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COUNTRY CLIMATE AND DEVELOPMENT REPORT

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Acronyms

AAL	Average annual loss
AI	Artificial intelligence
AI/ML	Artificial Intelligence and Machine Learning
AKIS	Agricultural Knowledge and Innovation Systems
ALMPs	Active Labor Market Policies
AROP	At risk of poverty
ASF	Financial Supervisory Authority
BAU	Business-as-Usual
BEVs	Battery electric vehicle
CAP	Common Agricultural Policy
CBAM	Carbon Border Adjustment Mechanism
CC	Climate change
CCDR	Country Climate and Development Report
CCGT	Combined Cycle Gas Turbine
CCUS	Carbon capture usage and storage
CEE	Central Eastern Europe
CGE	Computable General Equilibrium
CISC	Interministerial Committee on Climate Change
CMB	Capital Market Board
CO2	Carbon dioxide
CO2e	Carbon dioxide equivalent
CoG	Center of government
COICOP	Classification of individual consumption by purpose
CPAT	Carbon Pricing Assessment Tool
CPI	Consumer Price Index
CPSD	Country Private Sector Diagnostic
CSA	Climate Smart Agriculture
CSR	Corporate social responsibility
CSRD	Corporate Sustainability Reporting Directive
DALYs	Disability Adjusted Life years
DCPP	Directorate for Coordinating Policies and Priorities
DESI	Digital Economy and Society Index
DFIs	Development Finance Institutions
DMDU	Decision Making Under Deep Uncertainty
DRM	Disaster Risk Management
DSD	Department for Sustainable Development
EC	European Commission
ECA	Europe and Central Asia
EE	Energy Efficiency
EGD	European Green Deal
ENVISAGE	Environmental Impact and Sustainability Applied General Equilibrium Model
EPBD	Energy Performance of Buildings
EPM	Electricity Planning Model
ESCO	Energy Services Company
ESD	Effort Sharing Decision
ESG	Environmental Social and Governance
ESR	Effort Sharing Regulation
ESRS	European Sustainability Reporting Standards
ETS	Emissions Trading System
EU	European Union
EU-SILC	European Union Statistics on Income and Living Conditions
EV	Electric vehicle
FAO	FAO dataset
FDI	Foreign direct investment
FGCR	Rural Credit Guarantee Fund
FNCGIMM	National Credit Guarantee Fund for Small and Medium Enterprises

FOLU	Forestry and Other Land Use
FRC	Romanian Counter-Guarantee Fund
FRMP	Flood Risk Management Plans
GCAM	Global Change Assessment Model
GCI	Green Complexity Index
GCP	Green Complexity Potential
GDP	Gross domestic product
GFC	Global Financial Crisis
GHG	Greenhouse gas
GSG	General Secretariat of the Government
GTAP	Global Trade Analysis Project
GVC	Global value chain
GW	Gigawatt
ha	Hectare
HDV	Heavy Duty Vehicle
HD-SDM	High-Dimensional Stochastic Dynamic Model
HICs	High-Income Countries
HOA	Home-Owner Associations
ICSD	Interdepartmental Committee for Sustainable Development
ICT	Information and communication technology
ILOSTAT	International Labour Organization Statistics
INECP	Integrated National Energy and Climate Plan
IP	Industrial policies
IPPU	Industrial processes and product use
IRA	Inflation Reduction Act
IWRM	Integrated Water Resource Management
JRC	Joint Research Centre of the European Commission
kg	Kilogram
ktoe	Kilotonne of oil equivalent
LSI	Latent Semantic Indexing
LTRS	Long-term renovation strategy
LTS	Long-Term Strategy
MAB	Multi-Apartment Buildings
MDBs	Multilateral Development Banks
MEIP	Ministry of European Investments and Projects
MEWF	Ministry of Environment, Water, and Forests
MFF	Multiannual Financial Framework
MFMod	The World Bank's Macro-Fiscal Model
MICROSIM	Micro-simulation
ML	Machine-learning
MMBtu	One million British thermal units
MOF	Ministry of Finance
MS	Member State
MSMEs	Micro, small, and medium-sized enterprises
MW	Megawatt
NACE	Nomenclature of Economic Activities
NBMP	Updated National Basin Management Plan
NBS	Nature Based Solutions
NDC	Nationally Determined Contribution
NECP	National Energy and Climate Plan
NGEU	Next Generation EU
NGFS	Network for Greening the Financial System
NGOs	Non-Governmental Organization
NRRP	National Recovery and Resilience Plan
NSP	National Strategic Plan
NUTS	Nomenclature of Territorial Units for Statistics
nZEB	Net Zero Energy Buildings
OECD	Organization for Economic Co-operation and Development

PEVC	Private equity and venture capital
PIAAC	Program for the International Assessment of Adult Competencies
PNASC	National Action Plan for Adaptation to Climate Change
PPI	Producer price inflation
PPP	Purchasing power parity
PPPs	Public-private partnership
PV	Photovoltaic
R&D+I	Research, development, and innovation
RCP	Representative Concentration Pathways
RDA	Regional Development Agencies
RER	Regular Economic Report
ROW	Rest of the World
RRF	Recovery and Resilience Facility
SCD	Systematic Country Diagnostic
SDM	System dynamic modelling
SMEs	Small and medium-sized enterprises
SNASC	National Strategy for Adaptation to Climate Change
SOE	State-owned enterprise
SSMS	Sustainable and Smart Mobility Strategy
SSP	Shared Socioeconomic Pathways
STEM	Science, technology, engineering and math
TCO	Total Cost of Ownership
TTW	Tank-to-wheel
TWh	Terawatt-hour
UHI	Urban heat island
UNFCCC	UN Framework Convention on Climate Change
VHI	Vegetation Health Index
WDLs	Working days lost
ZET	Zero Emission Truck

Executive Summary

Romania has made impressive strides in raising its economic performance over the past two decades but continues to face substantive economic, inclusion and sustainability challenges. Over the past couple of decades, Romania has achieved impressive economic progress, transitioning to a market-based economic model, acceding to the European Union (EU) in 2007 and reaching high income status. Between 2000 and 2022, living standards (real GDP per capita in PPP) more than doubled (from US$12,177 to US$32,738). From 2015 to 2020, the share of Romanians living below the upper-middle-income poverty line (i.e., on less than US$6.85-a-day in 2017 PPP) declined rapidly from 27.8 to 10.7 percent. However, with economic prosperity unevenly distributed, regional disparities in income and service delivery are wide, with poverty and inequality rates among the highest in the EU. Poverty remains highly concentrated in rural areas, which host approximately 70 percent of Romania's poor. The Systematic Country Diagnostic (SCD) of 2018 summarized the overarching narrative of the country's socio-economic development as 'A Tale of Two Romanias'. This continues today: one urban, dynamic, and integrated with the EU; the other rural, poor, and isolated. A range of structural challenges impact Romania's prospects for economically sustainable growth and inclusion, while also hampering the transition to a greener economic model, with a clear need for continued structural reforms going forward. Challenges related to institutional capacity; ability to absorb and deploy funds; and persistent structural challenges will need to be addressed to unlock the opportunities that the green transition can offer. (SCD Update 2023).

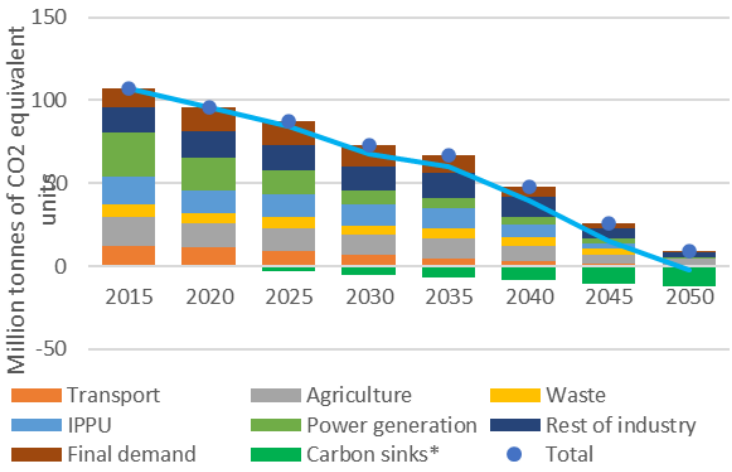
Romania is actively pursuing Net Zero by 2050 (Net0@2050). As a Member State (MS) of the EU, Romania has committed to key tenets of the European Green Deal (EGD): (i) reducing net GHG emissions by at least 55 percent by 2030, relative to 1990 levels ('Fit for 55'); and (ii) achieving net zero GHG emissions by 2050 ('net zero'). Given the substantial reductions in emissions in recent decades, the medium-term targets are within reach. According to Eurostat data, Romania already reduced its emissions from 1990-2018 by 53.2 percent, leaving it only a further 3.9 percent reduction to meet the goals of "Fit for 55" in 2030. While the EU emissions inventory report of 2023 shows even further emissions reductions for Romania, care must be taken in interpreting this trend, which has clearly slowed in the past few years and which has been distorted by reductions in emissions related to COVID. Indeed, the 2023 report notes that emissions increased in Romania from 2020 to 2021.[1]

Reaching Net0@2050 will present substantial challenges, requiring political and population buy-in. Achieving ambitious objectives will require substantive emissions reductions in hard to abate sectors and an additional 96 percent reduction in emissions even if the Fitfor55 target is met. Romania has passed a number of critical climate related laws in order to drive the decarbonization of the economy in the short run and importantly released its proposed Long-Term Strategy (LTS) in early 2023, which will follow into force in due course. In addition, it has established structures to encourage inter-governmental collaboration, the most important of which is the Interministerial Committee on Climate Change (CISC), currently displaying high buy-in at the political level. In the broader society, public concern about climate change now rates in the top five of socio-economic concerns. However, only a minority (just over 40 percent) of Romanians indicate willingness to pay for climate action.

[1] Some data presented in this report may not reflect the latest data available due to a combination of factors, including but not limited to: better representation of structural factors by pre-COVID data; alignment with the data underpinning the models used for the analysis; consistency with recently published World Bank reports; general cut-off point for the preparation of the report.

Early success in reducing emissions will need to be followed by very determined efforts to decarbonize, now and in the medium term, with action required across the whole-of-economy. While good progress has been made already in reducing Romania's emissions, much of this was due to structural changes in the economy during the post-Communist era. With an expanding economy and growing living standards (which, for instance, comes with higher material consumption and car ownership), there is a real threat that current emissions could increase, as opposed to meeting the current plans for Net0@2050. The required decarbonization will have to occur across the whole economy, requiring all sectors to raise energy efficiency and shift away from fossil fuels. Figure ES.1 demonstrates a potential pathway to achieve this, highlighting the need for additional focus and accelerated action on existing and future sectoral interventions. Notably, all sectors are to face major decreases in their current emissions levels, with power generation, agriculture and transport needing to accelerate their reductions substantially in the near term. The Figure also demonstrates the need to expand carbon sinks (specifically, additional forests and carbon capture - or other future technologies). These additional sinks will be critical to balance residual emissions in later years to reach Net0@2050 and their achievement will require deliberate policy and regulatory interventions to rationalize land use and increase afforestation.

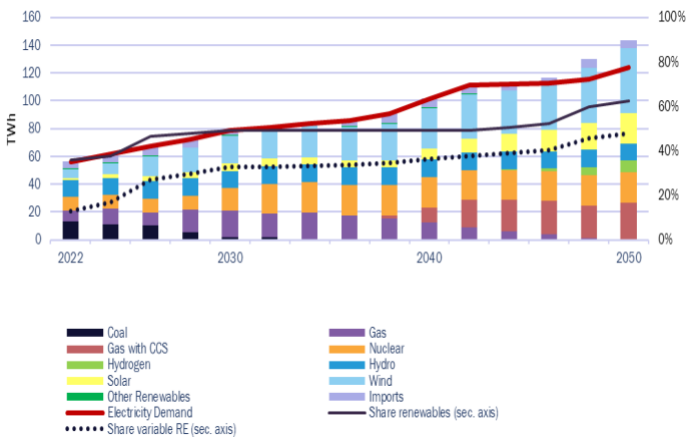
Figure ES.1: Achieving Romania's net zero targets



*Source: World Bank simulation based on CGEBox, in coordination with other models, with GTAP as the primary data source. Note: 'IPPU' denotes Industrial Processes and Product Use. *Carbon sinks reflect additional sinks compared to current stocks.*

Shifting from direct fossil fuel consumption to an electrified economy based on low carbon sources will require a major transition including a massive electrification program. Although the carbon intensity of energy has fallen in the past twenty years, it remains very high. Currently over 70 percent of Romania's total energy usage is dependent on fossil fuels, with transport, industry and residential heating being the main consumers of high carbon fuels. On the other hand, only 34 percent of electricity generation is fossil fuel based, with the other 66 percent coming from renewables and nuclear power. To reduce the dependency on fossil fuels and reach Net0@2050, a massive electrification program will be necessary to remove direct consumption of fuels and replace it with energy generated from non-fossil fuel sources. Results of modelling (Figure ES.2)

Figure ES.2: Evolution of power generation under the proposed net zero pathway



Source: EPM in coordination with other models.

indicate that 47 percent of power generation would come from solar and wind by 2050 under the net zero pathway, with an additional seven percent from hydropower, five percent from green hydrogen and one percent of other renewables, bringing the share of renewables to 60 percent. All coal-based generation will be phased out from 2032, and limited nuclear generation is projected to be added after 2030, representing 13 percent of generation by 2050. By the mid-2030s, Carbon Capture, Utilization and Storage (CCUS) will have to be deployed and scaled up rapidly to decarbonize natural gas-based power generation, which has an important role to play in balancing out the variability of solar and wind power, reaching a 23 percent share by 2050. The remaining 4 percent share will be covered with electricity imports.

While electrification and economic growth may double demand for electricity, the incremental cost of developing a greener, renewable power system does not substantially increase investment needs. Under all scenarios, the modelling of the CCDR shows that demand for electricity will more than double as a result of electrification and growth. Analysis presented in this CCDR (Figure ES.2) and also the LTS show that this switching is possible, mainly using existing power generation technologies, and with only limited reliance in later years on technologies that are currently not fully mature (e.g., green hydrogen and industrial carbon capture). Notably, the incremental cost of developing a greener, renewable power system versus a non-green approach does not substantially increase investment needs. However, the build-out and strengthening of electricity transmission and distribution networks will be essential to success. Battery storage, critical to support the rapid growth of renewables, is projected to reach 4 GW of capacity by 2030 and more than 11 GW by 2050, although its early uptake may require policy support and some grant financing. The NECP estimates a need for 400 MW of battery storage by 2030 but achieving regional climate neutrality by 2050 will require a rapid deployment of larger amounts of storage.

It will be critical to increase energy efficiency in buildings, especially through better insulation, with a sizeable role for private finance to complement national and EU public funding. Per the revised EU Directive on the Energy Performance of Buildings (EPBD 2010/31/EU), every EU member state must develop a long-term renovation strategy (LTRS) to achieve a near-zero energy building stock by 2050 (the so-called Renovation Wave). Currently, approximately 0.5 percent of the Romanian building stock is renovated per year, with the LTRS indicating a gradual increase to 3.39 percent per year by 2030. The LTRS estimates total investment needs in the amount of €12.8 billion by 2030, which may grow to €16-18 billion due to rising costs. A major challenge with the plan is that 61 percent of the costs are expected to come from private and commercial sources. The NRRP already allocates €2.2 billion to the Renovation Wave, but more capital needs to be urgently mobilized and financing models created to catalyze the provision of private finance. Additionally, this level of renovation will require a 500 percent increase in the number of suitable workers and a 600 percent increase in the number of architects and engineers.

Households and the services sector are ready for greater electrification and energy efficiency, though solving high up-front costs for the poorer consumers will require more support. The residential and services sectors together account for almost 40 percent of the country's demand for natural gas, 50 percent of electricity demand, and 74 percent of district heating demand. Furthermore, rising temperatures are expected to boost demand for cooling and change its seasonal profile. Decarbonization will require further electrification of cooking appliances and the adoption of heat pumps for individual heating systems (preferably reversible heat pumps, capable of cooling in the summer); the latter in particular will require innovative financing instruments with potential blending with grants, given their considerable up-front costs. For the poorest households, which currently burn wood for heating, the impact of heat pumps on electricity bills may make them unaffordable even if installation costs were fully covered by grants.

Decarbonizing district and other centralized heating systems remains a challenge, yet with abundant untapped opportunities. District, large-neighborhood, and centralized building heating systems remain an important source of heating in Romania, although their user base shrank by 85 percent, to only 1.3 million people, between 1992 and 2020. Low-temperature renewable heat from geothermal, solar thermal, bioenergy, and waste heat sources is widely available in many regions of Romania but remains untapped due to limited technical capacity and the need to renovate and adapt existing infrastructure.

Industry faces a double challenge of needing both to move up value chains and to decarbonize, yet existing technologies present some already workable solutions. Industry accounts for almost 46 percent of the country's total electricity demand (plus direct consumption of 26 percent of natural gas, 17 percent of coal and 10 percent of oil used in the country). The emissions intensity (measured in CO2 equivalent emissions per euro of value added) of Romanian manufacturers is three times greater than the EU27 sectoral average, and more than twice as high as the sectoral average of peer countries such as Poland and Hungary. Bringing emission intensity in manufacturing down to the EU27 average level would lower Romania's *total* GHG emissions by 14 percent, while matching the levels achieved in best-performing Denmark would cut total emissions by 25 percent, although the latter goal would require moving up the value-added ladder, in addition to reducing actual emissions. In the short-term, reductions are achievable in light industry through i) energy efficiency; ii) using renewable sources for low- to medium-temperature heat production; iii) electrifying manufacturing processes; and iv) substituting existing processes with low-carbon alternatives. Moreover, certain industrial processes (e.g., fertilizers production) may substitute natural gas with green ammonia produced with electricity from renewables. For heavy industry CCUS and green hydrogen solutions are expected to play an important role, but their current cost is unattractive. The EU's Carbon Border Adjustment Mechanism (CBAM), set to take effect in 2026, will have an influence on the pace of industrial decarbonization, though more work is needed to understand its full impact on the value chains.

The double development-climate challenge pertains also to Romania's transport sector, which remains underdeveloped, holding back growth; and is both critical to Net0@2050 and hard to abate. The subpar quality of transport infrastructure is one of the key bottlenecks to Romania's competitiveness, development and its convergence with the EU. The country faces a range of transport-related challenges, including regional disparities in connectivity and vulnerability to climate change. Despite sizeable EU funds providing a boost for significant public investment, especially focused on roads, Romania still lags in Europe in terms of transport infrastructure and service quality (please see Romania Country Private Sector Diagnostic for more details). Emissions from the sector increased by 50 percent from 2005 to 2019, now accounting for 17 percent of total and set to rise in the absence of increased climate action. 96 percent of transport emissions relate to road transport – in 2019, 95 percent of passenger kilometers were by car or coach and 70 percent of tonne-kilometers were by truck, the impact of which is exacerbated by a vehicle fleet 40 percent older than the EU average.

