportation. Further investments in the RRP target the construction of 3,000 km of cycle paths. The renewal and improvement of infrastructure for alternative transport modalities will require clear governance, particularly in the context of the planned expansion of road transport infrastructure –

[29] Cazan, R., Stoica, M., Brooks, H., et al., 2018. Emission reduction strategies for the transport sector in Romania, Transport and Environment, Brussels.
[30] Diaconu, D., Duma, D., Miu, L., et al., 2021. Romania's Post COVID-19 Recovery: Enabling a green transformation of the economy, Energy Policy Group, Bucharest.
[31] Ministry of Investments and European Project, 2021. National Recovery and Resilience Plan.
[32] European Commission, 2022. Commission Staff Working Document (2022) 33, Brussels.

which, similar to the expansion of the gas network, is construed as a narrative for national development and security.

Figure 13: Share of walking, bikes, buses, and rail in passenger demand (%)



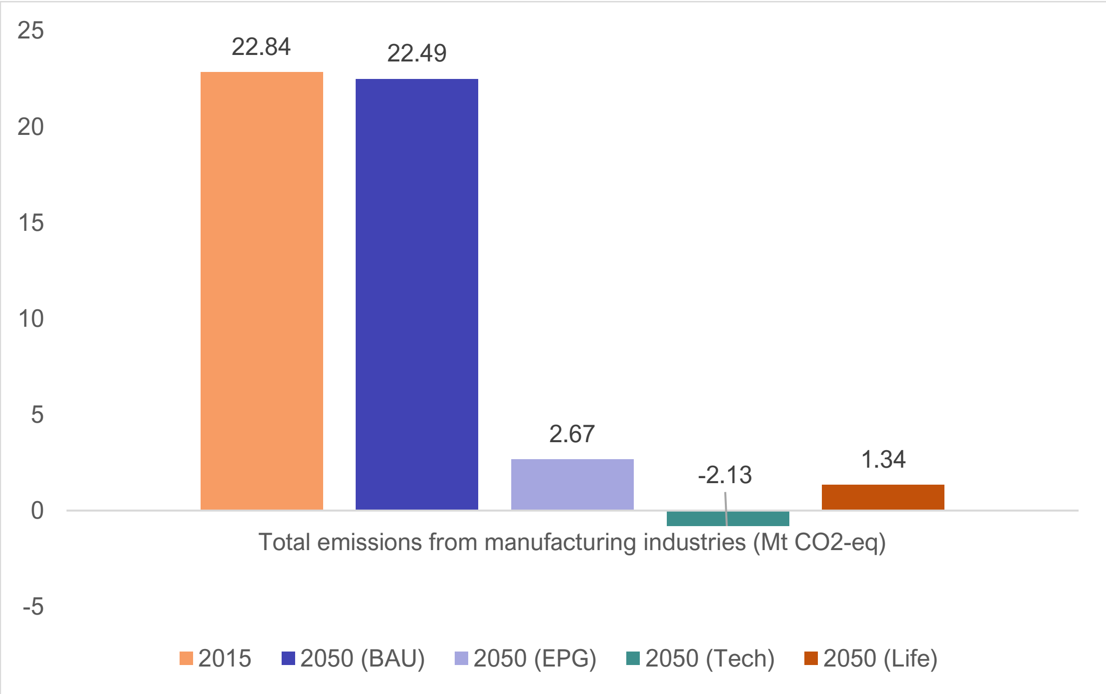
Source: Climact, 2050 Pathways Explorer, EPG calculations