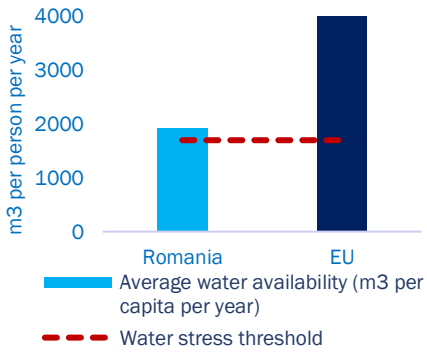
Accelerating investments, deploying existing technologies and encouraging behavioral shifts can already help curb transport emissions and help put the sector on the decarbonization path. The decarbonization of the transport sector will rely on reducing the number of road trips, shifting transport to urban transit systems and rail, and progressively replacing the existing fleet with low and no-emission vehicles. Promoting active mobility and public transport to reducing the number of road trips should be prioritized, especially in urban areas, through the expansion of dedicated space for public transport vehicles, parking and access management strategies (including pricing instruments), investing in cycling infrastructure, and developing High Speed Rails (HSR), i.e., the construction of HSR between Constanta and the Hungarian border at Oradea. On freight transport, accelerating investments to renew the railway infrastructure –more than 60 percent of the railway network were due for renewal as of 2020– and improve the sector's performance will be key to achieve the Romanian RRP target of shifting 10 percent of freight road traffic to rail by 2026, and subsequent decarbonization objectives.

Interventions should also aim at strengthening intermodal transport through more seamless and efficient intermodal transitions (e.g., with inland waterways transport). Moreover, decarbonizing the trucking sector by improving fuel efficiency in the shorter term and the progressive uptake of Zero Emission Trucks (ZET) is crucial, as it will likely remain relevant even with a significant modal shift to rail. Likewise, the electrification of passenger cars needs to be accelerated, aiming at reaching 50 percent of new registrations of passenger cars and vans being zero-emission by 2030, and 90 percent by 2035, including second-hand imports. To reach these targets of replacing the vehicle fleet, the Government should deploy a mix of policies including targeted measures to reduce the share of second-hand vehicles, carbon taxes on road fossil fuels—with appropriate compensatory measures, differentiated vehicle taxation or feebates for low emitting vehicles, incentives to electrify highly utilized fleets and tailored financing instruments and charging schemes, with particular support to small capital-constrained enterprises and vulnerable users to ensure a just transition.

Partnering with the private sector to deploy publicly accessible and rapid charging infrastructure with large coverage would be a key enabler for the transition to e-mobility. Considering the instrumental role of e-mobility in the decarbonization of the transport sector—especially for passenger vehicles which showcase rapidly decreasing costs, the strengthening of the charging network with a larger number of chargers, increasing coverage and reducing charging time, should be a priority. Incentivizing charging tariffs, deploying tax incentive schemes, financing mechanisms, and partnerships can help improve the business case for private sector investment and ensure fast build-up of charging infrastructure.

Water is among the most urgent emerging issues in both adaptation and mitigation agendas in Romania, with critical development gaps also yet to be plugged. On the adaptation side, climate change and natural hazards pose a twin threat to continued growth. In terms of nature related risks, Romania faces twin threats to its long-term growth—the impacts of climate change and exposure to natural hazards. Climate change in Romania will particularly impact hydrological cycles, altering the timing, frequency and intensity of precipitation. Romania already faces a dichotomy—on the one hand already close to the water scarcity threshold (Figure ES.3), including manifesting through recent droughts; and on the other severely at risk of flooding, with projected potential annual losses of up to almost €2 billion per year. The development challenges related to the sector are clear—Romania had the highest percentage of population (21 percent) without access to basic sanitary facilities in 2020, water is critical to low carbon power generation (both hydro and nuclear); transport decarbonization hinges on using maritime and river routes, and traditionally rainfed agriculture is increasingly needing irrigation. The need for Romania to dramatically increase its implementation of Integrated Water Resource Management (IWRM) is urgent.

Figure ES.3: Water availability



Source: Bank Staff with Eurostat data.

Rising temperatures and an increased frequency of heatwaves will pose additional threats to the economy, people, and infrastructure. Urban climate projections show a substantial increase in urban heat by 2050 (50 percent increase in the number of heat-wave days in a high-emissions climate scenario) and it is estimated that fatalities associated with extreme temperature events already increased 25 percent in the 1991–2018 period. This effect is further exacerbated by the tendency of built-up neighborhoods to absorb and trap heat (the Urban Heat Island {UHI} effect) and is a particular problem for urban populations (where also much of the economic activity is concentrated), with heatwave days in Bucharest and Cluj more than three times the surrounding rural areas. Addressing this challenge will lead to an increase in demand for energy for cooling (and thereby increased

emissions) unless proactive steps are taken to reduce the UHI effect through a greening of urban spaces in conjunction with deployment of other technologies and approaches that reduce temperature absorption of structures and shared spaces.

The combined threats of water scarcity, increased variability of precipitation and increasing heat pose significant challenges to the agricultural, land-use and forestry sectors. With agriculture accounting for around 20 percent of labor and 4 percent of GDP, it holds an important socio-economic place in Romania. With already relatively high interannual variability, growth has been characterized by expansion of low-value commodities; contraction of other agri-food and livestock sectors; modest gains in productivity; and erratic yield patterns. Climate change will increase weather related losses, particularly under non-irrigated conditions, further increasing the divide between large- and small-scale producers where the latter are less able to manage risks. Expansion of irrigation systems in particularly drought prone areas should be a priority, while simultaneously identifying the drivers behind current low usage rates of existing irrigation infrastructure and risk management tools available under the EU Common Agricultural Policy (CAP). Analysis in the CCDR demonstrates that Romania has the potential to undertake large scale land rationalization and associated expansion of forestation, while even expanding overall agricultural production.

Investing in mitigating the impacts of earthquakes and energy efficiency in tandem presents an opportunity to save scarce funds. Although not related to climate change directly, seismic risks in Romania also remain very high (third in the EU based on loss ratios). While seismic risk is not impacted directly by climate change the issues are linked because Romania's existing building stock accounts for 42 percent of total final energy consumption and is highly vulnerable to seismic risks. To cope with the high seismic risk and to achieve significant energy efficiency co-benefits, almost 4 million pre-1980 Romanian buildings (of which around 95 percent are single-family dwellings) located in areas exposed to medium/high seismic hazard will need retrofitting or reconstructing, and rehabilitation. Considerable savings are possible from leveraging the synergies of seismic and energy efficiency renovations.

Romania has the potential to significantly improve its living standards while decarbonizing the economy towards the climate objective of reaching Net0@2050. Although the challenges to achieving decarbonization are high and necessitate considerable structural and complementary socio-economic reforms, analysis indicates that Romania’s economy has the potential to benefit from a strong convergence dynamic with above EU average GDP growth rates over the coming decades, almost tripling standards of living by 2050 (Figure ES.4). Simulations undertaken as part of the CCDR analysis show only marginal (2 percent) foregone GDP compared to a business-as-usual path where net zero targets are not achieved and only towards the end of the period, where projections are highly uncertain (Figure ES.5). Analysis also points to limited external competitiveness effects, in part due to the rest of the EU being Romania’s main trading partner. However, these findings hinge not only on the cost-competitiveness of the existing technologies for energy decarbonization and continued structural reforms, but also on the implementation of efficient carbon pricing, i.e., the pricing of carbon at social cost across all sectors of the economy where the carbon externality is present.

Figure ES.4: With Romania's high growth potential (hinging on structural reforms), standards of living can almost triple by 2050

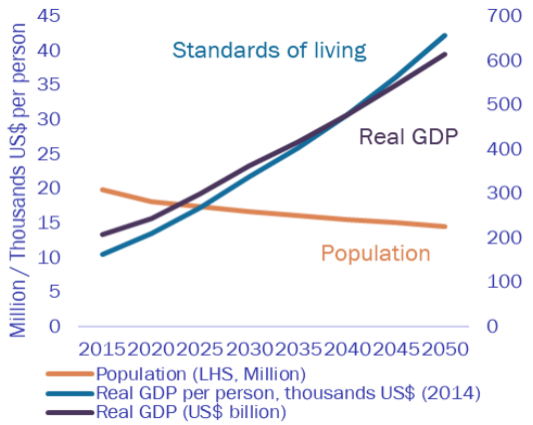
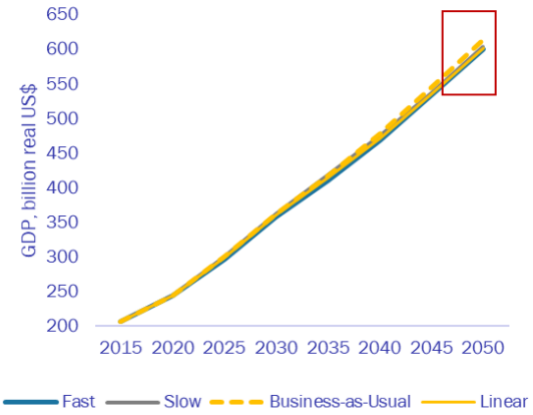


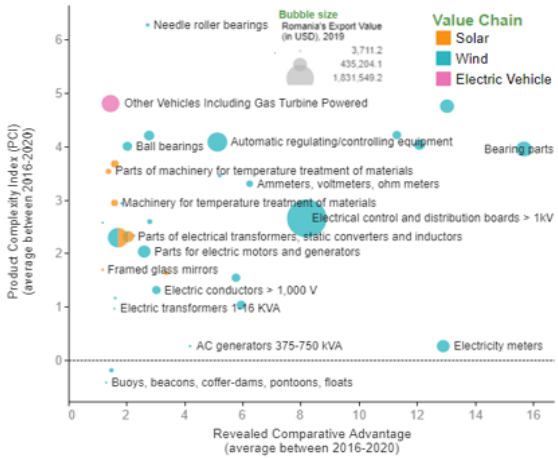
Figure ES.5: The cumulative impact of decarbonization on the size of Romania's economy is modest, provided complementary policies to minimize trade offs are pursued



Source: World Bank simulations using CGEBox in coordination with other models

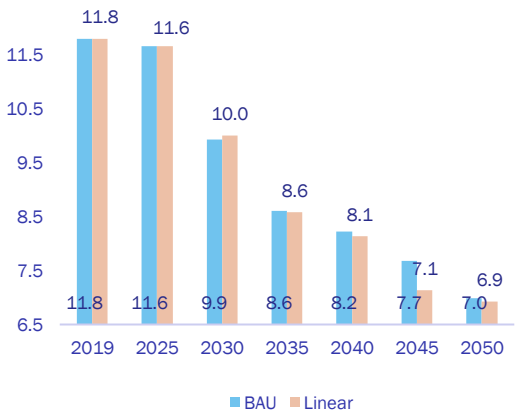
There are concrete green economy opportunities in the short term, building up Romania's existing strengths and potentially moving it up the value chains. The transition to a green economy will present unprecedented opportunities for growth, development, and technological upgrades. Seizing upon these opportunities will require companies and businesses who, in addition to needing suitably trained labor, will also need access to finance and an enabling environment that is stable. Based on the World Bank's Green Transition Navigator, analysis shows that Romania has advantages plugging in to the value chains for low-carbon energy generation—particularly wind (Figure ES.6). This highlights some concrete opportunities for Romania to move up the sectoral value chains, which is important both for its competitiveness and for reducing emission intensity in the economy.

Figure ES.6: Romania Green Opportunities



Source: World Bank Green Value Chain Explorer, using 2016-2020 data

Figure ES.7: Projected Evolution of Poverty Rate (AROP, fixed at 2016), BAU vs linear decarbonization scenario



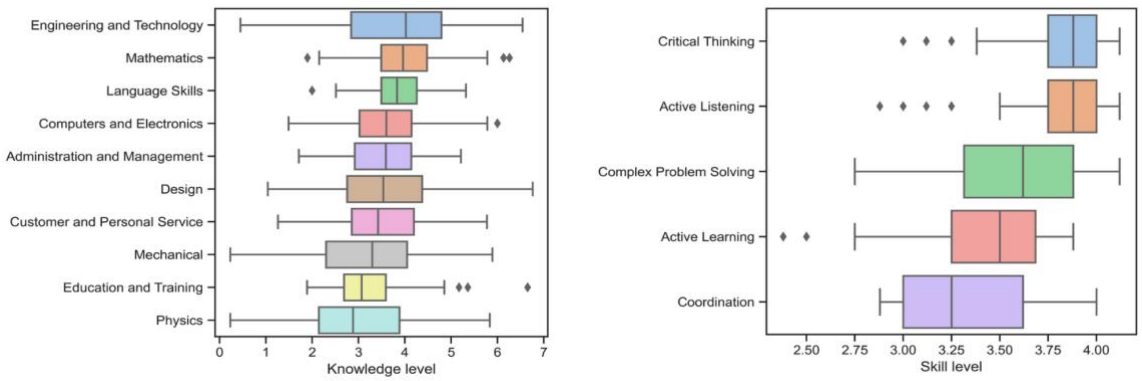
Source: World Bank estimates based on microsimulation; poverty measure is anchored at-risk-of-poverty Poverty rate (percent) at 2016

Importantly, distributional simulations indicate that, even ambitious decarbonization policies need not significantly affect the overall pace of national poverty reduction and may even improve its prospects. Simulations showcase that policies to achieve Net0@2050 do not have a significant impact on the overall rate at which poverty is reduced and may even accelerate poverty reduction in the long-term (Figure ES.7). While there are no major impacts on the pace of poverty reduction at the national

level, decarbonization policies can have disproportionate impacts in lagging regions, and on certain population groups, necessitating targeted interventions. The micro simulation results (coordinated closely to energy and macro simulations) indicate that while reaching net zero and reducing poverty is feasible, careful consideration of the tradeoffs between poverty and environmental goals is required; both must be addressed in a coordinated and integrated manner to achieve long-term sustainable development. Well-funded and targeted social transfers may play a crucial role in facilitating the green transition and can lead to a better long-term path toward poverty reduction than the business-as-usual (BAU) scenario without achieving net zero emissions (see Annex 1 for the summary of modelling assumptions).

Human capital and skills development will be critical to achieving economically and environmentally sustainable growth. As articulated in the SCD Update and the CPSD, Romania already faces considerable skills gaps, impeding the quality and inclusiveness of economic growth. The potential to achieve not only economically but also environmentally sustainable growth rests not only on suitable policies and investments—it is critically linked with the development of human capital. To enable green transition at the macro level, and to ensure the labor force and households can benefit from the transition, existing and future workers will need to be upskilled, including through rethinking school education and leveraging Active Labor Market Policies (ALMPs) to help vulnerable population groups, in particular women and the Roma, adapt to the green economy and contribute to a new productive model, based on new technologies and a circular approach to production and consumption (World Bank 2023). The ability of education systems to deliver not only the skills, but the research, development, and innovation capacity for technological change, is essential to achieving the EGD goals. Figure ES.8 shows that not only do the emerging green jobs in Romania require more skills, but also ones that Romania currently lacks. Given that the availability of these new green jobs and specialized training is currently mainly available in major urban centers, measures will be needed to ensure that existing spatial disparities are not further worsened. A strengthened adaptive social protection system will be needed to ensure support for workers that lose their jobs but cannot transition to greener roles.

Figure ES.8: Romania Green Opportunities



Source: World Bank calculations based on AI/ML analysis.
*Note: Skill levels min: 0, max: 5, Knowledge levels min: 0, max: 7. Knowledge definitions: O*NET. Skills definitions: O*NET.*

The whole-of-economy green transition will require substantial investments: the green development investment needs in key selected sectors are estimated at around 3 percent of cumulative GDP by 2050. The investment needs capturing development and climate mitigation in key decarbonizing sectors—electricity, buildings, and transport—are estimated at US$356 billion up to 2050 (2.9 percent of cumulative GDP) with more uncertain additional investment needs in other sectors. An additional US$160 billion (1.3 percent of cumulative GDP) investments may be required for climate adaptation. Mobilizing public, blended, and private finance hinges on putting in place appropriate institutional and governance frameworks and incentives (including efficient carbon pricing across emitting sectors),

enabling the financial sector to efficiently allocate capital toward the transition to net zero. Although public financing (including from the EU funds) will play a critical role, Romania faces substantive fiscal constraints, and incentivizing green investment from the private sector will be key. With reduced fiscal space, it will be critical to galvanize green private investment through price signals (manifested through the carbon pricing, with instruments such as ETS, carbon taxes, and fossil fuel subsidy reductions) that direct investors towards cleaner sectors and technologies. However, as the financial industry remains less developed than the EU27 average, both developing and greening the financial system will be required in tandem, including through efforts on fundamental financial sector reforms to improve access to credit, increase capital market financing, and expand the private equity, venture capital and asset management markets, in synergy with green finance development.

Long term success will depend on proactivity in the immediate future to define clear goals and actions and to ensure coordinated responses. To meet the interim goal of Fitfor55 and put in place the critical foundations for deeper decarbonization that will be needed to achieve Net0@2050, the CCDR presents a number of priority recommendations (Figure ES.9) which will require the government's attention in the short and medium term, as well as already laying foundations for action further down the line. Notably, these recommendations and the overall analysis of the CCDR are very well aligned with the recently released LTS. To implement these recommendations and to deliver on the LTS, collaboration and coordination across government will need to be further deepened and strengthened. The role of CISC in this process will be critical, especially in its ability to convene ministries and agencies around particular sectors and challenges, where multi-stakeholder planning and implementation will be needed for success.

Recommendation:	Consisting of:
Increase electrification and fuel switching	Increasing renewable generation to about 735 MW per year up to 2030; reducing connection and administrative constraints; increase competition and transparency in wholesale and balancing markets; progressively redress price-distorting emergency measures taken during the energy crisis in 2022 and 2023; urgent investment in transmission and international interconnectors; focused development of hydrogen resources; and implementation of the Just Transition and specifically Territorial Just Transition Plans.
Increase energy efficiency	Increase the renovation pace from current 0.5 percent to 3.4 percent of the building stock per year, mobilizing investments of over €1.6 billion per year–over €1 billion per year of private investment. Introduction of financial products to incentivize attracting private capital and increasing stability in the EE renovation market. Additional focus on companies and industry through financial products.
Increase strategic management of water resources	Improve governmental integrated water resource management systems; enhance diagnostics related to climate change, water availability and water accounting; invest urgently in water storage and irrigation systems; integrating economic value of water in power wholesale market to optimize water use for electricity generation; and development of drought/flood risk management plans.
Build and protect human capital	Focused interventions to reduce existing skills gaps and provide enhanced skills needed for green jobs; introduction of active labor market policies and social protection systems to protect displaced workers.
Accelerate decarbonization of transport	Meeting the NRRP target of 10% shift from roads to rail by 2026 and targeting a 25% shift by 2050. Accelerate the electrification of the road vehicle fleet through a range of measures, aiming at 50% of new registrations of passenger cars and vans being zero-emission by 2030 and 90% by 2035 (including second-hand imports). For trucks, outperforming the currently adopted C02 emission standards for new HDV is crucial and target should be 70% of new registrations being zero emission by 2035 (including second-hand imports), accelerating thereafter.