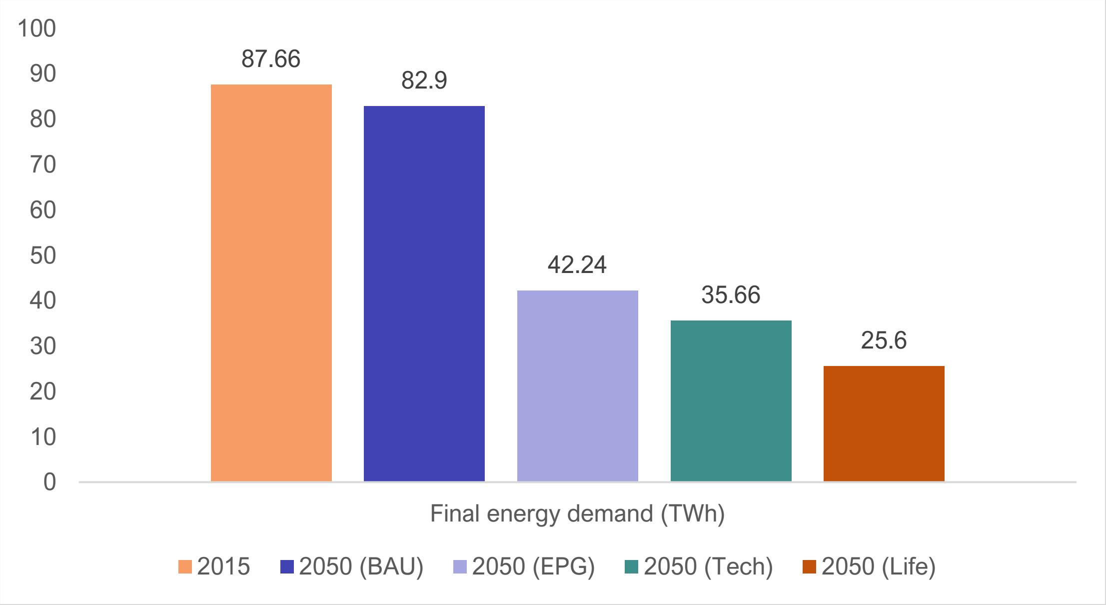
Industry

Although progressively transitioning towards a service-based economy since 1990, Romania is still heavily reliant on the economic contribution of its industry. Today, Romania's industry generates about a third of the Romanian economic activity (33.2% of nominal GDP), employs 29% of the workforce and is forecasted to have an average yearly growth of 4.8% until 2025, in terms of output. In 2020 emissions from fuel combustion in the industrial sector (14.5 Mt CO_2) accounted for 22% of Romania's energy-related CO_2 emissions, with process emissions amounting to another 10.5 MtCO_2. The largest contributors are the non-metallic minerals sector (including cement), chemicals production and iron and steel production. Decarbonising Romania's industrial sectors is particularly challenging given the high share of both economic value and emissions from industries with hard-to-abate process emissions, such as cement, lime, chemicals, and steel production, which require significant investment in abatement technologies such as hydrogen and carbon capture and storage (CCS).

The main drivers for decarbonisation of industry foreseen in the modelled scenarios are increases in material efficiency (highest for cement with -50% and -10% for steel in the ***EPG*** scenario), material substitution (15% switch from cement to wood in construction in the ***EPG*** scenario), switching of technologies, including the penetration of less mature technologies such as hydrogen-DRI in steelmaking, the use of alternative fuels including electricity, zero-carbon hydrogen, and biomass and, in some cases, natural gas as a replacement for solid and liquid fuels, and the use of carbon capture at an assumed capture rate of 85%. Of the modelled scenarios, the ***Tech*** scenario introduces the highest ambitions around all drivers, including attaining the full potential of alternative fuels use in industry, resulting in only small residual shares of fossil fuels present in the 2050 energy consumption. It also assumes more ambitious levels of technological development and technology cost reductions, and the application of higher levels of BECCS and direct air capture (DAC), resulting in overall negative emissions from Romania's industry by 2050. The mix of technical options for decarbonisation of Romania's industry results in a decrease of 51%-70% of emissions by 2050, relative to the 2015 baseline, reinforcing the hard-to-abate nature of industrial emissions, compared to other sectors such as buildings or transport. The largest decreases in emissions are projected in the cement, ceramics, and steel sectors across all scenarios, while emissions from wood production are projected to increase, driven by increased demand due to material substitution, as well as the use of BECCS for industrial heat supply. Total energy demand is slashed across industries, reducing by half in the ***EPG*** scenario compared to business as usual.

Figure 14: Evolution of emissions (MtCO2-eq) and final energy demand (TWh) in industry

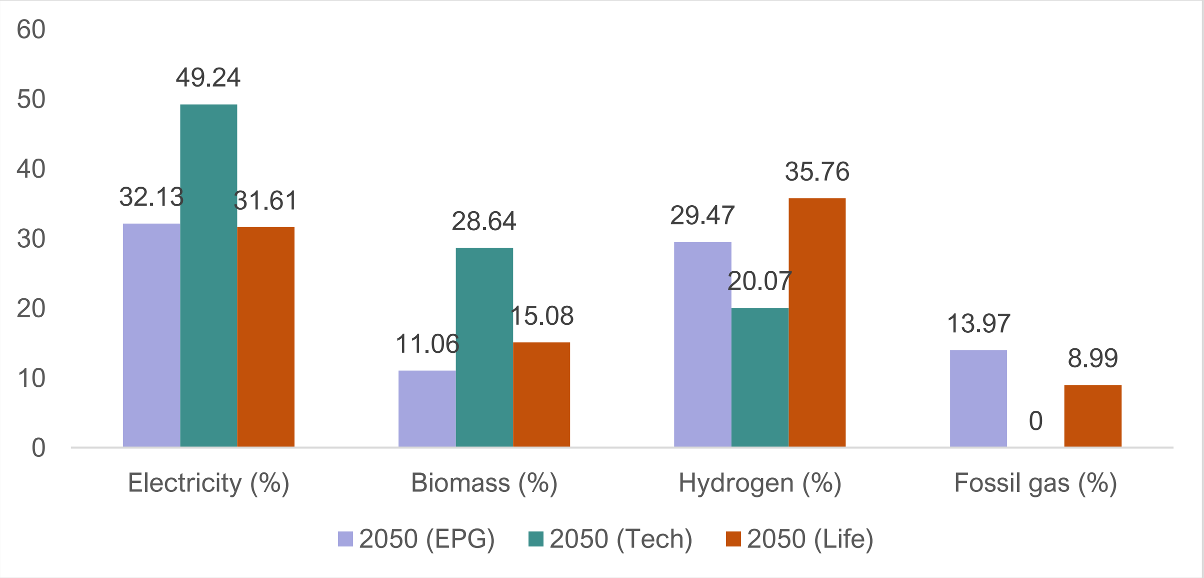




Source: Climact, 2050 Pathways Explorer, EPG calculations

While electrification is the most important vector for decarbonisation especially in the ***EPG*** and ***Tech*** scenarios, there is no one-size-fits all solution for industry, given the plethora of processes and production methods involved. The use of fossil gas is completely eliminated in the ***Tech*** scenario and is reduced to 5.9 TWh in the ***EPG*** scenario. This mainly happens through the electrification of heat production, especially under 500ºC, as well as through the use of other decarbonised molecules such as clean hydrogen and its derivatives (ammonia, methanol, etc.) and biomethane. In 2050, industry would consume between 7.26 and 12.45 TWh of hydrogen and derivatives and between 1.33 and 3.12 TWh of biomethane in the ***EPG*** and ***Tech*** scenario respectively.

Figure 15: Share of final energy demand in industry by vector (%)



Source: Climact, 2050 Pathways Explorer, EPG calculations

Carbon capture and storage would also need to be deployed at scale to decarbonise Romania's industry, with 1.16 $MtCO_2$ already being captured in 2030 in the ***EPG*** scenario. The lowest quantities captured and stored in 2050 would be in the ***Life*** scenario, amounting to 1.24 $MtCO_2$, and the highest in the ***Tech*** scenario with a total of 4.42 $MtCO_2$. 3 $MtCO_2$ are captured and stored annually in the ***EPG*** scenario by 2050, 0.7 $MtCO_2$ of which representing BECCS with negative emissions. CCS applications across scenarios is applied to processes in the production of cement, lime, aluminium, ceramics, and chemicals.

Despite the key role of industry and its large contributions to Romania's GHG emissions, there is no national plan or framework for industrial decarbonisation, nor is deep decarbonisation for industry discussed in an integrated manner. In general, the measures pursued by public authorities, including in the RRP and Modernization Fund disbursements, relate to improving energy efficiency in existing industrial facilities or, in the current context, protecting industrial consumers from high gas and electricity prices. The only sporadic mentions of decarbonisation solutions such as carbon capture or hydrogen are generally through the public communications of various industrial companies, such as Liberty Steel Galați or the association of cement producers, CIROM. As such, there is no cohesive planning for the Romanian industrial transition, and a general lack of understanding from public authorities on issues such as direct electrification and the associated required renewable energy, low-carbon hydrogen production, and carbon capture and storage infrastructure. Circular economy, material efficiency and material substitution are also rarely considered.

As a result, the long-term planning of Romania's industrial transition is challenged by a lack of visibility of industrial decarbonisation as an issue of strategic importance, and the absence of a clear governance framework with competent ministries. For example, the competent authority for CO_2 storage, a key component of CCS and generally the purview of the state in Europe, acts under the auspices of the Ministry of Energy; various aspects of decarbonisation relevant to industrial facilities are split between multiple ministries. Developing long-term decarbonisation plans for industrial facilities will necessarily start with the formulation of an appropriate national strategy and associated governance framework, as well as clear financial frameworks to incentivise deep decarbonization by large industrial emitters, such as carbon contracts for difference (CCfDs), or legal instruments such as carbon takeback obligations.

For industrial decarbonisation to succeed, the relevant technologies and associated infrastructure (e.g., CO_2 transportation and storage) must be made available and accessible to Romanian emitters. The looming phase-out of free allocations under the revised EU Emissions Trading Scheme Directive (currently undergoing negotiations)[33] will create mounting pressure for an industrial decarbonisation framework to make available the deep decarbonisation technologies cited as main drivers of our modelled net-zero scenarios, so that industrial emitters can respond to a tightening carbon market and remain competitive in the EU industrial landscape. Finally, the opportunities for economic development and a virtuous cycle of industrial competitiveness should also not go unnoticed – growing domestic research, development, and innovation around low-carbon technologies is an opportunity for Romania to break out of its traditionally low level of innovation performance ranking (the country has one of the lowest R&D investment levels in the EU – only one-fifth of the EU average[34]). Demand for low-carbon products can be incentivised specifically through public procurement and product standards.

---

[33] White&Case, 2022. European Parliament and Council adopt positions on ETS and CBAM proposals: next steps—final agreement & formal adoption, White & Case LLP (whitecase.com).

[34] Romania Insider, 2021. Romania invests 0.5% of GDP for R&D | Romania Insider (romania-insider.com)

Agriculture, forestry, and other land use

The achievement of Romania's net zero target is heavily reliant on its natural carbon sinks and the negative emissions generated – ranging from 19.9 Mt CO_2-eq in the ***Life** and **Tech*** scenarios to 26.2 Mt in the ***EPG*** scenario. This is explained by the fact that in the EPG scenario as much as 37% of the freed-up land is transformed into forests and natural prairies. Overall, emissions from agriculture are projected to decrease, primarily driven by a reduction in livestock-related emissions, by 47% in the ***EPG*** and ***Tech*** scenarios, and by 82% in the ***Life*** scenario. This is mainly the result of a reduction in meat consumption in line with deep behavioural changes oriented towards sustainable living. Across all scenarios, the main assumptions are that the decline in population will lead to less internal demand for food, and that grassland areas will decrease due to animal feed substitution, being partially converted into forests and prairies.