Improve fiscal incentives	Reduced consumer energy related subsidies; introduction of carbon pricing through aligning environmental tax burden; and use of carbon tax revenues to accelerate the green transition and adoption of green technologies.
Deepen government collaboration and coordination	Enhance existing government systems of collaboration (CISC); deepen sectoral collaboration on specific transition issues (e.g., transport); expand knowledge sharing across government and between central through to local administrations; increase monitoring and analysis of results

1. Climate and development context

1.1. Development context

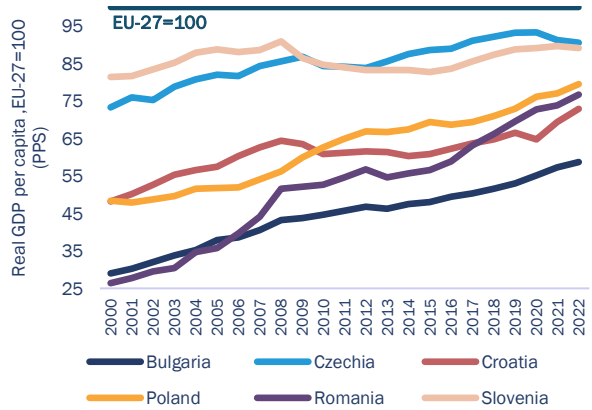
Romania has achieved the status of high-income country and remains on a path of economic progress. As outlined in the 2018 Systematic Country Diagnostic (SCD) and the SCD Update (2023), Romania has made impressive strides in economic performance over the past two decades, transitioning to a market-based economic model, acceding to the EU in 2007, and reaching high income status. On many key metrics, the country's growth during this time has been among the fastest in the EU: between 2000 and 2022, income per capita in PPP (2017 international US$) rose from 26.4 percent to 76.7 percent of the EU average (Figure 1), real GDP per capita in PPP more than doubled (from US$12,177 to US$32,738), and GDP grew at an average annual rate of 3.8 percent (nearly triple the EU average).

While robust economic growth has translated into poverty reduction, Romania still has among the highest poverty rate in the EU. Between 2015 and 2020, the share of Romanians living below the upper-middle-income poverty line (i.e., on less than US$6.85-a-day in 2017 PPP) declined rapidly from 27.8 to 10.7 percent, on the back of strong labor markets domestically and across the EU and rising labor and pension incomes. However, the country's poverty rate remains among the highest in the EU, and inequality is acute. The Gini coefficient of equivalized disposable income was 34.3 in 2020 (improving to 32 percent in 2022), among the highest among EU members, while the impact of social transfers on reducing poverty and inequality is among the weakest in the bloc.

With economic prosperity unevenly distributed, a 'tale of two Romanias' persists. Regional disparities in income and service delivery are wide. Poverty is highly concentrated in rural areas, which host approximately 70 percent of Romania's poor. The SCD 2018 summarized the overarching narrative of the country's socio-economic development as 'A Tale of Two Romanias': one urban, dynamic, and integrated with the EU; the other rural, poor, and isolated (Figure 2). The population in the bottom 40 percent of the income distribution has limited access to opportunities for productive employment and struggles to benefit from the country's growth. Poverty and inequality also have a strong ethnic dimension with Roma populations facing stark gaps from non-Roma across all development indicators. Nearly half of those in the bottom 40 percent do not work, a further 28 percent are involved in subsistence agriculture and only 41 percent of Roma adults have paid work as their main activity. Social disparities are widening, with vulnerable groups (for example, the Roma) suffering from multiple forms of deprivation. Moreover, the gender gap in labor force participation is the largest in the EU.

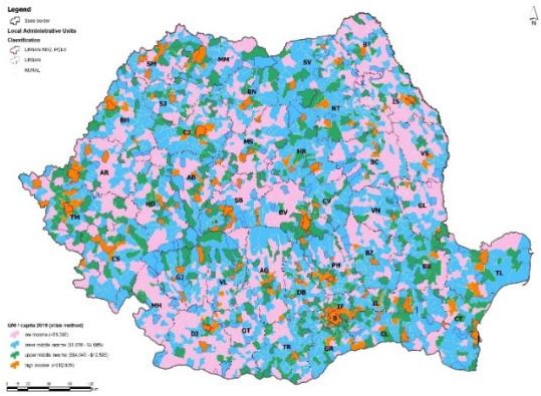
A range of structural challenges affect Romania's prospects for growth and inclusion, while also hampering the transition to a greener economic model. Weak fundamentals threaten the economic sustainability of Romania's development over the long term. Growth remains largely consumption-driven and institutional reforms are needed to sustainably boost public investment and improve the business environment. The private sector is dynamic with relatively high levels of investment but remains underdeveloped. The combination of a shallow financial sector and the prevalence of micro, small, and medium-sized enterprises (MSMEs) constrain the availability of long-term funding. Notably, Romania has one of the lowest levels of financial intermediation in the EU, both in banking and capital markets. The quality and quantity of available labor and capital, as well as slow productivity growth, limit the country's potential and its international competitiveness. The population is shrinking due to emigration and ageing, while widespread inactivity among women and the young depresses labor force participation rates. Skills shortages and mismatches—already the most widely reported constraint for businesses, with vacancy rates doubling between 2013 and 2019—are growing ever more acute. Despite a thriving ICT sector, the basic digital skills of the Romanian population are the poorest in the EU. The vast shadow economy, estimated at 21 percent of GDP (EC 2019), generates additional challenges.

Figure 1: Boosted by one of the highest rates of economic growth in the EU, Romania's living standards have been converging toward the bloc's average



Source: Eurostat

Figure 2: Romania is a high-income country, but vast rural areas have low-income status



Source: National Institute of Statistics

In parallel, governance and institutional constraints impede responsive and coordinated policymaking, private sector development and investment, as well as progress on environmental sustainability. Political volatility is high—the average tenures of Prime Ministers and cabinet members are among the shortest in the EU— leading to constant change in priorities and discontinuity in reforms. Firms routinely cite political instability and corruption among the top five constraints in the business environment. The insufficient administrative capacity of public institutions, and a lack of cross-sectoral and cross-institutional collaboration result in limited strategic planning, less-than-adequate policymaking and reform implementation, and low absorption and use of EU funds. Inefficient public investments and scarce capacity for their planning hamper the provision of public services in key sectors such as healthcare, education, energy, and water. Strikingly, Romania is the only country in the EU without universal access to water and sanitation (see SCD Update 2023 for more details).

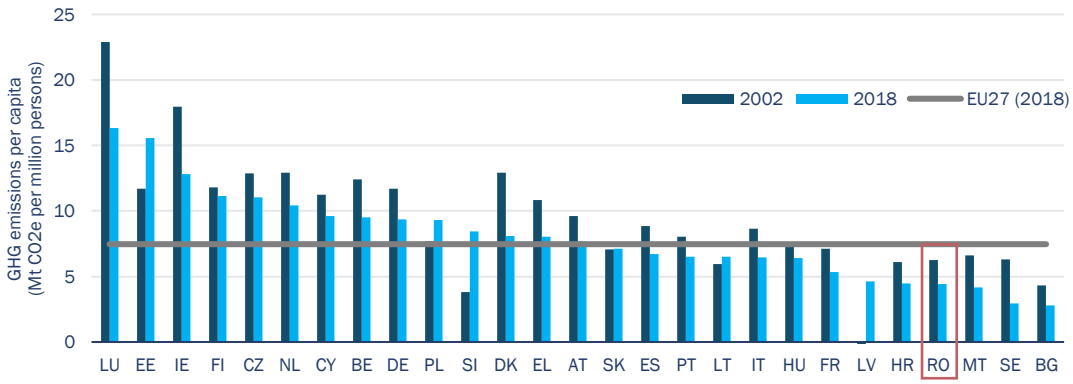
1.2. Climate and environmental challenge

Romania's greenhouse gas (GHG) emissions are relatively low and have been declining in recent years (Figure 3). Romania contributes approximately 3 percent of the EU's emissions, while accounting for 1.2 percent of the bloc's GDP and 3.8 percent of its population (as of 2019). Notably, emissions have been on a downward trend—including on a per capita basis, despite a shrinking population. Economic activity[2] accounts for 82 percent of Romania's GHG emissions, with the remaining 18 percent generated by households. However, without policy action, emissions are projected to increase, and risk compromising the achievement of targets set out in the Paris Agreement and the European Green Deal (EGD).

Emission intensity in the country remains high, signaling the need for a shift to different forms of economic activity that sit higher up on sectoral value chains (Figure 3). At 0.61 kg CO2e/€ of value-added, Romania's emission intensity (i.e., the ratio between emission levels and value-added produced) is almost 2.5 times higher than the EU27 average (Figure 4). Although emission intensity has decreased by a third in Romania over the past decade—due to a 10 percent drop in emission levels and a 40 percent increase in value-added—it remains high, largely because the value-added generated in the country is still limited. For Romania, success in reducing emission intensity will hinge on both moving up the value chain and reducing GHG emissions through greater energy efficiency and a shift to renewable energy.

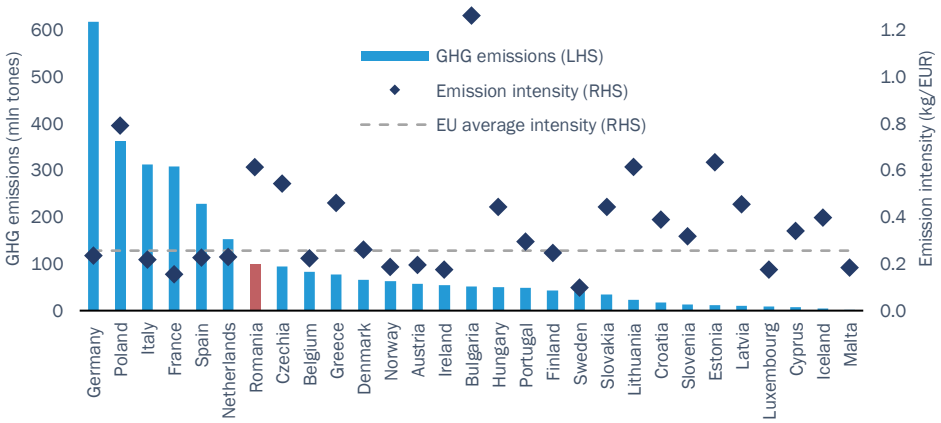
[2] Economic activity encompasses all activities with NACE Rev. 2 codes, including, among others: agriculture, manufacturing, supply of electricity, gas, and water, construction, wholesale and retail trade, public administration, education, and healthcare.

Figure 3: Romania's emissions per capita are below the EU average and have been declining



Source: Eurostat

Figure 4: Total GHG emissions (LHS) and intensity (RHS) from economic activity in Europe, 2021



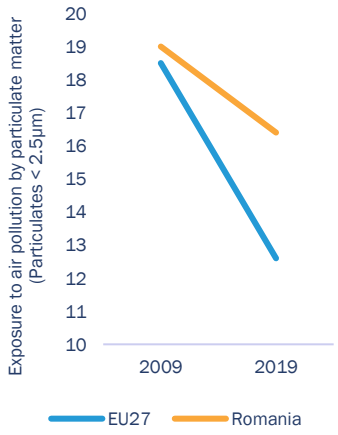
Source: World Bank analysis based on Eurostat.
Note: Following Eurostat, the emission intensity is defined as kg CO2-eq/EUR value-added (chain linked volumes, 2010).

Similarly to GHG emissions, the levels of broader pollution and other environmental externalities have been declining, but remain above the EU average (Figure 5). Bucharest is one of Europe's most polluted cities, while waste management in the country relies on landfills at the highest rate in the EU, and recycling rates are among the lowest in the EU (0.39 tons per capita, versus the EU average of 2.30 tons per capita, per Eurostat). At a time when the EGD highlights the importance of the Circular Economy, Romania is the least circular economy in the EU: only 1.4 percent of the materials used in the country in 2021 were sourced from recycled waste,[3] and more than 98 percent of all materials eventually go to waste (just over half of them in landfills).[4]

Romania's natural capital calls for increased environmentally sustainable growth actions. Romania's overall forest sink has not expanded in comparison to the levels recorded in 1990 and has showcased a slight declining trajectory since 2016 (Figure 6). Although significant measures have been taken in recent years to address the issue of overexploitation of forests and combat illegal logging through enhanced wood traceability, it is imperative to substantially scale up measures to achieve the required sinks for net zero by 2050.

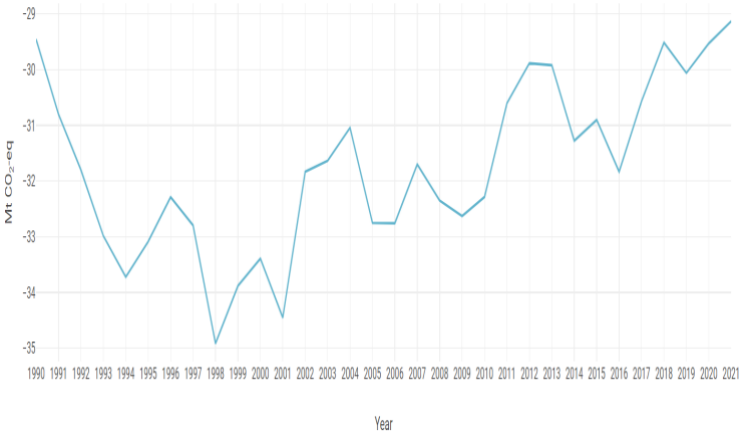
[3] ec.europa.eu/eurostat/databrowser/view/cei_srm030/default/table?lang=en
[4] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_management_indicators&oldid=590469#Landfilling

Figure 5: Air pollution in Romania has been decreasing, but remains above the EU average



Source: Eurostat (sdg_11_50)

Figure 6: Emissions and removals of CO2-eq from forest land, Mt CO2-eq



Source: European Environment Agency (EEA) greenhouse gase—data viewer provided by EEA, based on national emissions reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism

Romania is vulnerable to a wide range of hazards induced or exacerbated by climate change, especially floods and droughts, exposing Romania to significant macro-fiscal risks. Exposure to flood risk, already considerable throughout most of the country (Figure 7) is set to increase due to climate change. Moreover, a Europe-wide drought event in the summer of 2022 had severe impacts in Romania—especially on crop yields, and on access to water in certain urban areas. In 2016, a National Risk Assessment coordinated by Romania's General Inspectorate for Emergency Situations had already found that 48 percent of agricultural land in the country was vulnerable to drought, especially in southern and south-eastern regions (Figure 8). Overall, Romania has already suffered an estimated €12 billion in losses (99 percent of which were uninsured) and more than 1,300 fatalities due to climatological and hydro-meteorological events since 1980[5]—including 36 river floods that affected 368,000 people, causing 403 deaths and €2.6 billion of damages, as well as 11 cold waves and eight heatwaves. According to the Joint Research Centre of the European Commission (JRC), more than 660,000 people in Romania are exposed to windstorm hazards, with an estimated €83 million in annual damages.[6] The potential resulting damage to natural, physical, and human assets can curtail economic growth while deepening inequality, as poorer counties in Romania and vulnerable segments of the population living in those spaces are disproportionately impacted by disaster risk.

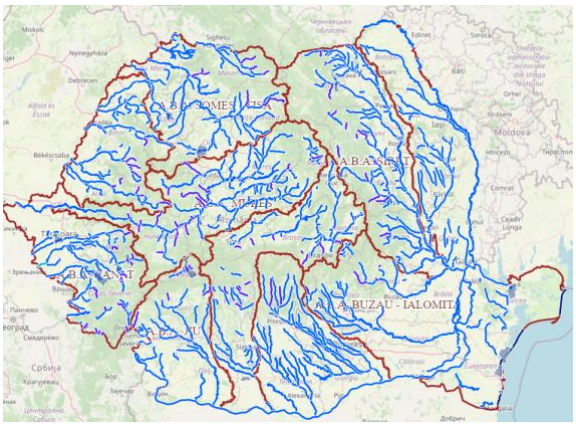
Despite its high vulnerability to the risks of climate change, Romania is not sufficiently ready to respond and adapt to them. Although the country has made significant efforts to strengthen its institutional framework for disaster response over the past decade and has developed a framework for adaptation[7], more needs to be done to mitigate disaster risk and adapt to climate change. In certain sectors—notably, agriculture and forestry—adaptation measures will also help mitigate the effects of climate change. In this context, well-funded and adequate response systems are crucial. In addition, enhanced financial and social protection systems will ensure not only direct support to the population, but also the foundation for effective mitigation efforts.

[5] MunichRe NatCat database https://www.munichre.com/en/solutions/for-industry-clients/natcatservice.html.

[6] Romania Disaster Profile from World Bank. 2021. Financial Risk and Opportunities to Build Resilience in Europe. Economics for Disaster Prevention and Preparedness.

[7] National Adaptation Framework, accessible here http://mmediu.ro/categorie/cadrul-national/408

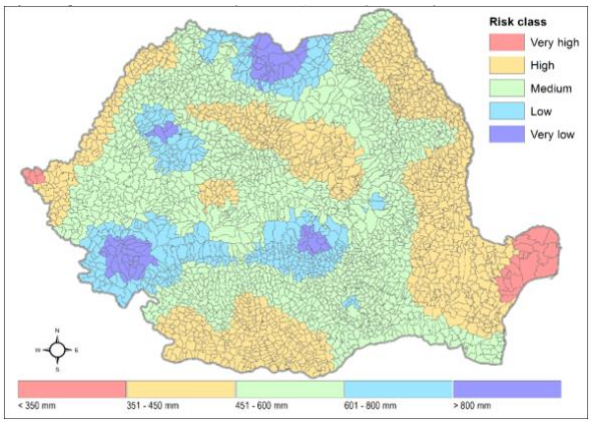
Figure 7: Most regions in Romania are at risk of floods…



Source: Webviewer indicating all Areas of Potential significant Flood Risk for which detailed maps are available https://harticiclul2.inundatii.ro/map@45.9891990,23.4491860,7z

Note: The map shows Areas of Potential Significant Flood Risk (APSFR)

Figure 8: …while drought risk is concentrated in the east of the country



Source: Drought Risk Classes. Soure: RO *Risk Country Report 5.1 Conditionality Romania 2016*

1.3. (A concrete) decarbonization challenge

As an EU member, Romania has committed to achieving net zero emissions by 2050 (Net0@2050). Romania is a contributor to the EGD and has made a legally binding commitment to its two key goals: (i) reducing net GHG emissions by at least 55 percent by 2030, relative to 1990 levels ('Fit for 55'); and (ii) achieving net zero GHG emissions by 2050 ('net zero'). The EGD also provides an action plan for EU member states to boost the efficient use of resources via a clean, circular economy, restore biodiversity, and cut pollution.

While all sectors of the economy will need to decarbonize, the energy transition is paramount. The energy[8] sector is the main contributor to GHG emissions in Romania (66 percent of emissions), highlighting the importance of the energy transition. Among the emissions attributed to energy, 32 percent come directly from energy generation, 24 percent from transport, and 15 percent from manufacturing activities (Figure 10). Beyond the energy sector, other major sources of emissions in the country are agriculture (17 percent), industrial processes and use of products (12 percent), and waste (5 percent). Delivering on Romania's ambitious climate targets will require a whole-of-economy approach.

Romania is on track to achieving the 2030 target, but the trajectory to net zero by 2050 is not fully detailed and meeting that goal will require substantive policy action and investments. Both climate and economic systems are inherently complex, with many cross-cutting linkages within each system and across the two. Certain elements of a successful decarbonization strategy are clear: electrifying fuel-intensive processes (e.g., in the transportation and heating sectors); greening the electricity supply; and boosting energy efficiency. Thanks to EU regulation, global technological developments and the push from geopolitical events following Russia's invasion of Ukraine, the share of renewables in Romania's energy mix has been on the rise, driving down emissions and facilitating progress toward the 2030 target (Figures 9 and 10). According to the EU emissions inventory report of 2023, emissions in 2021 were already 71 percent below 1990 levels. However, care must be taken in interpreting this trend for a number of reasons: (i) some reductions are driven by the decline of heavy industries during

[8] Energy covers, among other things: i) electricity (which powers both industrial plants and households); ii) heating (both industrial and household consumers); iii) transportation (of goods and passengers); iv) some industrial processes.