The main natural carbon sinks of Romania are its forest cover, while its primary sources of emissions are land being converted to settlements and other types of land (excluding cropland and grassland). Forest area in Romania did increase by 10% between 1990 and 2010, largely due to the abandonment of large-scale cooperative agricultural practices and intensive mining characteristic of the communist regime. However, good forest management practices have also been hampered by land restitution efforts, complex ownership environment, and poor law enforcement, and afforestation rates decreased from 12,000-15,000 ha/year to just 1,000 ha/year after 1990. Natural carbon sinks have been slightly decreasing since 2000, due to increased harvesting of wood which is frequently done through illegal logging and improper harvesting practices. Even just maintaining the coverage of Romania's forests is reliant on a strong policy environment for forestry – currently mostly governed through the National Forestry Strategy, due to be updated (including secondary legislation) in 2023 – and investments in combating illegal logging and improving forest management.

Romania's agricultural sector, an important part of the national economy, is largely comprised of small, individual farms and is difficult to align with principles of a green economy. Recent declines in methane and nitrous oxide emissions from agriculture are driven by a decrease in livestock rather than emissions reduction efforts. As with the industry sector, there is a lack of coherent planning for emissions reductions from farming, including concerted efforts to reduce emissions from agricultural soils through sustainable cultivation practices. Conversely, recent commitments in the RRP target emissions from farm waste management, which represent a smaller share of agriculture-related emissions and whose mitigation under the RRP serve only to bring up to standard the farm waste management practices in Romania.

In the ***EPG*** and ***Tech*** scenarios the use of chemical pesticides and fertilizers based on nitrogen, phosphorus, or potash is reduced by 20%, while maintaining similar yields. In the **Life** scenario, chemical pesticides and fertilizers based on nitrogen, phosphorus or potash are completed eliminated by 2050, but crop yields also decrease by 25%. Farming is also faced by climate adaptation concerns, with 172,000 ha of farmland affected by extreme weather in 2019. Although not directly addressing decarbonisation (at most the reduction of short-term emissions from the avoidance of flooding), climate adaptation measures are also important for securing the long-term vision necessary for transition planning and integrating the build-out of infrastructure (including transportation and energy infrastructure) with measures to protect agricultural land from the worst impacts of climate change.[35]

[35] Diaconu, D., Duma, D., Miu, L., et al., 2021. Romania's Post COVID-19 Recovery: Enabling a green transformation of the economy, Energy Policy Group, Bucharest.

3 A Long-Term Strategy fit for purpose

Having identified key measures that will enable pathways to net zero emissions in Romania by 2050, this section focuses on how these measures should be encapsulated in a strong Long-Term Strategy for Romania, which in turn is embedded in the relevant national, European, and international policy contexts. This section draws on best practices from other LTSs, which have been discussed under several comprehensive assessments in the Climate Recon project, with the aim of understanding whether they are fit for purpose in the current EU policy context. The following section summarises the key elements of best-practice LTSs, and briefly discusses how they should be incorporated in the development of the Romanian LTS.

Broadly, the key components of a best-practice LTS are its vision (how well the targets and pathways for net zero are incorporated into the strategy) and its relevance (how current, sustainable, and aligned with the national and EU context the strategy is).[36] Within these two components, several elements and their associated best practices are presented below.

Vision

Long-term climate targets

Given the role of LTSs in setting out the pathway to climate neutrality of Member States, a key element of these strategies is the presence of climate targets: i) an economy-wide net zero emissions target,[37] as well as ii) credible emissions reductions targets and iii) pathways for achieving them. Higher-income countries may be required to reach net zero emissions before 2050, according to the ambitions of the Paris Agreement, giving developing and emerging countries more time to contribute to global climate neutrality.

Romania is uniquely suited to achieve significant land-based emissions removals, given its low population density - a fact which was enshrined in the significant national target set for CO_2 removals through the LULUCF sectors, in the recent political agreement on CO_2 removals achieved as part of trilogue negotiations on the Fit for 55 package.[38] Romania also has the lowest CO_2 emissions per capita in the EU and already one of the least carbon intensive economies. As a result, Romania could set an ambition to reach net zero emissions before 2050, as has been done by other Member States in their LTSs (Finland, Austria, Sweden, and Germany), and achieve negative emissions in 2050 as demonstrated in the modelled scenarios.

To achieve their proposed emissions targets, LTSs must provide a combination of sectoral emissions reductions and removals, which in most LTSs are not a firm goal or commitment but rather an outcome of modelled scenarios. The Netherlands is a notable exception, with its 95% emissions reduction target by 2050 enshrined into the national climate law. As a minimum, the Romanian LTS must provide concrete emissions reduction targets for 2050, with a strong recommendation for interim targets for 2030 and 2040 aligned with the National Energy and

[36] Velten, E.K., Evans N., Spasova, D., et al., 2022. Charting a path to net zero: An assessment of national long-term strategies in the EU, Ecologic Institute, Berlin.
[37] Some Member States submitted their LTSs before the adoption of the EU's target to reach net zero emissions by 2050; however, almost all countries which submitted an LTS included a net zero target, mostly aimed at 2050. Source: Velten, E.K., Evans N., Spasova, D., et al., 2022. Charting a path to net zero: An assessment of national long-term strategies in the EU, Ecologic Institute, Berlin.
[38] Euractiv, 2022. Deal reached on EU law regulating CO2 removals from forestry, land use – EURACTIV.com

Climate Plan (NECP) targets, offering reasonable milestones for assessing progress.[39] These emissions targets should cover the whole economy (i.e., not focusing solely on net emissions or ETS emissions) and should be in line with the goal of climate neutrality.

When it comes to emissions reductions pathways, two aspects of good practice can be discussed. Firstly, it is opportune to plan for higher annual reductions in early years and lower ones in later years, [40] to avoid shifting the burden of emissions reduction and relying on the contribution of emerging technologies and energy carriers, such as hydrogen and carbon capture, utilisation, and storage. Another reason for frontloading emissions reductions is that there is still a lot of untapped potential in energy and material efficiency which can reduce the scope of deployment of the emerging technologies and energy carriers in hard-to-abate sectors. Secondly, scenarios must be used to present credible emissions pathways, underpinned with robust assumptions, and producing accessible data (rather than, for example, static graphs). These two aspects will ensure accountability for emissions reductions as well as credible pathways for emissions reductions involving immediate action.

Sectoral elements

Strong LTSs include sectoral information, to better present how much sectors of the economy will contribute to emissions reductions and climate neutrality. Sectoral information should at a minimum cover energy supply and demand, disaggregated by transport, buildings, and industry, as well as non-energy emissions from industry and agriculture and greenhouse gas (GHG) removals from natural and technical sinks.

Energy supply information should necessarily cover current and future shares of different fuels, provide clear dates for phase-out of fossil fuels, and be aligned with existing commitments on fossil fuel phase-out. In the case of Romania, any projections of the energy mix must align with the national commitment to coal phase-out by the end of 2032[41] and with realistic evaluation of the contribution of natural gas, considering both the emissions burden and the current geopolitical situation. As shown in the pathways explored in the first part of this report, Romania needs to plan for a near-complete phase-out of fossil gas use by 2050, likely at an accelerated phase following the gas crisis of 2022. The role of nuclear energy must be clearly outlined, and in line with Romania’s plans to increase its operational capacity for conventional nuclear power, as well as install decentralised small nuclear reactors. Projections of the share of renewable energy, which necessarily must increase substantially, should be further aligned with national commitments such as the Recovery and Resilience. Importantly, the current and projected share of fuels should be disaggregated into the electricity, heating and cooling and transport sectors; many LTSs provide no information on renewable energy shares of the heating and cooling sector.[42] For Romania, a country with a significant share of legacy district heating systems in its heating and cooling sector, it is particularly important to provide pathways for renewable energy penetration in this sector,

[39] Interim targets may become the norm, if an EU greenhouse gas (GHG) emissions target is set for 2040 as per Article 4(3) of the European Climate Law. Official Journal of the European Union, 2021. Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 (‘European Climate Law’).
[40] Velten, E.K., Evans N., Spasova, D., et al., 2022. Charting a path to net zero: An assessment of national long-term strategies in the EU, Ecologic Institute, Berlin.
[41] Euractiv, 2022. Legea privind decarbonizarea sectorului energetic, adoptată de Parliament.
[42] Velten, E.K., Evans N., Spasova, D., et al., 2022. Charting a path to net zero: An assessment of national long-term strategies in the EU, Ecologic Institute, Berlin.

given the potentially significant efficiencies of centralised heating systems as well as the substantial investment needs to achieve these efficiencies.

As a country with a significant industrial legacy, Romania should not ignore the pathways for emissions reductions from its industries, particularly those with hard-to-abate emissions such as steel, cement, and chemicals, which contribute a significant share of national Gross Value Added.[43] The pathways for reduction or avoidance of hard-to-abate emissions should be underpinned with credible technology pathways, taking into account specific national deployment conditions as well as technology and commercial readiness levels. In addition, GHG removals should be projected in detail, given the potentially significant contribution of Romania's AFOLU sector to its achievement of a net zero emissions goal. Both natural and technical sinks should be estimated in terms of GHG removal potential, and these removals should not be overestimated, nor delayed with planned application in the later decades to 2050. Their implementation should also account for other concerns, such as human health and biodiversity.[44]

Technologies

When it comes to technologies enabling emissions reductions, it is important for LTSs to clearly state and justify their foreseen impact and take a targeted approach as to which sectors and industries these technologies will be applied to. One pertinent example is district heating, an example of a mature technology with significant efficiency benefits and emissions reduction potential for the heating and cooling sector in both buildings and industry. Many countries' LTSs fall short of providing a clear picture of the role and impact of district heating, including the technological advances able to further increase its efficiency, such as low-temperature networks and coupling with thermal storage. This leads to uncertainty in the contribution of district heating to the decarbonisation of heating, as well as a lack of clarity on future investment needs for district heating expansion and/or modernisation, both of which are capital-intensive.[45]

The same reasoning applies for "new" technologies and emerging energy carriers, particularly hydrogen, biomass and carbon capture, utilisation, and storage. Most LTSs do include some statement on hydrogen as part of their climate neutrality strategies, but the level of detail varies and qualitative, rather than quantitative, information is prevalent. Given the significant interest of Romanian industrial players in developing hydrogen production[46] (even in the absence of a national hydrogen strategy[47]), it is key that the LTS pinpoints a clear framework for application of hydrogen to specific sectors and industries and quantifies its emission reductions benefits and investment costs. The LTS must be well-aligned with the forthcoming national hydrogen strategy and build upon existing assessments of potential for developing large-scale hydrogen valleys.[48]

Many LTSs include limited information on biomass, including generation and import estimates, sustainability considerations and explicit loci for application. The application of biomass must be

---

43 Miu, L., Nazare, D., Cătuți, M, et al., 2021. Assessment of current state, past experiences and potential for CCS deployment in the CEE region.