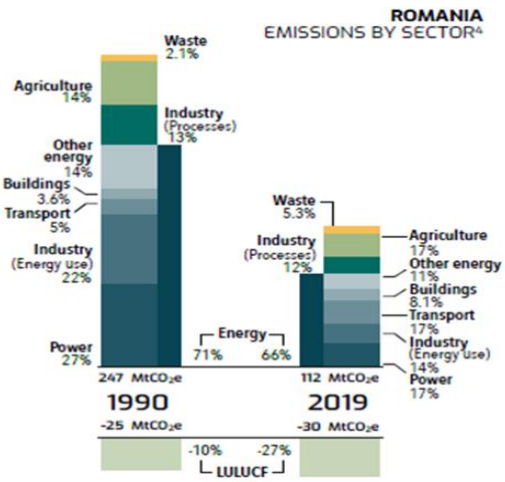
the transition to market economy; (ii) emissions increased from 2020 to 2021; (iii) 2021 should still be considered a COVID year in terms of economic activity; and (iv) some sectors (e.g. transport) continue to post increases in emissions, not reductions. While progress is being made in the short term in some sectors, the path to decarbonizing the wider economy is yet to be defined, both at the EU and domestic levels. In parallel to the national authorities developing the Long-Term Strategy (see Chapter 2), this CCDR aims to assess the options Romania has (Chapter 3) and their economic impacts (Chapter 4). Importantly, the relevant policy decisions will have to be forward-looking despite being made under considerable uncertainty, be it technological, geopolitical, or behavioral (see Box 1).

Figure 9: GHG emission reduction, actual (1990-2018) and required (until 2030 and 2050) to meet European Green Deal commitments

Percent change	Actual	To achieve target	
	1990-2018	2018-2030	2030-2050
EU27	**-20.7**	**-43.2**	**-56.8**
Bulgaria	-42.8	-21.3	-78.7
Croatia	-24.8	-40.2	-59.8
Poland	-12.6	-48.5	-51.5
Romania	-53.2	-3.9	-96.1

Source: Eurostat, World Bank calculations as in World Bank (2022)

Figure 10: Romania's emissions by sector



Source: Romania. 2021 Common Reporting Format (CRF) Table Source: Government of Romania (2021).

The green transition under the EGD will impact people as much as the economy. Decarbonization efforts will prompt a structural change in the economy, shifting demand for jobs away from brown (emitting) to green sectors. In the process, demand for higher skills will increase, in a context where skills shortages are already a major constraint. Such transformation will in turn have distributional impacts, through adjustments in prices and household incomes. Please see Chapter 4 for more details.

Romania's shift to a sustainable growth model will require substantial action from the public and private sectors, as well as a change in consumer behavior. The environmental externalities at the root of climate change stem from market failures that require government interventions (e.g., carbon pricing, regulation, investments, and industrial policy). Notably, fiscal measures will be critical to achieving the objectives of the EGD; relevant steps include raising carbon taxes, eliminating fossil fuel subsidies, and—with support from EU funds—ramping up green public investment, especially to decarbonize the energy and transport sectors. Furthermore, climate change mitigation and adaptation policies will create winners and losers. Therefore, the government will need to enact redistributive measures (e.g., targeted transfers and reskilling programs) to ensure the green transition is equitable ('just') and aligned with Romania's socio-economic development objectives. At the same time, the financial sector is expected to finance the bulk of the anticipated green investments, but also faces risks from the green transition (e.g., from stranded assets in polluting sectors). In this context, the government's role in steering the complex transition is paramount, and coordination is required within the central government as well as between national and subnational entities. The private sector has a critical role to play in the green transition but may require targeted incentives to invest and innovate in the absence of adequate price signals. Green policy action will also need public support and substantive change in consumer behavior.

Plans for a 'just' transition need to account for existing inequalities. While overall the green transition is expected to bring long term benefits, it carries risks that may deepen regional and income inequalities, requiring policy action to protect those adversely affected and ensure that changes are managed in a just and equitable fashion. Climate mitigation action may disproportionately affect regions where polluting activities (e.g., the coal industry) are concentrated, as well as specific occupations, skills, or income groups through structural changes. The impacts from climate change-related extreme weather events (such as floods and droughts), the potential losses from mitigation measures, and the capacity for adaptation are not distributed equitably across the Romanian population. For example, low-income households are highly dependent on subsidized solid fuel for heating, with few or no clean alternatives available to them. Many among the poor and vulnerable, especially the Roma, live in informal settlements and/or face severe housing deprivation and are disproportionately exposed to natural disasters, heat stress and disease. With half of Romania's female labor force not formally employed and the highest share of informally employed women in agriculture in the entire EU27, women risk to become disproportionately impacted by the transition. The possibility for such groups to have a voice and involvement throughout the green transition will be critical to its fairness.

2. Romania's climate commitments, policies, stakeholders and capacities

A 'whole-of-economy' approach to climate change mitigation requires 'whole-of-government' action, with a range of policies beyond the specific mandate of any single ministry. As noted in Chapter 1.3, the public sector will need to take action on climate change through direct interventions (e.g., carbon pricing), coordination with and incentives to the private sector, and redistributive measures for a 'just' transition. No single government agency is equipped to be the sole point of engagement for such a broad and challenging agenda. This chapter outlines Romania's key commitments and policies for climate action, as well as the domestic stakeholder landscape and relevant institutional and governance frameworks.

2.1. Romania's major commitments and policies on climate change

Romania has committed to multiple frameworks to stabilize GHG emissions and prevent harmful human-induced disruption to the climate. Notably, Romania ratified the UN Framework Convention on Climate Change (UNFCCC) in 1994, the Kyoto Protocol in 2001, the Doha Amendment to the Kyoto Protocol in 2016, and the Paris Agreement in 2017. In addition, Romania is party to the Sendai Framework for Disaster Reduction, the Minamata Convention, the Ramsar Convention, and the 2030 Agenda for Sustainable Development.

As an EU member, Romania is covered by the European Green Deal (EGD) and other EU policies which established and relate to firm decarbonization targets and timelines. As noted in Chapter 1, the EGD is an ambitious package of measures aiming to turn the EU into the first climate-neutral continental bloc by 2050, resulting in a cleaner environment, more affordable energy, smarter transport, new jobs, and better quality of life overall. Beyond decarbonization targets, the EGD's priorities include supplying clean, affordable, and secure energy; mobilizing industry for a clean and circular economy; building and renovating in an energy- and resource-efficient way; accelerating the shift to sustainable and smart mobility; designing a fair, healthy, and environmentally friendly food system; preserving and restoring ecosystems and biodiversity; and achieving a zero-pollution ambition for a toxic-free environment. This supranational agenda comes with substantial EU funds to help member states achieve its objectives (see Chapter 4.3 and Box).

The EU submits a joint Nationally Determined Contribution (NDC) covering all its member states, including Romania. In addition to the supranational NDC, EU members are required to develop national long-term strategies (LTS) for reaching net-zero by 2050 and meeting their commitments under the Paris Agreement. Romania's emission reduction targets[9] are outlined in the recently published LTS, based on a modeling exercise with scenario work following similar logic to this CCDR. While the LTS provides an overview of Romania's progress in reducing emissions and sets out sectoral emission targets and the corresponding investment needs, this CCDR additionally assesses: (i) institutional set up for climate action; (ii) economic and distributional impacts; (iii) implementation challenges and selected bottlenecks (e.g., on filling the skills gap); and iv) more detailed and broader scenario work.

To fulfill its international commitments, Romania has developed several overarching strategies and implementation plans. These range from national policies aiming for broad cuts to GHG emissions, to narrower frameworks targeting specific sectors (e.g., forestry or building renovation. Local governments are also stepping up efforts to develop climate-related action plans. For example, the municipalities of Cluj-Napoca and Suceava, as well as the Sector 2 administrative unit in Bucharest, are preparing their climate neutrality action plans as part of 100 Climate Neutral and Smart Cities—the EC's flagship

[9] Previously outlined in its National Energy and Climate Plan (NECP) 2021-2030

initiative to support cities in achieving climate neutrality by 2030. Other municipalities have signed up to the Global Covenant of Mayors for Climate and Energy, a coalition of cities that have pledged to cut GHG emissions and prepare for the impacts of climate change.

Overall, Romania has taken important steps to align with the EU's climate efforts. Further action is needed to ensure consistency across sectoral policies and stability in the legal framework for environmental action, as well as to foster public participation in decision-making on climate-related issues. A stricter implementation of existing environmental laws is also important—especially with regard to environmental impact assessments, and to waivers from environmental protection rules for projects of national importance.

2.2. Stakeholder landscape and political economy analysis

Decision-making and policy implementation on climate change in Romania take place within an intricate stakeholder landscape. Although national government agencies hold significant power to shape climate and development policies, they have to account for various competing interests and resource constraints. Local authorities have direct influence over policy implementation, but face capacity and resource limitations. Environmental NGOs have relatively little institutional power but can influence public opinion. Multilateral organizations support climate and development action through a range of financial and technical programs. Research and academic institutions provide essential evidence-based input for policy formulation. The private sector has been showing growing interest in green markets and corporate social responsibility (CSR).

Romania can make progress toward its climate change goals through stakeholder collaboration, private sector engagement, international support, enhanced public awareness, and increased transparency and accountability in sustainable development initiatives. To address the challenges on its path, Romania can: (i) enhance stakeholder coordination through platforms that bring together government agencies, local authorities, multilateral organizations, the private sector, communities and civil society; (ii) encourage private sector involvement in climate change mitigation and adaptation initiatives, through incentives, PPPs, and regulatory frameworks that promote sustainable practices; (iii) leverage international support, both financial and technical, to build the capacity of the national government, local authorities, the private sector, and civil society; (iv) strengthen public awareness through educational campaigns on climate change and environmental protection, while engaging with civil society organizations, the media, and educational institutions (see Box 1); and (v) increase the transparency and accountability of climate and development initiatives through public participation, open data, and regular monitoring and evaluation.

Box 1: Public perceptions will make or break the transition—behavioral insights

Climate-change mitigation action will require popular support. Mitigation efforts will involve increases in carbon prices and potential transitory increases in consumer prices and/or taxes, while new or revised regulations may entail changes to certain patterns of consumption. The successful implementation of the new paradigm hinges on support from consumers, taxpayers, and voters. This is particularly important since Romania's social contract is already strained: 63 percent of Romanians state they tend to not trust their national government and 76 percent identify lack of social rights as a serious problem.

Many Romanians are concerned about climate change and the environment.[i] In the ECA Citizens Survey on Climate Attitudes,[ii] climate change and the environment were the fifth- and seventh-most cited socio-economic issues among Romanian respondents, with 41 percent of them listing climate change as an important theme (compared with healthcare at 71 percent, and corruption at 68 percent).

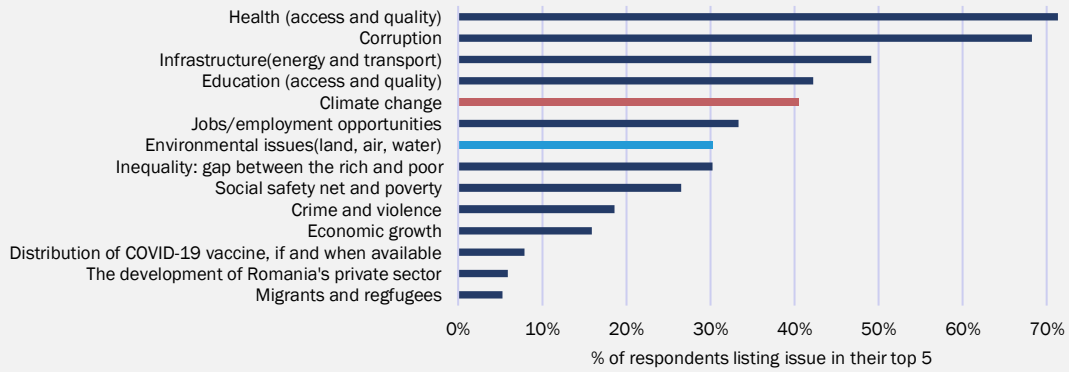
But not many Romanians are willing to pay to avert climate and environmental damage. Less than half (about 46 percent) of respondents in Romania would be willing to pay an amount equal to 1 percent of the country's monthly GDP per capita to reduce the impacts of climate change, while another 12 percent would pay half that—considerably below the estimated investment needs for climate change mitigation and adaptation (Chapter 4). The share of respondents willing to pay this amount is slightly higher for women and people living in densely populated areas. The most supported alternative uses of such revenues were investing in clean energy and providing a boost to economic growth. Knowing that friends and neighbors would also pay a fixed amount to address climate change impacts, trusting the international media and the government, and feeling highly concerned about the environment were features associated with a greater willingness to pay.

Social influence and education are the main determinants of the willingness to adopt energy-saving practices against climate change. Romanians have a relatively high propensity to adopt more sustainable consumption behaviors, but often do not feel well informed about the impacts of climate change. Notably, people who are 'strongly' or 'somewhat' sensitive to the actions of their friends and neighbors are, respectively, 11 and 12 percent more likely to reduce their use of electricity and fuel at home to contrast climate change. Similarly, people who completed tertiary education are 9 percent more likely to adopt energy-saving practices, but they appear more willing to change their consumption habits than their mobility patterns.

i. 'Climate'-related concerns pertain to precipitations and temperatures, while 'environmental' issues are meant to encompass land, air, and water pollution.

ii. Financed by the World Bank, the survey was conducted by Ipsos in Romania and 13 other countries in Eastern Europe and Central Asia between October and December 2021.

Figure 11: Relative perceived importance of climate change and other social issues in Romania



Source: World Bank calculations based on ECA Citizens Survey on Climate Attitudes

2.3. Institutional and governance frameworks for climate change action

To support 'whole-of-government' climate action, Romania has been establishing new institutional arrangements. These focus on: i) ensuring inter-institutional coordination; ii) setting ministerial mandates with a sectoral focus, or occasionally cross-sectoral (e.g., on sustainable development monitoring); and iii) implementing sub-national initiatives. In addition to the Government, the President of Romania and his administration (through the Department of Climate and Sustainability–DCS) play an active role in fostering concerted action. Romania's international commitments, especially those associated with access to EU funds, have been a primary driver and catalyst of such efforts. For an institutional mapping of Romania's emerging multi-level governance context, see Figure 12.

The establishment of an Inter-ministerial Committee on Climate Change (CISC) in April 2022 was an important step toward better cross-government coordination. CISC was created to meet a key NRRP milestone, which entailed reinforcing coordination at the center of government (CoG) for an integrated approach to climate change. The CISC convened regularly throughout 2022 and 2023 and remains

operational, with the support of the Presidential Administration. Through the work of CISC, Romania is expected to meet 90 percent of the NRRP's 2025 targets by March 31, 2026. In addition, the Interdepartmental Committee for Sustainable Development (ICSD) proposes legislative and institutional steps to foster the implementation of Romania's sustainable development commitments across ministries. The ICSD meets biannually.

The DCS and a dedicated Department for Sustainable Development (DSD) within the General Secretariat of the Government (GSG) support broad stakeholder engagements and strategy development. The DCS formed a working group to produce high-level reform strategies, convening national and international experts, members of the academic community, and representatives of public institutions, NGOs, and international financial organizations. Within the central government, the DSD—which reports directly to the Prime Minister—oversees the implementation of the National Strategy for Sustainable Development 2030 and was recently tasked with implementing the newly adopted National Strategy on the Circular Economy. Moreover, the Directorate for Coordinating Policies and Priorities (DCPP) sets the framework for defining government priorities in relation to climate change and advises ministries in formulating their climate change policies.

The Ministry of Environment, Water, and Forests (MEWF) is the ministerial authority primarily responsible for policy on environmental protection and climate change. Although other ministries have specific mandates for climate action in sectors such as energy, agriculture, and education, the MEWF develops, updates, and coordinates the application of the National Strategy and National Action Plan for Adaptation to Climate Change, 2022-2030 (SNASC and PNASC), and the National Strategy and National Plan on Romania's contribution to the EGD's emission targets. Certain entities controlled by the MEWF have specific climate-related tasks: (i) the National Agency for Environmental Protection is responsible for environmental monitoring, the implementation of environmental policies, and the production of climate change scenarios and forecasts; (ii) the Environmental Fund Administration provides financial support to environmental protection programs, while collecting levies based on the EU principles of "polluter pays" and "producer responsibility"; and (iii) the National Meteorological Administration monitors extreme weather events and conducts meteorological research.

The Ministry of Finance (MOF) and the Ministry of European Investments and Projects (MEIP) have critical roles in green financing. The MOF plays a major part in drafting an annual list of priority investments and assessing projects for financing from the state budget. In addition, the MOF leads on the development of a green budgeting framework, to be implemented across the government with support from the CISC. For its part, the MEIP is tasked with overall coordination of EU-funded investments, including those under the NRRP, and works toward achieving a target of allocating 30 percent of all expenditures from European Structural and Investment Funds to support the climate agenda. For the 2021–2027 period, the MEIP is also responsible for managing six programs—including the Program for Sustainable Development, which has been allocated €5.2 billion from EU and domestic funds (see Chapter 4 on financing green transition).

Subnational implementation of climate initiatives involves 71 municipalities and eight Regional Development Agencies (RDA), and coordination is a key challenge. The multi-level governance system for implementing the environment and climate agenda in Romania is critically linked to Climate and Energy Action Plans prepared by municipalities. At the regional level, the RDAs assess needs and distribute funds—usually to local authorities—for projects related to the zero-carbon economy, the energy transition, as well as climate change mitigation and adaptation. Institutional capacity at the subnational level remains uneven.

Figure 12: Governance System Supporting implementation of climate change policies in Romania

INTER-INSTITUTIONAL/ CROSS-GOVERNMENT COORDINATION	
MAIN STAKEHOLDER INSTITUTIONS	**CLIMATE CHANGE CORE MANDATES**
The President of Romania (supported by the Presidential Administration)	• Climate change working group "Fighting climate change: an integrated approach" for issuing reports
Inter-ministerial Committee on Climate Change (2022)	• Ensures the strategic coordination of climate change policy development across institutions • Other key objectives: approve indicators for measuring Romania's climate commitments; setting annual policy priorities; coordination, monitoring and evaluation of public institutions for meeting European targets.
Inter-ministerial Committee for coordinating the integration of environmental protection into sectoral policies and strategies at national level (2011)	• Takes decisions for ensuring coherence in the process of creating regulations for environmental protection • Approval of the National Action Plan for Environmental Protection and plans to ensure environmental protection integration into implementation of sectoral policies and strategies at national level • Monitors their effective implementation and initiate steps to allocate and mobilize financial resources.
General Secretariat of the Government, Directorate for Coordinating Policies and Priorities	• Establishes the methodological and organizational framework for the system of planning, elaboration and implementation of CC public policies (including strategies).
General Secretariat of the Government, Department for Sustainable Development	• Coordinates and monitors the implementation of the National Strategy for Sustainable Development 2030
Interdepartmental Committee for Sustainable Development (2019)	• Ensures coherence in the process of elaboration and promotion of regulations aimed at sustainable development, to comply with the reporting obligations of Romania at international and EU level.
NATIONAL	
Ministry of Environment, Waters and Forests (incl. subordinated institutions)	• Coordinates the national environment and climate change policy; • Formulates and implements climate policies, in line with the international and EU framework, in the context of the long-term temperature objective set out in the Paris Agreement.
Ministry of Finance	• Reviews and approves significant investment projects (rejects investments without environmental agreement)
Ministry of European Investments and Projects	• Coordinates the implementation of EU funds in Romania and NRRP • Management Authority for the Sustainable Development Program 2017-2021
Ministry of Energy	• Drafts and coordinates the implementation of the Integrated National Energy and Climate Plan
Ministry of Development, Public Works, and Administration	• Prepared and will help implement the Long-Term Renovation Strategy • Drafted the Urbanism Code, with measures for addressing urban sprawl
Ministry of Agriculture and Rural Development	• Coordinates the Inter-ministerial Committee for Mitigating the Effects of Climate Change in Agriculture
Ministry of Education	• Coordinates the implementation of the National Strategy for Education on Environment and Climate Change
Ministry of Foreign Affairs	• Coordinates a network of climate diplomacy
Ministry of Internal Affairs	• Coordinates the implementation of the National Plan for Disaster Risk Management • Performs risk assessment analysis, including climate projections.
Ministry of Economy; Ministry of Entrepreneurship and Tourism	• Potential for coordinating green industrial policies and circular economy initiatives
SUBNATIONAL	
Regional Development Agencies	• Management Authorities for the Regional Operational Program, including regional objectives, measures for fighting climate change
County Councils / Local Councils	• Draft Action Plans for Sustainable Energy and Climate (EU Covenant of Mayors for Climate and Energy) • Responsibility for local-level emergency management—assessments and risk maps.

Source: World Bank analysis

3. Policies and investments to advance decarbonization and address resilience challenges

This chapter builds on a modelling exercise which considers how Romania can achieve the net-zero emissions target and adapt to climate change, and what economic trade-offs each relevant policy choice entails. The analysis, underpinned by a coordinated system of models and tools, illustrates:

i. various scenarios for the decarbonization of the power generation and transport sectors, and relevant climate change impacts (Chapter 3.2).
ii. the economic and distributional impacts of decarbonization and its financing requirements, depending on the pace at which it may proceed (Chapter 4).

Please see Box 2 for an overview of the modelling system and key scenarios, and Annex 1 for more details on selected models and the key underpinning assumptions.

Box 2: Analytical underpinnings and scenarios for the modelling exercise

The modelling exercise involved the World Bank's energy, transport, water, urban, macroeconomics, microeconomics, and fiscal teams, among others. It relied on two types of models: (i) **core models:** EPM for electricity, CGEbox for macroeconomics, and microsimulation model for distributional impacts; and (ii) **auxiliary tools,** mainly used to capture sectoral inputs (Figure 13). **A set of scenarios were used to highlight key aspects of potential decarbonization pathways** (Figure 14). In line with EU-level commitments, all scenarios were set to achieve net zero emissions by 2050 (Net0@2050).

i. **Choice of Pace** scenarios illustrate options about the pace of progress toward Net0@2050, and the related impacts on growth, investment needs, household consumption, and other key socioeconomic variables. Three such scenarios were modelled: a) **"linear",** where the pace is in line with key EU targets (specifically, the Fit for 55 milestone);[i] b) **"fast"** and c) **"slow",** where decarbonization action is frontloaded or delayed, respectively. A **Business-as-Usual** scenario, which captures existing decarbonization policies, is used to shed light on the trade-offs from the other scenarios but is not considered a viable path to Net0@2050.
ii. **Context** scenarios test the 'choice of pace' scenarios against a range of variables, namely: a) decarbonization efforts in the rest of the EU and globally; b) associated climate impacts and damages; c) domestic policies; and d) adaptation and resilience measures.

Please see Annex 1: Modelling and assumptionsfor a brief explanation of the macroeconomic model (CGEBox) used for this report, and the key economic and sectoral assumptions underpinning the scenarios (Table A1).

i. Fit for 55 entails reducing net GHG emissions by at least 55 percent by 2030, relative to 1990 levels.

Figure 13: Models and tools for the modelling

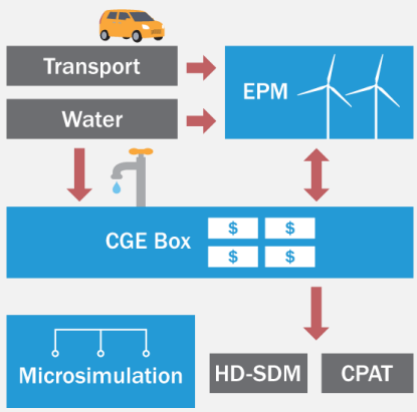


Figure 14: Key scenarios considered

Scenarios		CONTEXT SCENARIOS	
		Supportive context	Challenging context
PACE SCENARIOS: All Net0@2050	Linear	1 'Central'	4 Risks
	Slow	2 Trade-offs	5 Risks
	Fast	3 Trade-offs	6 Risks

Source: World Bank elaboration. Notes: 'Core' models in blue, 'auxiliary' models and tools in grey.

Box 3 outlines further methods to help decision makers under considerable uncertainty. Chapter 3.3, which considers major adaptation and resilience challenges, is based on existing reports and analysis and has not been the subject of a separate, consolidated modeling exercise.

Box 3: Decision-making under deep uncertainty

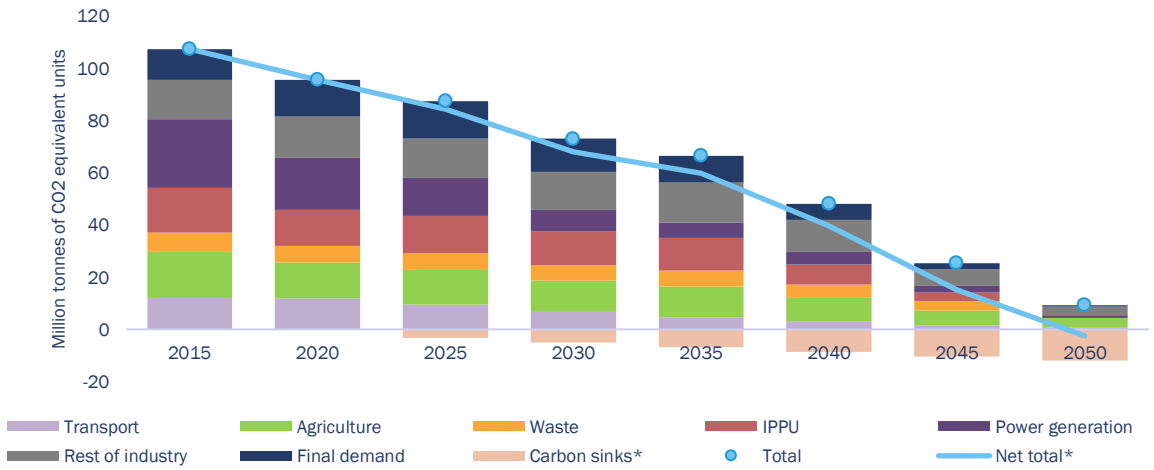
Achieving Romania's ambitious climate targets in a timely and cost-effective manner depends on numerous uncertain factors, such as the future cost of low-carbon technologies, fuel prices, consumption choices, and future demand for electricity. Policy makers can use a methodology called "Decision Making Under Deep Uncertainty" (DMDU), which estimates the probability of success of alternative targets and policy choices under a wide range of future scenarios and identifies those expected to i) be successful in as many scenarios as possible, or ii) minimize future regret.

Romania could consider applying DMDU methods to assess the robustness of potential policy choices. By systematically evaluating the probability of success of possible strategies in a wide range of future conditions, DMDU methods would highlight key vulnerabilities, and provide transparent information to help policymakers decide which strategy might be most appropriate. This CCDR does not fully apply DMDU methods, which require multiple consultations with stakeholders and rounds of analysis. However, the few scenarios developed for this CCDR could be the starting point for a more in-depth DMDU assessment.

3.1. How Romania can achieve net zero by 2050: an illustrative path

Romania's commitment to Net0@2050 will require substantial decarbonization efforts across all sectors. Decarbonization technologies are well developed or making rapid progress in certain sectors (e.g., energy generation), but their potential contribution in other sectors is uncertain (e.g., agriculture and heavy transport). In this context, the illustrative scenario in Figure 15 presents a feasible path to Net0@2050 for the country.

Figure 15: Romania's potential path to net zero by 2050 (linear scenario)



*Source: World Bank simulation based on CGEBox, in coordination with other models, with GTAP as the primary data source. Note: 'IPPU' denotes Industrial Processes and Product Use. *Carbon sinks reflect additional sinks compared to current stocks.*

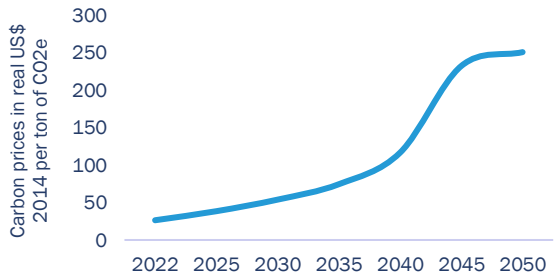
Such a scenario assumes the following:

- **Changes in power generation deliver an important contribution to the net-zero strategy.** This entails the phasing-out of coal generation by 2032; greater use of renewables and nuclear; and the use of carbon capture in gas generation.

- **Romania implements an ambitious program to improve the energy efficiency of buildings; adopts heat pumps and electrified heating on a large scale; and decarbonizes transport.** Heat pumps should enable 75 percent of the electrification of low-heat process energy industrial processes, with the remaining 25 percent covered by solar and geothermal heating. In addition, transport decarbonization entails a gradual electrification and modal shifts, including a greater role for public transport.

- **Process emissions from agriculture and certain industries will be a challenge, especially after 2040.** The price of carbon is expected to rise sixfold over the decade starting in 2040 (Figure 16), which will necessitate interventions in sectors where abating emissions is currently difficult and expensive. Even if such emissions were offset though carbon capture or natural carbon sinks, reaching net zero will require the use of abatement measures that are projected to cost around 5 percent of GDP in 2050 (after more cost-efficient options have been exhausted). Future technological development is expected to reduce these costs.

Figure 16: High carbon price after 2040 reflects considerable uncertainty



Source: World Bank simulations using CGEBox in coordination with other models. Note: The decarbonization scenario assumes a highly efficient market-based decarbonization policy whereby all climate-change relevant emissions and emitters are taxed. Conceptually, this entails attaching the EU ETS carbon pricing (or an ETS-equivalent domestic carbon tax, whose amount is set at the EU level) to all sectors of the economy. Data and simulations are presented in real (2014) US$.

- **Timely investments in forests can expand carbon sinks and provide flexibility as 2050 approaches.** Reducing deforestation, afforesting areas freed up by more efficient intensified agriculture, and improving forest management could offset much of the country's remaining emissions (see chapter 3.3). Conservatively, sinks from Forestry and Other Land Use (FOLU) can absorb 10 percent of benchmark emissions.

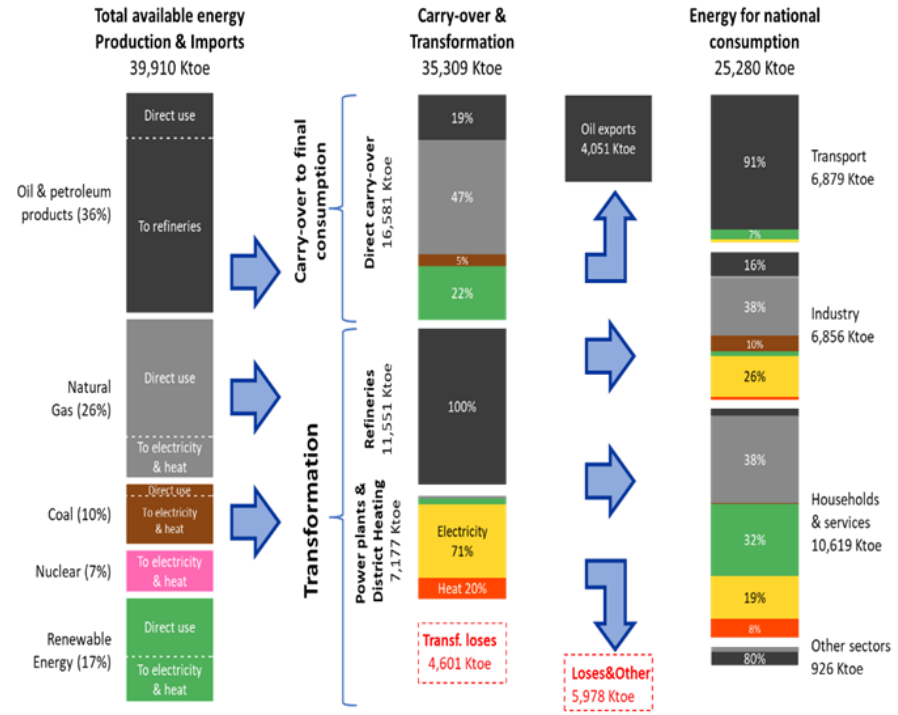
- **While variables pertaining to resilience are hard to capture, the modelling sets out to incorporate them.** For example, the modelling accounts for water availability (including for river transport) and variability, impacts on critical infrastructure (transport and electricity generation), and potential damages from floods.

- **The decarbonization pathway presented here is broadly aligned with the pathway articulated in Romania's first LTS.** While the precise sectoral emission reduction end points and the technologies or policies to achieve may differ between the CCDR and LTS, the decarbonization pathways in these two reports are broadly aligned.

3.2. Energy+: Decarbonizing energy—opportunities and challenges

Romania remains heavily dependent on fossil fuels for its energy needs. Around 72 percent of total available energy in Romania currently depends on fossil fuels. The transport sector is the main consumer of oil products; coal is transformed into electricity or directly consumed by the industrial sector; and natural gas is widely used by industry and households, including after being transformed into electricity and district heating (Figure 17). Moreover, Romania's energy intensity remains more than 60 percent greater than the EU average, despite having dropped by 30 percent over the past decade (Figure 4).

Figure 17: Energy balance flow in Romania—2021



Source: EUROSTAT

The energy sector is still responsible for about two-thirds of Romania's total GHG emissions, but current decarbonization policies are building on the emission reductions already achieved. Energy-related emissions dropped by 37 percent between 1988 and 1994, largely due to structural economic change, and by 21.5 percent between 1994 and 2019. To deliver on EU-level commitments, Romania adopted its Integrated National Energy and Climate Plan (INECP) 2021-2030, which aims to reduce primary energy consumption by 45.1 percent and final energy consumption by 40.4 percent (from 2007 levels); and to increase the share of renewables in the energy mix to 30.7 percent. In addition, the energy crisis stemming from Russia's invasion of Ukraine drove another policy initiative (REPowerEU Communication) focused on shoring up energy security, diversifying the energy matrix, and increasing the use of local renewable energy sources.

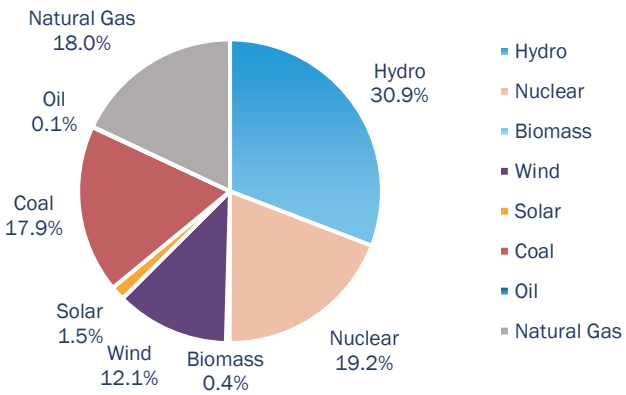
To meet Net0@2050, Romania will need to make major progress in energy generation and consumption, and to expand the electrification of the economy. Short-term priorities should include a rapid improvement in energy efficiency, increased deployment of renewables, and greater electrification of the economy—especially in road transport, light industry, and low-temperature heating for buildings. While the reduction of emissions from energy generation can rely on readily available and affordable technology, it will be critical to also lay the foundations for the long-term decarbonization of hard-to-abate sectors (e.g., heavy industry, agriculture, waste management, and shipping). The latter step will hinge on technological progress coming to fruition in the later years of the transition, e.g., on green hydrogen and carbon capture, use, and storage (CCUS).

Reducing fossil fuel demand would contribute to energy security by mitigating supply- and price-related risks. Although it is the largest producer of oil and gas in Central and Eastern Europe, Romania still imports 32.1 percent of the energy it needs, which exposes it to volatile global energy prices and potential supply disruption. In 2021, Romania imported 69.0 percent of the oil, 23.4 percent of the gas, and 24.1 percent of the coal that it consumed. Notably, natural gas discoveries in the Black Sea have the potential to reduce dependency on gas imports.

3.2.1. Decarbonizing electricity

Although Romania's electricity generation matrix is well diversified, fossil fuels maintain an important role. In 2021, fossil fuels accounted for about 36 percent of Romania's electricity production (Figure 18), with the remaining 64 percent coming from renewables and nuclear. Installed capacity amounts to 16.5 GW with 7 GW delivered to the system on average, of which 46 percent is consumed by industry, 31 percent by households, and 19 percent by the services sector.

Figure 18: Romania's Electricity generation by source (2021)



Source: ANRE

Decarbonizing electricity requires phasing out coal generation in the short term. Coal accounts for less than 18 percent of electricity generation, but more than 68 percent of sectoral emissions. The phase-out of coal generation is set to be completed by 2032, but together with the likely rise in electricity demand from natural growth and increased electrification, it will create supply pressures. To address them, three main tools are available:

- **Additional non-fossil fuel generation.** Romania has the greatest potential for wind generation in southeast Europe, estimated at around 14,000 MW or 23 TWh per year. The INECP targets adding 6,000 MW of solar and wind, 1,100 MW of hydro, and 675 MW of nuclear power by 2030, relative to 2015 levels.

- **Additional gas generation.** The INECP indicates a need to add 1,400 MW of gas generation capacity by 2030, to ensure the system is flexible enough to accommodate more renewable energy. However, the EU Taxonomy for Sustainable Activities defines tight conditions around the eligibility of new investments in gas-fired power plants for EU funding, which require a shift to low-carbon gases by 2035. Investment in CCUS may be necessary to decarbonize final emissions.

- **Energy efficiency and conservation.** Progress on this front will be key to easing the pressure on electricity supply, reducing emissions in a cost-effective manner, enhancing industrial competitiveness, and making electricity more affordable for end users.

To manage the expected increase in the share of electricity from renewables and a potential drop in hydropower availability, major investments in electricity infrastructure will be necessary. Power generation is highly concentrated in eastern Romania, near the Black Sea. This area has ample renewable resources, hosts a nuclear plant in Cernavoda, and is expected to be on the receiving end of both future offshore wind production on the Black Sea and a planned submarine interconnection with Georgia. A stronger transmission system will be necessary to connect the region's capacity with demand hubs in the west of the country, while investments in ancillary services and back-up capacity will be needed to ensure security of supply. Moreover, reinforced international interconnections will shore up energy security and facilitate the export of renewable energy. Transelectrica, Romania's transmission system operator, has committed to investing €1.4 billion by 2031 to modernize transmission networks, integrate supply from renewables, and boost the share of regionally interconnected capacity up to the 15 percent threshold required by the EU (please see more detail on investments in Chapter 4). The NECP estimates a need for 400 MW of battery storage by 2030 but achieving regional climate neutrality by 2050 will require even more.