44 Velten, E.K., Evans N., Spasova, D., et al., 2022. Charting a path to net zero: An assessment of national long-term strategies in the EU, Ecologic Institute, Berlin.

45 Miu, L.; Nazare, D.; Diaconu, D. 2022. District heating in national Long-Term Strategies. Energy Policy Group, Bucharest.

46 Curs de Guvernare, 2022. România și hidrogenul: Proiectele energetice deja desenate chiar în lipsa unei strategii (cursdeguvernare.ro)

47 Romania's national hydrogen strategy is planned for release in 2023.

48 Bălan, M., Cătuți, M., 2021. Dobrogea – developing the first clean hydrogen valley in Central and Eastern Europe. Energy Policy Group, Bucharest.

bound by robust sustainability criteria and closely linked with Renewable Energy Directive recast,[49] which in the case of Romania is particularly important given the prevalence of traditional biomass for heating. Furthermore, any proposals for domestic biomass should be bound by commitments on avoidance of deforestation, a widespread and growing problem in Romania. Planning should also take into consideration the increasingly strict sustainability criteria for biomass considered renewable in EU legislation, as well as its limited availability and competing potential uses in industry, transport, heating and cooling, and electricity supply.[50] Biomass with CCS can also represent a crucial carbon direct removal (CDR) technology, which may be key in achieving negative emissions. Therefore, similar to other emerging technologies and energy carriers, potential uses should be prioritised in sectors with the highest value added and greatest emissions reduction potential.

CCS and CCU represent a capital-intensive chain of technologies with most impact in reducing hard-to-abate process emissions and generating negative emissions. It is mostly quoted as a general statement in countries' LTSs, although some do include projections of captured emissions in climate neutrality scenarios. Pathways for CO_2 storage and/or use, estimates of storage potential and specific capture volumes from different industries are relatively rare, despite being mandatory prerequisites for ensuring the permanence of CO_2 storage and consequently the climate sustainability of CCS. Given the presence in Romania of hard-to-abate industries of economic importance, such as steelmaking, cement production and chemicals, Romania's LTS should include clear pathways for decarbonisation in these industries, outlining plans for using CCS and CCU alongside other decarbonisation solutions, e.g., energy and material efficiency improvements or hydrogen use. It should also provide estimates of and pathways to developing storage potential, based on assessments such as the CO_2STOP database.[51]

Projections for such innovative technologies and energy carriers should take into account the primacy of direct electrification as the most efficient means of reducing emissions in end uses where this is technically feasible. The centrality of electrification in decarbonising the economy makes planning for the large-scale deployment of renewable energy capacities even more important. To support the RES rollout, planning should also be done for the roll-out of enabling technologies such as storage (not just in forms of batteries), smart grids, smart metering and other tool for demand-side management.

Horizontal elements

Non-technological elements of decarbonisation are equally important to assess and include in LTSs. These cross-cutting elements include behaviour change, finance, research and development, climate adaptation and the impacts of decarbonisation measures (socio-economic, health and environmental). The Governance Regulation requires only the inclusion of investment needs, and impacts "to the extent feasible", while climate adaptation is suggested as for voluntary inclusion.

Despite the cross-cutting importance of these elements, they are frequently addressed only weakly, or in a largely qualitative way (except for finance, where many LTSs quantify their investment needs). Best-practice approaches to incorporating horizontal elements start with quantifying and justifying, wherever possible, their perceived impact, and provide a clear plan of

[49] European Commission, 2022. Biomass.
[50] Cătuți, M., Elkerbout, M., Alessi, M. et al., 2020. Biomass and climate neutrality. Center for European Policy Studies, Brussels.
[51] European Commission, 2022. European CO2 storage database, Brussels.

how they will be enabled. For example, stating that a certain share of investment needs will be met by private sector funding must be corroborated by a clear plan to mobilise private financing. A thorough discussion of sustainable finance is also paramount in this regard –in Romania this is only an emerging topic. Essentially, Romania must address "contradicting support" such as fossil fuel subsidies in its LTS, singling out existing subsidies and providing a clear plan for their re-allocation to decarbonisation measures in line with its climate neutrality commitment.

A detailed evaluation of the potential impact of decarbonisation measures will also be key for Romania, as a Just Transition country. Its LTS should quantify the impact of the transition (i.e., the proposed decarbonisation measures) on its economy and employment, but also the distribution of impacts among different income classes and regions. The impacts and their distributions should be as specific as possible, limiting generic statements and focusing on the characteristics of Romania's Just transition regions. This targeted assessment and evaluation of distributive impacts will also be key for treating climate adaptation in the Romanian LTS and tying it in to well-reasoned investment costs for adaptation measures (both technological and "soft" – such as education on sustainable farming practices, for example).

Relevance

As important as the "content" of an LTS is, arguably the largest contributor to its impact will be how it is translated into concrete measures and policy instruments. The governance of LTS preparation, implementation and integration into the national and international policy landscapes will dictate how much it is reflected in Member States' concrete decarbonisation efforts.