Water resources are critical to Romania's energy security and decarbonization. About 50 percent of the country's electricity generation already comes from hydropower and nuclear, and thus relies on water availability. Hydro provides clean energy at scale and can help compensate for the variability of other renewables, while nuclear ensures carbon-free base-load electricity generation. Furthermore, water is necessary to the electrolysis process that produces green hydrogen and is thus even more important for the energy transition.

With water becoming increasingly scarce, the energy transition and climate adaptation are inextricably linked. As rainfall variability and demand for water increase, balancing the needs of all water users will be ever more complex. The drought of 2022 was a harbinger of the challenges to come - hydropower generation dropped to a historical low; nuclear power plants were ready to stop due to reduced water flow in the Danube; and more than 200 small towns needed tankers to supply them with water. Moreover, extreme floods may impact hydropower generation by damaging storage reservoirs and power plants, as well as by making it necessary to use reservoirs for flood control purposes.

3.2.2. Decarbonizing the industrial sector

As industry is a major consumer of energy, its decarbonization will be critical to achieving both climate goals and green competitiveness. Romania's industry accounts for almost 46 percent of the country's total electricity demand. Moreover, it directly consumes 26 percent of the natural gas, 17 percent of the coal, and 10 percent of the oil used in the country, as well as 15 percent of the district heating supply.

Romanian industry is highly emission intensive, with opportunities to improve using existing technologies. Romanian producers of basic metals, non-metallic materials (i.e., glass, ceramics, clay, concrete, cement), and chemicals have the highest emission intensity among the country's manufacturers and have recorded the sharpest increase in emission intensity in recent years. The emission intensity of Romanian manufacturers is three times greater than the EU27 sectoral average, and more than twice as high as the sectoral average of peer countries such as Poland and Hungary (Eurostat). Bringing emission intensity in manufacturing down to the EU27 average level would lower Romania's total GHG emissions by 14 percent, while matching the levels achieved in best-performing Denmark could cut total emissions by 25 percent—although the latter goal would require moving up the value-added ladder, in addition to reducing actual emissions. Special policy attention must be paid to, and more research is needed to understand the underlying heterogeneity within the emission-intense sectors.

Opportunities to decarbonize already exist, especially in light industry. In the short term, the best options for decarbonizing the industrial sector (especially in textiles, food and beverages, and other light industry) are: i) energy efficiency; ii) using renewable sources (solar, geothermal, and bioenergy) for low- to medium-temperature heat production; iii) electrifying manufacturing processes; and iv) substituting existing processes with low-carbon alternatives. Moreover, certain industrial processes (e.g., fertilizers production) may substitute natural gas with green ammonia produced with electricity from renewables.

The decarbonization of heavy industry (e.g., iron, steel, and cement manufacturing) is more complex. CCUS and green hydrogen solutions are expected to play an important role in the decarbonization of heavy industry over the long term, but their current cost is unattractive. The EU's Carbon Border Adjustment Mechanism (CBAM), set to take effect in 2026, is bound to influence the pace of industrial decarbonization (see Box 8).

3.2.3. Decarbonizing the residential and services sectors

Households and the services sector are ready for greater electrification and energy efficiency but growing demand for cooling is a challenge. The residential and services sectors together account for almost 40 percent of the country's demand for natural gas, 50 percent of electricity demand, and 74 percent of district heating demand. Decarbonization will require further electrification of cooking appliances and the adoption of heat pumps for individual heating systems (preferably reversible heat pumps, capable of cooling in the summer)—although the latter will require innovative financing options or grants, given their considerable up-front costs. For the poorest households, which currently burn wood for heating, the impact of heat pumps on electricity bills may make them unaffordable even if installation costs were fully covered by grants. Notably, rising temperatures are expected to boost demand for cooling and change its seasonal profile.

Decarbonizing district and other centralized heating systems remains a challenge. District, large-neighborhood, and centralized building heating systems remain an important source of heating in Romania, although their user base shrank by 85 percent, to only 1.3 million people, between 1992 and 2020. Low-temperature renewable heat from geothermal, solar thermal, bioenergy, and waste heat sources is widely available in many regions of Romania but remains untapped due to limited technical capacity and the need to renovate and adapt existing infrastructure.

Buildings must become more energy-efficient, especially through better insulation. A key pillar in Romania's decarbonization strategy for the residential sector is the renovation of the building stock, to improve energy efficiency and cut emissions (Box 4). Such renovations can be combined with structural building improvements, to enhance resilience to seismic events. To avoid overinvestment in heating and cooling systems, upgrades of this nature should only occur after a building has been renovated and its energy demand optimized.

Box 4: The Renovation Wave in Romania

Per the revised EU Directive on the Energy Performance of Buildings (EPBD 2010/31/EU), every EU member state must develop a long-term renovation strategy (LTRS) to achieve a near-zero energy building stock, highly energy-efficient and decarbonized, by 2050 (the so-called Renovation Wave). Currently, approximately 0.5 percent of the Romanian building stock is renovated in a given year. Romania's LTRS proposes a gradual increase to 3.39 percent per year by 2030, as well as improvements in energy performance on at least 18 percent of the total floor area of all heated and cooled buildings.

The LTRS estimates total investment needs in the amount of €12.8 billion by 2030—which may grow to €16-18 billion due to rising costs—of which 39 percent is expected to be financed from public sources, and 61 percent from private and commercial sources. The NRRP already allocates €2.2 billion to the Renovation Wave, but more capital needs to be mobilized.

Delivery of the LTRS will require greater renovation capacity, including a fivefold increase in the number of suitable workers (to 85,600), and a sixfold increase in the number of architects and engineers (to 5,000). Boosting capacity depends on an enabling environment that encourages private sector investment, as well as availability of workers with adequate skills (please see Chapter 4 for potential challenges). However, an excessive reliance on grants for building renovation has so far exacerbated demand volatility and distorted the willingness of the public to pay for renovations.

3.2.4. Decarbonizing transport

Although overall GHG emissions have declined in Romania in recent years, emissions from transport have increased. In 2019, emissions from transport were 50 percent higher than in 2005, and accounted for 17 percent of Romania's total GHG emissions (Figure 19), with road transport

responsible for 96 percent of the sector emissions (Figure 20). Per the EU's NDC, Romania has a target of reducing its GHG emissions from non-ETS sectors by 12.7 percent (as amended in March 2023) by 2030 relative to 2005 levels and the EGD sets a target of reducing transport emissions by 90 percent by 2050, relative to 1990 levels.

Figure 19: GHG emissions in Romania, 2005-2019

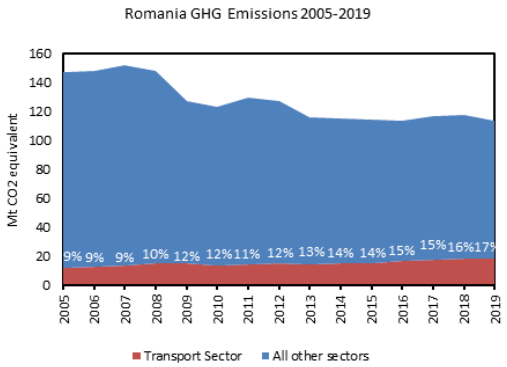
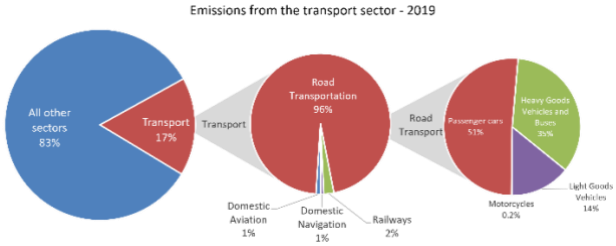


Figure 20: GHG emissions from transport in Romania 2019



Source: Own elaboration using data from the European Energy Agency (National emissions reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism).

Growth in road transport, which is likely to continue, has been driving the rise in transport emissions. From 2009 to 2019, overall passenger transport increased by 39 percent, while freight transport increased by 24 percent. Notably, in 2019 transport by car or coach accounted for 95 percent of passenger-km, while transport by truck accounted for 70 percent of ton-km. Moreover, Romania's fleet of both light and heavy-duty motor vehicles is about 40 percent older than the EU average. Despite a shrinking population, the vehicle stock will keep growing, as the rate of car ownership is expected to rise from its current level of 400 cars/1000 inhabitants, which is still below the EU average (560 cars/1000 inhabitants). Finally, freight transport by road is projected to grow rapidly, potentially doubling in terms of ton-km by 2050. Please see Romania SCD Update and the forthcoming Romania CPSD for more detail on trends and challenges in transport sector; and Box 5 for recent cost development of electric vehicles (EVs).

Romania has already initiated efforts towards decarbonizing the transport sector, but much more needs to be done. Initiatives at central level include subsidies for purchasing electric and hybrid new vehicles (e.g., *Rabla Plus Program*) and environmental taxation. Yet, existing investment and policies in Romania are limited and the sector is off-track to meet its 2050 climate objective. In particular, Romania's transport system is increasingly relying on private cars and trucking, while rail use has been consistently declining, contrary to the targets set in the EU *Sustainable and Smart Mobility Strategy* (SSMS).

A comprehensive decarbonization strategy following the "Avoid-Shift-Improve" principles, could reduce transport-related emissions by up to 90 percent:

- ***Avoid*** unnecessary travel, especially motorized travel, without limiting access to goods and services.
- ***Shift*** to more sustainable modes of travel, such as active mobility, public transport, and intermodal freight transport.
- ***Improve*** vehicle technology for gains in fuel economy and, ultimately, zero emissions.

'Avoid' strategies for passenger transport should focus on creating transit-oriented developments. Such developments allow for greater access to services within compact mixed-use communities; combined with technology-enabled remote access to work and services, they can limit the need for both long trips and daily commuting. In freight, consolidation centers, logistics digitalization, asset sharing, and the use of High-Capacity Vehicles can reduce the average distance travelled per unit of freight. Such measures alone could enable a 10 percent reduction in transport GHG emissions.

For passenger transport, active mobility and public transport should be prioritized, especially in urban areas. Incentivizing modal shift away from passenger cars will require a set of multiple policies, including: (i) dedicated space for public transport vehicles; (ii) parking and access management strategies (including pricing instruments); (iii) enhancing the integration, reliability and coverage of public transport services; (iv) investing in extensive, safe, attractive, and cohesive cycling infrastructure. For non-urban transport, the development of High Speed Rail (HSR), still missing in the country, should be explored. The European Commission made a proposal in 2021 to revise the TEN-T regulation[10], including the construction of HSR between Constanta and the Hungarian border (at Oradea), as part of a broader strategy to get on track with the EU target to triple HSR traffic by 2050 as set in the EU SSMS.

A significant freight modal shift from roads to rail should be pursued, requiring a step up in investment pace to renew the infrastructure and improve the sector's performance. The Romania NRRP set a target of shifting 10% of freight road traffic to rail by 2026, but larger efforts should be pursued in the longer term, targeting a shift of up to 25% by 2050 (compared to a BAU scenario). This shift would result in volumes that the Romanian railway system has already shown to be able to move in the past, and this alone would reduce GHG by 14% compared to the BAU scenario in 2050. This will require significant investment efforts to overcome the rehabilitation backlog, as more than 60% of the railway network were due for renewal as of 2020, which hinders commercial speeds and reliability. Reverting the declining trends in modal share of the past decades will require a step up in institutional capacity to absorb available funds, but also to properly prioritize and execute investments that truly reflect in performance improvements. Interventions should also aim at strengthening intermodal transport through more seamless and efficient intermodal transitions (e.g., with inland waterways transport).

The electrification of passenger cars is underway but needs to be accelerated (Box 5:), with targeted measures for the second-hand market. The high share of second-hand imports and the longer life-span of vehicles in Romania may significantly delay the sector decarbonization, even if all new passenger cars and vans are zero-emission by 2035 as per the recently adopted EU regulation[11]. Romania should aim at 50% of new registrations of passenger cars and vans being zero-emission by 2030, and 90% by 2035 (including second-hand imports). Reaching these interim goals alone may reduce TTW emissions by 29% in 2050 compared to a BAU scenario with lower EV uptake. Carbon taxes on road fossil fuels, with appropriate compensatory measures, can accelerate this transition. Additional recommended actions include: **(i) CO2-differentiated vehicle taxation targeting also second-hand imports.** Current subsidies provided through the *Rabla Plus Program* benefit only new vehicles, which represent less than one third of the market and tend to be purchased by higher-income segments. Alternatively, carefully designed CO_2-differentiated vehicle taxation or feebates could be more fiscally sustainable in the longer term and socially equitable[12], and have larger impact if applied to second-hand imports as well. **(ii) Regulatory measures and incentives to electrify highly utilized fleets (both public and private),** which benefit the most from reduced operational costs of EVs. Early electrification of fleets can also increase availability of affordable EVs later on in the domestic second-hand market.

[10] European Commission. 2021. Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on Union guidelines for the development of the trans-European transport network, amending Regulation (EU) 2021/1153 and Regulation (EU) No 913/2010 and repealing Regulation (EU) 1315/2013

[11] Regulation (EU) 2023/851 of the European Parliament and of the Council

[12] Transport & Environment. 2019. How Vehicle Taxes Can Accelerate Electric Car Sales.

Decarbonizing the trucking sector is crucial, as it will likely keep the largest share of domestic freight transport even with a significant modal shift to rail. While fuel efficiency improvements will contribute to the objective, the emission reduction needed to reach the climate goal will require the progressive uptake of Zero Emission Trucks (ZET). Reaching 70% of new registrations of trucks being ZET by 2035 (including second-hand imports) and accelerating fleet renewal afterwards, could reduce transport TTW GHG emissions in 2050 by 36% compared to a BAU scenario with minimum levels of ZET penetration. The modelling results indicate that the current CO2 emission standards for new Heavy-Duty Vehicles adopted by the European Council in 2019[13] are not stringent enough to be aligned with the 2050 sectoral objective. Further analysis shall be developed in this area at EU-level to assess and enhance the readiness of the sector to develop and adopt more rapidly new technologies, as well as to boost innovation and private sector involvement. In addition, financing and taxation instruments might be needed to achieve sooner TCO parity with diesel counterparts. This can take the form of CO_2-differentiated taxation/charging schemes, carbon pricing, and differentiated low-interest rates, with particular support to small capital-constrained enterprises to facilitate a just transition.

Public financial support for the deployment of publicly accessible charging infrastructure should be strengthened and extended until higher electrification levels are achieved. Tax incentives, financing mechanisms (with properly identified funding sources), and partnerships can help improve the business case for private sector investment and ensure fast build-up of charging infrastructure.

Successful decarbonization will require a change in how revenue is raised from transport users. The shift to electric vehicles will result in a significant reduction in fuel tax revenue; alternative funding mechanisms, such as distance-based charges, will be necessary. Such charges could help internalize some of the externalities from transport, other than emissions, and may also support a just and inclusive transition.

Box 5: EVs are increasingly attractive green option in the EU and Romania

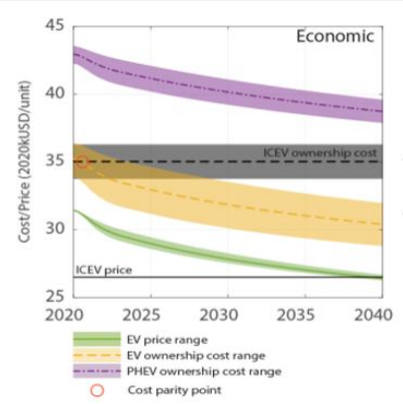
While car ownership is on the rise, EV use in Romania remains limited. Romania's car use continues to increase, with rising incomes and still limited public transport alternatives. While e-mobility has been on the rise, currently only 0.3% of passenger cars are fully battery electric and other 1.6% are hybrid. While registrations of electric vehicles are growing every year, the prevalence of second-hand imports, holding around 70% of the market, slows down the transition: only 0.2% of second hand imported passenger cars were Battery Electric Vehicles (BEV) and 4% hybrid during the first semester of 2023, compared to 10% BEV and 28% Hybrid for new vehicles.

Rapidly falling costs make EVs an increasingly attractive green alternative for consumers. Over the last ten years EV costs have fallen by over seventy percent across key segments of ownership. Meanwhile, prices of internal combustion engine vehicles (ICEVs) have been relatively stable, shrinking the cost difference between EVs and ICEVs. Results from the Future Technology Transformation (FTT) model shows that while BEVs may currently have higher purchase prices, they have lower operating and maintenance costs, making them a cost-effective option. With falling upfront costs and lower operating expenses, BEVs are expected to have lower cost of ownership in Europe by 2022-2025 (Figure 21).

The automotive industry, accounting for around 15%1 of the total manufacturing employment in Romania, needs to be prepared for the technological transition. Although electrification of the automotive sector is not expected to have significant impacts in vehicle assembly plants, adapting manufacturing capacities might be needed to compensate for employment losses in transmission and combustion engine parts manufacturing[1]. Given the importance of trade with many EU countries where the powertrain transition has already started, opportunities to develop and adapt manufacturing capacities should be strategically assessed and planned for in the short term.

[13] Regulation (EU) 2019/1242 of the European Parliament and of the Council

Figure 21: Cost comparison of EVs and combustion engine vehicles



Source: FTT. Note: Trajectory of total ownership costs (dashed lines) and prices (solid lines) of BEVs/PHEVs/ICEVs (median and 95% confidence range learning rates). Total cost of ownership = ICEV price + fuel cost/electricity cost + maintenance cost.

3.2.5. Bringing it all together: Results of the Energy+ Modelling

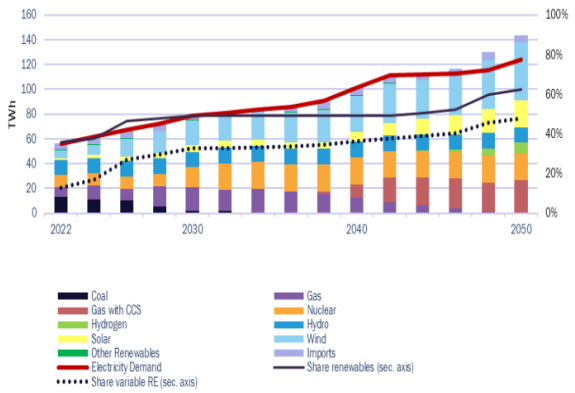
This section highlights the main findings of the modeling exercise described in sections 3 and 3.1 regarding the future of Romania's electricity and transport sectors. The assumptions, methodologies, and detailed results for all scenarios considered in the exercise are outlined in a supporting background report.

The decarbonization pathway proposed in section 3.1 requires a varied mix of sources for power generation, accounting for greater electrification throughout the economy. The modelling indicates that 47 percent of power generation will come from solar and wind by 2050, and an additional seven percent from hydropower, five percent from green hydrogen and one percent of other renewables, bringing the share of renewables to 60 percent (Figure 22). All coal-based generation will be phased out from 2032, and limited nuclear generation is projected to be added after 2030, representing a 13 percent of the generation by 2050. By the mid-2030s, CCUS will have to be deployed and scaled up rapidly to decarbonize natural gas-based power generation, which has an important role to play in balancing out the variability of solar and wind power, reaching a 23 percent share by 2050. The remaining 4 percent share will be covered with electricity imports.

Power demand more than doubles between 2022 and 2050 in all projected net-zero scenarios (Figure 23). As a result, the build-out and strengthening of electricity transmission and distribution networks will be essential. Battery storage—critical to support the rapid growth of renewables—is projected to reach 4 GW of capacity by 2030 and more than 11 GW by 2050, although its early uptake may require policy support and some grant financing.

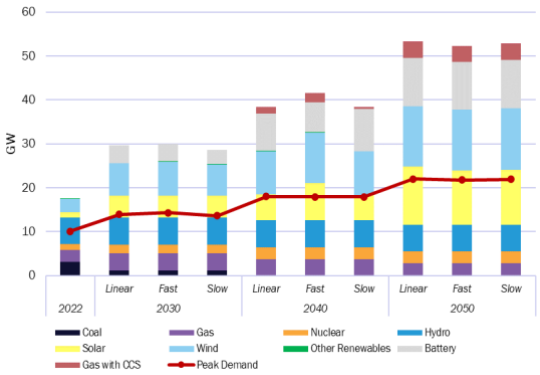
The modelling suggests that the 90 percent reduction in transport emissions targeted by the EGD requires ambitious policy actions and investments. The pathway to near net-zero in transport entails a dramatic reduction in tank-to-wheel emissions (i.e., those produced while a vehicle is in use) (Figure 24), achievable mainly through shifting to more sustainable modes and large-scale electrification of transport systems plus a limited amount of hydrogen usage (Figure 25).

Figure 22: Evolution of power generation under the proposed net-zero pathway



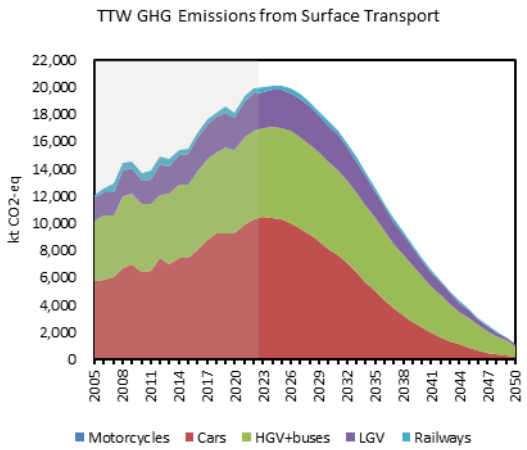
Source: World Bank elaboration based on EPM in coordination with other models.

Figure 23: Evolution of power generation capacity across three net-zero scenarios (linear, fast, slow)



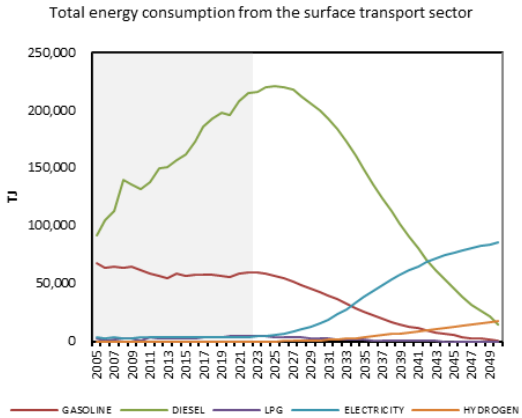
Source: World Bank elaboration based on EPM in coordination with other models.

Figure 24: Tank to wheel (TTW) GHG emissions



Source: World Bank elaboration based on EPM in coordination with other models.

Figure 25: Total energy consumption from transport

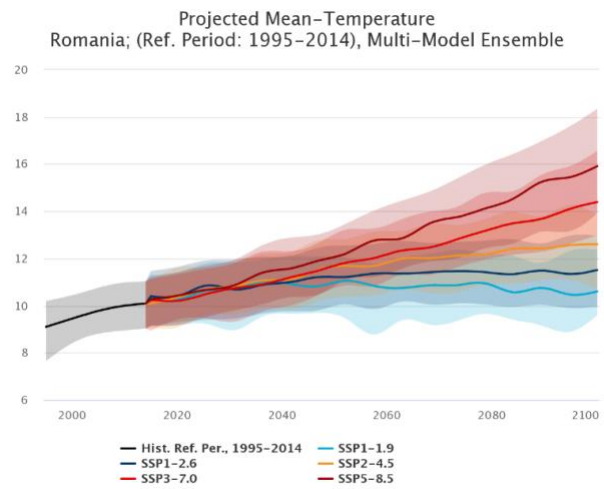


Source: World Bank elaboration based on EPM in coordination with other models.

3.3. Building resilience to natural disasters; adapting to climate change

Climate in Romania is already changing and witnessing more extreme weather events. Data from the European Climate Adaptation Platform for 1901 to 2020 shows an ongoing warming in Romania at annual timescale (with 1.3°C over the entire period), resulting in warmer summers, winters and springs, as well as heatwaves. Overall mean temperatures have increased and are projected to increase under multiple climate scenarios (Figure 26). While precipitation trends over the 1901-2020 period show no major changes in annual totals, regional variability is increasing. Some regions of Romania (e.g., the Transylvanian Depression, the Apuseni Mountains) exhibited an increase in autumn precipitation, whereas others (such as the Danube Delta, the Banat Region) show decreases in winter and spring. IPCC (2021) predicts that Romania's climate will be different 50 to 100 years from now, with damages from extreme weather events increasing up to six times, caused by floods, droughts, fires, landslides, epidemics and zoonoses.

Figure 26: Projected mean temperatures



Source: World Bank Climate Change Knowledge Portal

Changes in temperature and precipitation will impact every socio-economic sector in Romania. Not all population groups will experience the same effects of climate change. Certain communities will face more significant challenges than others, especially those residing in climate-sensitive areas like large urban centers or floodplains. Additionally, vulnerability will be exacerbated by inadequate infrastructure and socio-economic factors (e.g. gender, age, poverty level) and chronic health conditions. For example, elderly are at particular risk of extreme weather and natural disasters, with past heatwaves resulting in increased mortality. Health conditions, social and economic disadvantages and insufficient coverage of social protection mechanisms can hinder the ability of elderly and other vulnerable and marginalized groups to prepare for and adapt to natural disasters. Moreover, disabled and older individuals are often not sufficiently connected to public communication and frequently overlooked in emergency response systems, often related to their capacity to evacuate and survive in temporary shelter arrangements during natural disasters.

While the impacts of climate change are uncertain, especially in later years, the report has identified specific areas of actionable concern, which are considered in this chapter.

3.3.1. Integrated water resource management (IWRM)

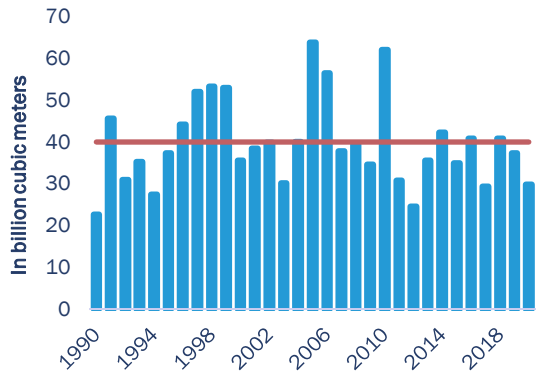
Romania is highly vulnerable to floods and droughts, with impacts felt across various sectors. Romania has experienced significant interannual variability in water availability over the past three decades (Figure 27), with many regions at significant risk of floods, while others face water scarcity. From 1970 to 2021 floods have been the most severe weather-related disaster in terms of number of events, affected people and total damage. Going forward, average annual losses due to flood could reach up to €1.7 billion, while affecting 150,000 people, for areas with the most substantial flood risk.[14] In juxtaposition, water availability in Romania is around half of the EU average and very close to the water stress threshold (Figure 29). Romania faced in 2022 the most severe drought ever recorded, disrupting

[14] European Commission. 2021. Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on Union guidelines for the development of the trans-European transport network, amending Regulation (EU) 2021/1153 and Regulation (EU) No 913/2010 and repealing Regulation (EU) 1315/2013

water supplies in 220 localities; reducing energy production by one-third (hydropower) and risking other energy sources (nuclear); reducing agricultural production by at least one-quarter; increasing forest fires by seven-fold; and causing navigation restrictions in the Danube River. With this trend expected to continue, pressure on water resources will continue to rise, increasing competition for water between agriculture, urban-users and energy production (as noted in 3.2).

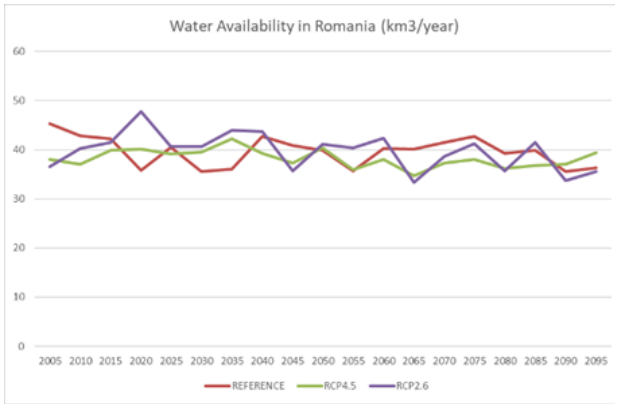
With climate change intensifying and varying the water cycle, increasing storage capacity and building drought and flood resilience are critical. The increased frequency, intensity and variability of hydrological events and the overall decrease of water availability (Figure 28) and requires increased rehabilitation and retrofitting of existing built storage, as well as the conservation and restoration of natural storage. Major investments are needed for dam safety; rehabilitation of deteriorated dams; retrofitting for new multi-purpose uses; and adjustment to new hydrological regimes. The NRRP estimates improving safety of twenty existing high-priority dams and the installation of early warning systems in all existing dams at €316.5 million. Under the current national Flood Risk Management Plans (FRMP) investments of €3.8 billion were identified. In addition, the Updated National Basin Management Plan (NBMP) has included measures to reduce the climate change related impacts of impoundments in key water bodies valued at €1.05 billion.

Figure 27: Interannual variability in water availability



Source: Bank staff with data from Eurostat (EC 2023b)

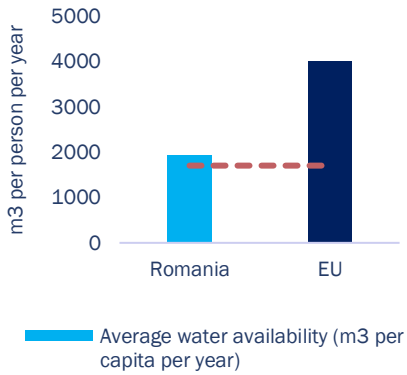
Figure 28: Projected Changes in Water Availability in Romania



Source: Estimates from an Integrated Assessment Model, GCAM. World Bank internal assessment.

Romania's water resources are critical for ensuring energy security and green energy. Hydropower is currently the largest source of renewable electricity in Romania (65 percent of renewables and 33 percent of national installed capacity) and there are plans to expand its use further. The hydropower producer Hidroelectrica plans expansion and modernization of infrastructure (including 714 MW of new hydropower). Additional adaptation measures include improved hydrological forecasting tools; better coordination with other users in the watershed/river basin; increased evaluation of system performance and operation under modified climate conditions; increasing capacity of spillways; modifying turbines and dimension of canals; and installing floating solar panels in reservoirs.

Figure 29: Water availability



Source: Eurostat.

Existing inequalities in water access risk being exacerbated by climate change, but solutions exist. About 25 percent of the population is not connected to a public water supply (mainly rural), and 60 percent of drinking water comes from surface water sources (more vulnerable to droughts). Additionally, 25 percent of rural inhabitants rely on unimproved sanitation, increasing their risk of using contaminated water from shallow aquifers polluted from inadequate agricultural practices and lack of solid waste collection. Building resilience among the rural population will require diversifying water sources; reducing water leakages; accelerating closure of the water supply and sanitation gap; adopting energy efficiency standards for the water industry; and promoting recycling and biogas capture. The updated NBMP estimates investment needs for ensuring compliance with the Drinking Water and Urban Wastewater Directives and closing the water and sanitation gaps in rural areas at €18 billion.

3.3.2. Climate Smart Agriculture

Agriculture plays a significant socio-economic role in Romania but is vulnerable to climate-induced shocks. While agricultural GDP has declined over the years, at 4.1 percent of total GDP in 2021 it was considerably above the EU average of 1.3 percent and employs about 20 percent of the total workforce (ILOSTAT). Romanian women account for 43.1 percent of the agricultural workforce. The majority of Romanian farm-managers are managing micro- and subsistence farms and with a share of 71 percent, women are overrepresented in the cluster of the vulnerable self-employed in agriculture in Romania. The added value of agricultural production grew at an average of 2.6 percent during the period 2010-2021, but with high interannual variability. The growth has been characterized by expansion of low-value commodities; contraction of other agri-food and livestock sectors; modest gains in productivity; and erratic yield patterns. Climate change will increase weather related losses, particularly under non-irrigated conditions, further increasing the divide between large- and small-scale producers where the latter are less able to manage risks.

Climate Smart Agriculture (CSA), an approach to agriculture that focuses on increasing productivity, reducing emissions and increasing resilience will be key to driving a green transition in the sector in Romania. While agricultural growth has been achieved with a reduction in emissions (50 percent of 1989 levels attained in 2010 and stable since), the sector is the second largest source of emissions after energy (17 percent of total). For growth to occur in the sector within the set boundaries of the INECP, it must be achieved by minimizing emissions in new production, reducing emissions in existing practices and enhancing carbon sinks (see Box 6). This will need to be driven by strategic planning, strong coordination and a solid knowledge base and focus on creating synergies between agricultural systems.

Investments in irrigation and the adoption of conservation agriculture practices are key adaptation strategies. Increasing rainfall variability will threaten non-irrigated agriculture and elevate the need for rehabilitation of existing irrigation schemes and investment in green irrigation infrastructure. This is particularly important in vulnerable areas like in the south, south-east and east, where climate models predict drought will be most frequent and the most severe. The updated Irrigation Strategy calls for the rehabilitation and expansion of the irrigation infrastructure to reach 2.87 million ha with functional infrastructure, including development of 123,500 ha of new gravity fed irrigation. It will be important for any expansion to be for lands that are economically viable and which require farmers' contributions to ensure utilization and move to gravity supply. Currently, gravity supplied schemes (about 250,000 ha) are less than 15 percent utilized, which is the main hurdle to fighting drought and addressing weather-variability of yields. Under the 2023-2027 National Strategic Plan (NSP) for the EU Common Agricultural Policy (CAP), the Government has allocated €400 million for the modernization of existing on-farm irrigation infrastructure and €85 million for establishment of new, small irrigation systems at the farm level. To support these investments in irrigation, the adoption of agricultural practices that conserve soil moisture will be essential to enhance the overall productivity of water management, reducing water requirements and increasing water productivity in both rainfed and irrigated conditions.

In addition to increasing soil water retention, CSA and other conservation practices provide other adaptation and mitigation benefits. The warmer climate and the associated extreme conditions, like more frequent heavy rainstorms, expose Romania to erosion and land degradation. Conservation Agriculture methods like reduced tillage provide a more stable soil less prone to erosion, maintain soil organic carbon, improving soil structure, fertility and water holding capacity. The practice of covering the soil with crop residues and leaving stubble on the field also protects the soil surface against water and wind erosion.

Further development of risk management tools in agriculture is needed to protect farmers and cushion losses. Less than one percent of Romanian farmers utilize EU CAP risk management tools and those that do are large farms. The most vulnerable producers—the small farms—do not take out insurance either due to a lack of knowledge about them or lack of ability to pay for the premiums. With risks increasing under climate change, development of risk management products suitable for and attractive to small farmers is essential. The current NSP has prioritized the creation of a risk management instrument to complement the agricultural insurance system and ensure the compensation of all farmers for losses due to climatic and environmental effects.

Improving agriculture related research, development and innovation can drive modernization in the Romanian agriculture sector. Romania has 2,686 communes and only 450 Local Agricultural Consultancy Centers, usually staffed with a single agronomist. One agricultural consultant in the government system serves 12,000 to 13,000 farmers, while the optimal ratio in other European countries is 1 consultant to 65-100 farmers. The lack of agricultural extension services creates barriers to modernization such as conservation agriculture, precision agriculture, nutrient management, renewable energy, etc. The CAP includes funding/provisions to strengthen Agricultural Knowledge and Innovation Systems (AKIS), opening the way for creating a strong knowledge and innovation agenda in support of sectoral investments.

Box 6: Maximizing the efficiency of natural capital to increase carbon sequestration without economic tradeoffs

How can Romania maximize its use of its natural capital endowments to increase carbon sequestration, without economic tradeoffs? Modelling work described in Damania et al. (forthcoming) examines Romania's use of its land, water, and forests to find where landscapes can be used more efficiently to simultaneously achieve both economic and environmental goals, including GHG sequestration.

The analysis estimates the net economic production of marketed outputs for crops, grazing, and forestry, measured in monetary terms and net greenhouse gas (GHG) sequestered, which includes changes in carbon storage due to land use change, as well as methane emissions from livestock production. It is estimated that Romania, with its current configuration of input use and efficiency levels, has a sustainable production of US$2.3 billion per year from crops, livestock, and forestry.

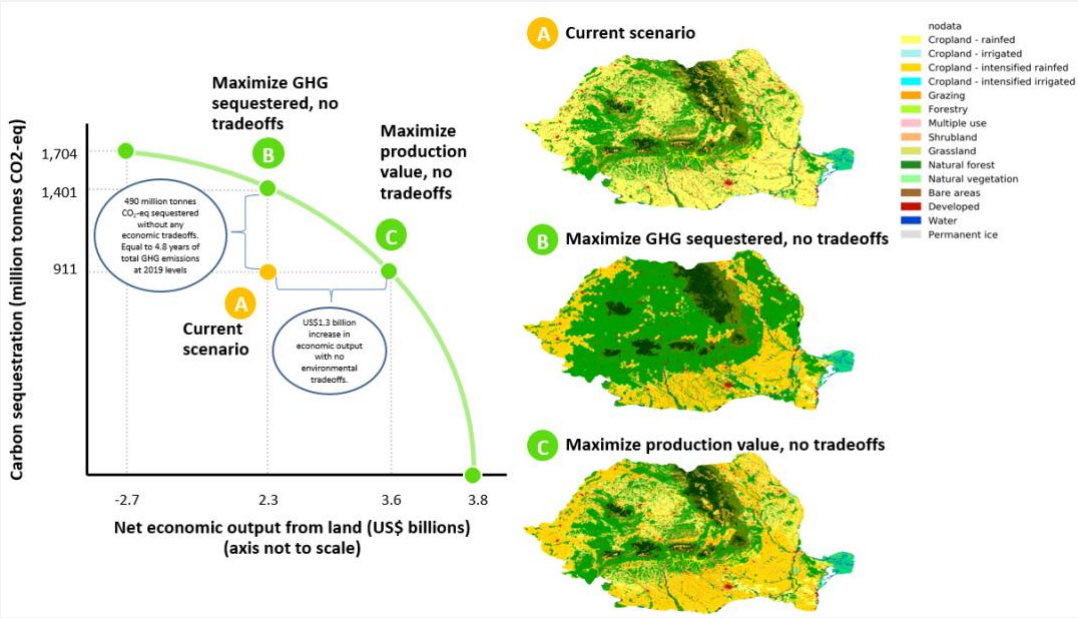
An efficiency frontier is calculated describing the maximum sustainable outputs (economic and environmental) that can be produced with given endowments (i.e., Romania's geography and climate). This frontier is depicted by the green line in Figure. Points on the frontier represent efficient land use and land management, where environmental outcomes cannot be increased further without economic losses (and vice versa). Points inside the resource efficiency frontier can be improved on by moving towards the frontier. This can be achieved by allocating resources more efficiently across different uses, or by using existing resources more efficiently, or both.