Preparation

In the first step of LTS preparation, Velten et al (2022) argue for three key elements for determining good- and bad-practices: compliance with legal requirements (i.e., whether the LTS of a Member State complied with provisions in the Governance Regulation), the scientific basis informing the strategy (the presence of scenarios and/or underpinning models, as well as expert input) and the participation of governmental and non-governmental actors as a means to measure buy-in into the strategy.[52]

Romania is currently uncompliant with the legal requirements of the Governance Regulation, in the sense that it has not adhered to the submission deadline. As a result, an ongoing procedure of infringement was launched by the European Commission in late September 2022.[53] Delayed submissions can introduce difficulties in keeping countries aligned with the cycles of EU climate governance and facilitate coordination, particularly the upcoming revision process for National Energy and Climate Plans. Other relevant legal requirements include compliance with the mandatory content (e.g., sectoral GHG data) and time horizon (30 years), which supports cross-Union coordination and forms a basis for comparison.

In terms of the scientific basis for developing the LTS, the existence of a robust projection methodology and of expert advice and review is a key good practice to tackle the complexities of decision-making across several decades. Modelling techniques should be economy-wide and avoid over-emphasising a specific sector where data may be more available.[54] Furthermore, the

---

[52] Velten, E.K., Evans N., Spasova, D., et al., 2022. Charting a path to net zero: An assessment of national long-term strategies in the EU, Ecologic Institute, Berlin.
[53] European Commission, 2022. September Infringements package: key decisions, Brussels.
[54] Miu, L., 2022. Assessment of Bulgaria's Long-Term Strategy for climate neutrality, Energy Policy Group, Bucharest.

developed scenarios must be suitable for integration into national climate processes and be consistent with the approach used for NECPs. When it comes to expert advice and input, Velten at all point to a growing number of EU countries with dedicated climate advisory bodies, comprised of researchers and scientists, inspired by the United Kingdom's Committee on Climate Change.[55] As the development of Romania's LTS has been outsourced with no establishment of a permanent scientific body on climate change, it will be useful for further planning to set up such a body, and develop in-house capacity for climate modelling (while still maintaining openness to expert input and advice).

Finally, the degree of participation of governmental and non-governmental actors (including the public) in the elaboration of the LTSs can be used as a proxy for buy-in by various groups (including other ministries). Given the economy-wide nature of LTSs and the significance of horizontal elements, as well as the long planning timeline, a good LTS should provide detail of inter-ministerial coordination undertaken for developing it, as well as broader political support. Transparent stakeholder engagement is necessary, achieving a high degree of representation across multiple formats as well as stages of the modelling and drafting processes. The results of this engagement should also be transparently reported in the LTS, and where necessary justify the inclusion of feedback based on this engagement, as some engaged groups may exhibit disproportionate influence at a strategic level.[56]

Follow-up

Realising the vision of an LTS is dependent on the quality of its actual implementation. The Governance Regulation provides little information on guidance on implementation aspects, except for monitoring and revision, where Member States are obliged to report on their policies and measures every two years and update their LTSs every ten years. How the LTSs are operationalised is therefore a matter where Member States are responsible for assigning implementation responsibilities and establishing concrete steps for monitoring and revision.

In this respect, a strong LTS would assign concrete implementation responsibilities (i.e., pinpointing a specific ministry as lead or coordinator, as well as sectoral and monitoring responsibilities) and, if relevant, detail the creation of new institutions or of roles for existing ones. Particularly if there is no national climate law, a strong or expanded structure for climate governance (including assigned responsibilities, clear monitoring processes and new or rethought institutions) will significantly contribute to the operationalization of LTSs. Monitoring and revision of the LTSs should be consistent and aligned with review cycles for other strategic documents such as the NECPs. The review cycle does not need to be specific to the LTS – for example, France is a good-practice example of enshrining into national law a "policy learning cycle" of five years.[57]

Romania's LTS could also offer an opportune launchpad for establishing a national Climate Law, which would enshrine the climate neutrality emissions reduction targets determined in the LTS into law. This higher ambition would make Romania only the third Eastern European country (after Latvia Hungary[58]) to enshrine a climate neutrality target into national law. It would also commit

[55] Velten, E.K., Evans N., Spasova, D., et al., 2022. Charting a path to net zero: An assessment of national long-term strategies in the EU, Ecologic Institute, Berlin.
[56] Ibid.
[57] Velten, E.K., Evans N., Spasova, D., et al., 2022. Charting a path to net zero: An assessment of national long-term strategies in the EU, Ecologic Institute.
[58] Mackaill-Hill, H., Mascolo, F., et al., 2022. Climate Laws in Europe. Essential for achieving climate neutrality.

Romania to the strong and growing consensus that national ownership of climate neutrality is key to delivery of emissions reductions.

Integration

A final element of LTS relevance relates to its alignment with, and position in, the national and international landscapes for climate governance. Ideally, LTSs should act as "umbrella" decarbonisation plans which align with shorter-term, more specific strategies and plans, as well as being relevant to the current policy context. Coherence with the NECPs is key, as is the acknowledgment and absorption of the dynamic EU policy context, particularly in times of rapid unfolding change such as the RePowerEU and Save Gas for a Safe Winter Plans. These two aspects (alignment with national frameworks and relevance in international contexts) are good practices for ensuring the sustainability and continued relevance of LTSs as key components of climate frameworks, rather than a "check-box" exercise to comply with EU regulations.[59]

Although one might assume that delayed publication of the Romanian LTS may be an advantage, given the rapid changes to the EU's energy landscape occurring between the official submission deadline and today, this is not always straightforward. The LTS of Bulgaria, officially published in November 2022, is only weakly integrated with the current policy context, and uses outdated information not consistent with events such as the Fit for 55 package negotiations or the Russian invasion of Ukraine. This is a feature of the strategy development process, which in Bulgaria's case was started in 2020 and put on hold due to frequent government changes. This may not be the case for Romania, but any pre-drafting work such as scenario development must be rigorously checked for compliance with current EU targets and trends.

As mentioned above, the absence of a framework Climate Law in Romania makes it essential to robustly integrate the LTS with national policies and planning frameworks. This is reliant both on an adequate vision, where technologies and horizontal elements of decarbonisation are clearly presented and can be linked to existing policies, and on firm relevance, where institutional actors are clearly assigned responsibilities for delivering these elements of decarbonization, in line with these existing policies. Integration starts with an assessment of the contributions of national policies and measures to achieving the targets of the LTS (a requirement of the Governance Regulation) but must be supported by a clear view of how the LTS will contribute to national policies and measures in its turn – as a cornerstone of long-term climate policy planning.

[59] Velten, E.K., Evans N., Spasova, D., et al., 2022. Charting a path to net zero: An assessment of national long-term strategies in the EU, Ecologic Institute, Berlin.

4 Conclusion and recommendations

Romania is still in the process of developing its LTS. This report presented three modelled scenarios through which Romania could achieve climate neutrality by 2050, outlining potential pathways for the decarbonisation of the electricity supply, buildings, transport, industry, and AFOLU sectors. Based on these results, a number of key recommendations can be made for each sector:

Electricity Supply

- Ensure a stable regulatory environment for renewables including removing barriers to large-scale development of solar PV and onshore wind, and launch offshore wind development before 2030
- Develop ambitious programmes for grid modernisation and expansion
- Plan for a 2030 coal phase-out and for a near-complete phase-down of fossil gas. Particular focus should be given to reskilling and long-term development of key components of the value chains of renewable technologies, electrolysers, electric vehicles, and batteries
- Develop a strategy for the deployment of energy storage technologies to ensure the flexibility needs of a future renewable-dominated electricity mix

Buildings

- Develop programmes to ramp up renovation rate and depth of existing buildings and improve the policy environment through prompt transposition of upcoming directives on energy efficiency and energy performance in buildings
- Design and implement support schemes for a large-scale deployment of heat pumps
- Invest in the maintenance and fuel transition of low-emissions district heating networks
- Develop coherent communication and awareness-raising campaigns to incentivise a change in energy consumption behaviour

Transport

- Invest massively in charging infrastructure necessary for supporting the electrification of road transport
- Adopt fiscal measures to gradually phase-out diesel and petrol ICE vehicles and to support the uptake of BEV vehicles
- Support the production of renewable-based hydrogen and e-fuels, as well as advanced biofuel production
- Repair, electrify, and expand rail infrastructure
- Improve alternative transport infrastructure, especially for cycling, walking, and public transport

Industry

- Create a policy framework for deep industrial decarbonisation
- Invest in the development of support infrastructure for industrial decarbonisation, especially related to electrification, renewable hydrogen, and CCS. Both renewable hydrogen and CCS are needed before 2030
- Incentivise material efficiency measures and develop product standards and public procurement procedures that favour low-carbon products

- Develop financial support schemes for the rapid, targeted, and concerted deployment of technologies for emissions reduction and technology-agnostic frameworks focused on emission reductions (e.g., CCfDs)

AFOLU

- Focus on afforestation and good forest management practices to increase the natural carbon sink capacity
- Implement sustainable agricultural practices to decrease use of chemical pesticides and fertilisers
- Develop a strategy for climate adaptation in the agricultural sector

Besides the sectoral recommendations based on modelling results, this report has also explored best practices in LTS development, highlighting some key aspects for a fit for purpose strategy:

- Include a clear commitment to net zero GHG emissions by 2050, with the ambition to reach it earlier
- Include scenarios presenting credible emissions reduction pathways, underpinned by a robust projection methodology and expert advice
- Plan for higher emissions reductions in earlier years
- Include sectoral targets and credible sectoral pathways for emissions reductions, taking into account national specificities
- Approach climate mitigation technologies with criticality and realism, prioritising efficiency of emissions reductions and outlining clear plans for onboarding innovative technologies where needed (including R&D and financing)
- Robustly address behaviour change, financing, and R&D as enablers of the proposed pathways, and present a detailed evaluation of the socio-economic impact of these pathways
- Ensure participation of governmental and non-governmental actors in the elaboration of the LTS
- Assign concrete implementation responsibilities, including monitoring and evaluation
- Ensure the LTS is aligned with short-term planning but also raises ambition in the medium- and long-term where relevant

A report written by **Energy Policy Group**

In collaboration with **Ecologic Institute**

as part of the **Climate Recon 2050** project

www.climatedialogue.eu

Follow us here:

@EUClimatePolicy