Figure 30 highlights two important points—points B and C. At point B Romania will continue to produce US$2.3 billion from crops, grazing, and forestry, but will sequester an additional 490 million tonnes of CO2e compared to the current scenario. At the WBGs shadow price of carbon of US$40-US$80 per tonne, this would amount to a value of US$19.6-US$39.2 billion. At point C economic production is maximized without reducing carbon sequestration, so that there are no tradeoffs; i.e.,

Romania is continuing to sequester 911 million tonnes CO2e, but will increase the value of crop, grazing, and forestry production by US$1.3 billion per year compared to the current scenario. Comparing land use and management between scenarios A and C in Figure 30 one sees that much of the land remains devoted to economic production. Indeed, in this scenario, land devoted to cropped agriculture increases from 10.9 million ha to 11.5 million ha. Natural land increases from 5.1 million ha to 7.7 million ha, largely from converting forests from forestry to non-forestry status.

Several key takeaways can be drawn from this analysis. First, it is evident that Romania is far below its efficiency frontier implying that there is significant room to increase carbon sequestration, economic production, or both simultaneously, without tradeoffs. Second, the landscape analysis shows that cropped agriculture is a significant driver of this inefficiency. Sustainably intensifying agriculture and employing best management practices can lead to large increases in production, which can either offset the release of more land for forests and carbon sequestration—leading to a shift towards point B in Figure 30—or shift Romania towards point C, where it is maximizing economic production without environmental tradeoffs. All points on the green line between B and C also represent efficient allocations where increasing in both economic production and carbon sequestration are feasible.

Figure 30: Natural capital efficiency frontier for Romania



3.3.3. Biodiversity and forest ecosystems

Romania is the most biogeographically diverse country of the EU. Romania contains five out of the ten officially recognized biogeographic regions by the EU (alpine, continental, Pannonian, Pontic, steppe). The country's unique forestry sector is characterized by rich biodiversity and has the largest area of primary forests in Europe, preserving a diverse genetic fund. Economically and socially, the forestry sector contributes significantly to Romania's GDP and supports the rural economy, providing numerous jobs. Romania's forestry sector faces challenges due to a lower technological level and limited access infrastructure, which hinders its overall efficiency. Biodiversity in Romania is threatened by expanded urbanization, desertification, overexploitation of natural resources, illegal logging, and the impacts of climate change and extreme events.

Climate-related hazards are expected to increasingly affect natural ecosystems. Projected climate models suggest that ecosystems will experience heightened thermal stress due to increasing frequency

and intensity of heat waves, which will impact biodiversity. Increasing temperatures, heat waves, and variable precipitation contribute to forest drying, making them more susceptible to diseases, pests, and reduced productivity. This affects carbon storage capacity and releases carbon through decomposition of damaged wood, potentially harming industry, markets, and communities. Elevated temperatures causing seasonal snowpack depletion may impact natural systems, including alpine environments that are particularly vulnerable given their short growing seasons and reliance on adequate moisture. Concurrently, the increased frequency of heavy rainfall events could heighten the risk of flooding and flash floods for terrestrial ecosystems.

As Romania's ecosystems will continue to be affected by climate change, targeted measures are needed to bolster their adaptation and resilience, such as: developing ecosystem services assessment; improving conservation status of swamps and lakes and ensuring the restoration and/or ecological recovery of wetland habitats; continue applying nature-based solutions to maintain the connectivity of populations or ecological corridors when planning and building infrastructure. For the forestry sector, actions should include identifying adaptive measures through sustainable forest management and research, adjusting forest regeneration practices, developing forest access infrastructure, strengthening institutional capacity, and employing minimally invasive or environmentally friendly technologies. While progress in developing the electronic wood traceability system (SUMAL) has been recorded over the recent years and new investments for its strengthening are envisioned, maintaining a transparent monitoring and real-time verification on wood transports will be vital to support further actions to combat illegal logging. In addition, improving risk monitoring systems, such as those for pests, wildfires, and invasive species, and risk management strategies to confront climate-related hazards will be needed.

3.3.4. Sustainable and resilient logistics

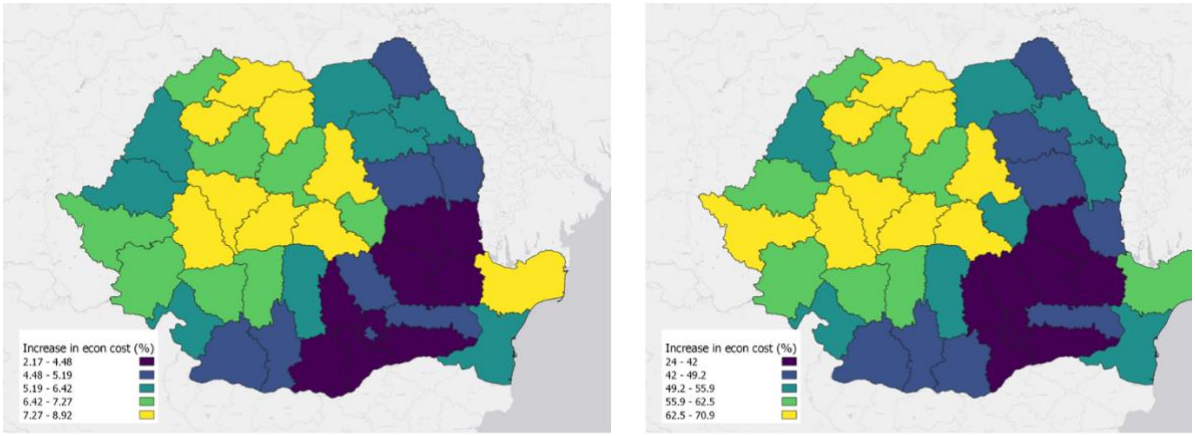
Floods can impact key assets such as transport infrastructure, vital for the country's economy and supply chain. As the flood risk is increasing in Romania, a comprehensive analysis (Figure 31) was conducted and identified four critical areas where both road and railway infrastructure face significant risks from flooding. These were between Suceava and Beclean; the vicinity of Vaslui; the area surrounding Alba, and the region between Ciumeghiu and Arad. On average, annual flooding is expected to raise the nationwide total road and agricultural road transport costs by almost 6 percent each, and economic passenger railway cost by an alarming 24.5 percent.

The analysis underscores the urgency of taking immediate action to address the challenges posed by climate change. In terms of adaptation measures, redundancy can be increased by building new transport routes in highly vulnerable areas, ensuring that alternative detour routes are available when primary routes are disrupted. Vulnerability analysis results could be used to prioritize areas for investment. Disaster resilience of exposed road segments can be further strengthened by upgrading drainage systems, expanding lanes for increased water retention, and enhancing maintenance. Criticality analysis results, especially the multicriteria criticality that combines road's exposure to disaster with the probable economic impact of its disruption, could be used to guide the prioritization of these actions. Furthermore, safeguarding agricultural supply is crucial. This can be achieved by identifying and prioritizing key agricultural supply chain routes for infrastructure improvements, ensuring continuity in food distribution during flood events.

Mitigation measures can further minimize future exposure to flood hazards and protect vulnerable areas. Some of these measures include (i) integrating flood risk considerations into infrastructure building regulations, (ii) promoting the use of multiple modes of transport and seamless integration between them, providing redundancy, and reducing the overall impact of disruptions on passenger travel and goods distribution, (iii) prioritizing vulnerable region by focusing resources on areas with both high transport disruption and socioeconomic vulnerabilities. These areas are more likely to experience

severe impacts due to a combination of infrastructure disruptions and marginalized communities. Nevertheless, using strategies like flood barriers and natural flood management to reduce the risk of significant flooding, particularly in critical areas where both road and railway segments are vulnerable, will also support flood mitigation.

Figure 31: Vulnerability to road network disruptions at county level, (a) annual expected increase in economic cost due to transport disruption from flooding, (b) increase in economic cost due to an extreme 100-year event flooding

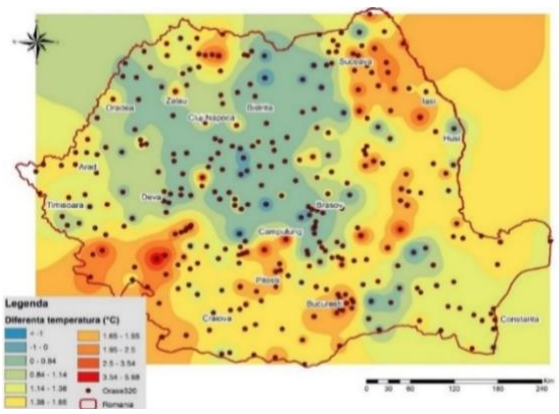


Source: World Bank.

3.3.5. Resilient, climate-smart cities

While a major source of emissions, cities in Romania also face major adaptation challenges. Key developmental challenges persist in urban centers in Romania including air pollution; aging and poorly maintained (residential) building stock; sprawling and uncoordinated urban development; and vulnerability to urban heat island effect and floods, especially for urban marginalized communities. Tackling these challenges requires integrated adaptation and mitigation measures tailored to each urban center through a mix of national policies and local interventions. However, progress is possible: for example, Cluj-Napoca is working with the World Bank to prepare a comprehensive NetZero City Action plan, one of the first such plans in the world, which provides a blueprint for the transition to climate neutrality by 2030.

Figure 32: Difference in air temperature between 2015 and the average temperature for the period 1960-2000



Source: Romania's Urban Policy

The urgency for city level action is increasing. The concentration of people, infrastructure, and economic activity in urban areas make them particularly vulnerable to climate change and average temperatures have already begun to increase (Figure 32). The location of most cities next to water bodies, coupled with poor drainage due to impervious land cover and obstructed waterways, makes cities particularly prone to flooding and sea level rise. Extreme heat is more frequent and intense in urban areas due to the high number of sealed surfaces and building densities which already produce strong urban heat island (UHI) effects. Urban neighborhoods in Bucharest and Cluj-Napoca are

significantly warmer than nearby rural areas during both daytime and night-time. The urban poor are particularly vulnerable, as marginalized areas in Bucharest are predominantly situated in zones with a strong urban heat island effect (Figure 33). Moreover, urban climate projections show a substantial increase in urban heat by 2050 (50 percent increase in the number of heat-wave days in a high-emissions climate scenario). An example of this effect is shown for Cluj in Figure 34. This can have serious impacts on health, as well as wide-ranging environmental impacts on vegetation, water and air quality, which in turn affect human well-being, labor productivity, mortality, energy consumption, and infrastructure.

Nature Based Solutions (NBS) can play a critical role in addressing heat extremes. Adaptation priorities should include strategic urban greening in under-provisioned areas (e.g. "3-30-300 rule"); use of NBS to manage urban flood risk; agroforestry and afforestation; improving ventilation through street design optimization; reducing building density; and implementing cool roofs or active cooling strategies. Creating community cool spaces, powered by renewable energy systems, encouraging sustainable cooling solutions and raising awareness and preparedness of citizens can also contribute to increasing resilience to heat weaves.

Figure 33: Overlap of marginalized areas and urban heat islands in Bucharest, Romania

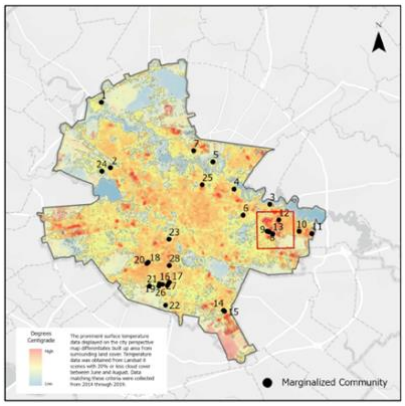
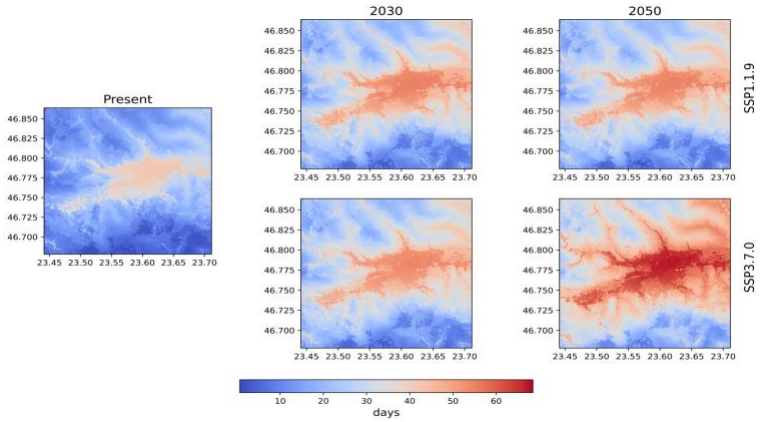


Figure 34: Number of heatwave days for Cluj at present, and towards the future (2030 and 2050) under low- and high-emission climate change scenarios (SSP119 and SSP370)



Source: City Resilience Program. 2022. Romani Urban Heat Final Report

Ensuring better resilience against disasters caused by seismic events along with improvements in energy consumption offer a win-win. Romania's existing building stock accounts for 42 percent of total final energy consumption and is highly vulnerable to seismic risk. To cope with the high seismic risk and achieve significant energy efficiency co-benefits, almost 4 million pre-1980 Romanian buildings (of which around 95 percent are single-family dwellings) located in areas exposed to medium/high seismic hazard will need retrofitting or reconstructing and rehabilitation. Out of the entire existing building stock built prone to severe earthquake damage, the National Seismic Risk Reduction Strategy has identified priority buildings in residential, healthcare, and education sectors for retrofitting interventions. These efforts can reap numerous rewards, such as saved lives, reduced building losses, new jobs in the construction sector, decreased energy consumption and emissions, improved thermal comfort and progress towards a low-carbon economy.

Interventions on the built stock should be done in a coordinated and integrated manner leading to a comprehensive transformation of neighborhoods. The starting point should be urban regeneration plans for entire neighborhoods, proposing not only integrated interventions for buildings (e.g., consolidation, thermal rehabilitation, upgrade of utilities networks, energy generation), but also

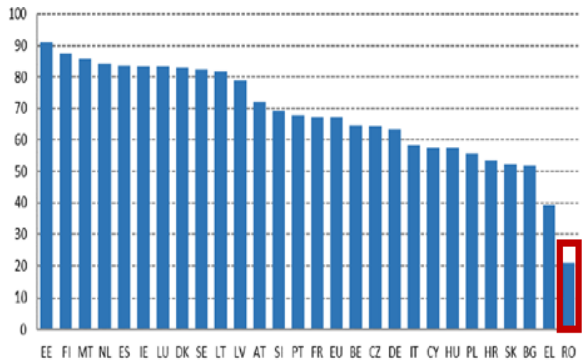
integrated interventions for the surrounding areas. This holistic approach should focus on not just improving energy performance, but also on improving quality of life and green transport.

3.3.6. Data Resilience

Romania's vulnerability to climate change related hazards poses risks to government information and systems. Understanding climate change related risks—and assessing the full extent of the Government's preparedness to respond to them—is difficult due to limited information about the public administration's risk management strategies. Open Data on Disaster Risk Management (DRM) in Romania is restricted and, in some cases, nonexistent, as shown in the 2019 Open Data for Resilience Index.

In the absence of a standard policy framework for systems redundancy, data resilience, and digitalization, most public institutions maintain documents and records on-site for ease of access, using inadequate infrastructure and inappropriate available space, increasing their vulnerability to damage from environmental hazards. Limited storage of data in electronic format further increases risks and compounds the already scarce provision of digital public services (Figure 35).

Figure 35: 2022 DESI rankings for digital public services



Source: DESI 2022, European Commission.

Leveraging Romania's digital transformation to establish certified redundancy centers in low-risk locations and cloud infrastructure can safeguard data from natural disasters and facilitate data restoration to reduce interruptions and ensure continuity in the delivery of services in the public and private sectors. Assessing the Government's data centers, use of cloud infrastructure and redundancy capabilities is important to design policies that support increasing data resilience in hazard-prone locations as well as the local and central governments.

Targeted initiatives, such as Romania's Euro-Atlantic Centre for Resilience and its interinstitutional working groups, are a step in the right direction and underline the Government's commitment to mitigating risks. Anticipating and responding to potential crises, including climate-related disasters, requires fostering collaboration across government levels (horizontal and vertical) and addressing policy gaps to implement safeguards and advance toward more resilient systems and services.

Setting up policies and standards on systems and data management should constitute an essential first step. These should include protocols for redundancy and backup, modernizing storage and archive requirements, disaster recovery and cybersecurity procedures, specific guidelines for protecting records from environmental threats and also building competencies and skills to apply these standards. In parallel, the central government should work with subnational authorities to conduct a systematic assessment to map the existing data resilience capabilities in public institutions, including vulnerabilities to climate-related hazards, and to identify bottlenecks (costs, staff, etc.) and training needs for advancing the implementation of the new policies and protocols.

4. Economy, People, and Companies—in Transition

4.1. A competitive whole-of-economy transition to net zero

Delivering on Romania's ambitious climate targets will require a whole-of-economy approach, and careful policy action to manage the economic and distributional impacts of the transition. With a relative contribution of services to economic output that ranks among the lowest in the EU, Romania's economy is still undergoing a structural transformation. The country also suffers from (relatively) high rates of poverty and inequality, as well as gaps in basic services—notably, it is the only EU member without universal access to water and sanitation. Decarbonization efforts towards Net0@2050 will have an impact on output, both economy-wide and in specific sectors (see Chapter 4.1), and potentially on competitiveness. Moreover, with labor demand shifting away from emission-intensive to greener sectors—in an economy that already suffers from a major skills gap (Chapter 4.2)—the transition will have distributional impacts through its effects on household incomes and prices. The financial sector will face the challenge of funding the transition (Chapter 4.3), with both the private and public sectors having a role to play. This chapter aims to illustrate the complexity of achieving both Romania's development objectives and its legally binding climate objectives; but also the immense opportunities from aligning climate and development ambitions, while rolling out carefully considered policies to support the green transition without compromising the wellbeing of the population.

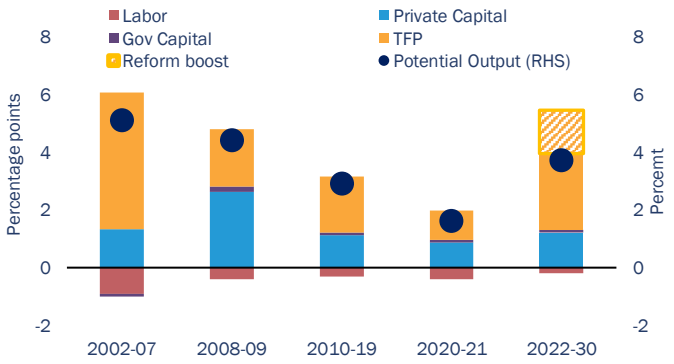
4.1.1. Macroeconomic implications of decarbonization policies

Structural reforms are needed to put Romania's growth on an economically sustainable path

Romania has substantive growth potential, but ensuring sustainable growth requires structural reforms. The World Bank's EU Regular Economic Report 8 (2022) showed that Romania can accelerate its potential growth[15] from 3.7 percent to 5.2 percent per year over the next decade (Figure 36), and enhance its broader economic performance, by implementing productivity-augmenting structural reforms. These include gradually closing institutional and educational gaps with the EU, achieving targets on digital investment, and expanding the economically active population (including through greater female labor force participation). Some of these reforms are built into the Business-as-Usual (BAU) and decarbonization scenarios presented in this chapter.

Figure 36: Romania has high growth potential, but needs structural reforms to achieve it

Drivers of growth, 2002-2021, and projections



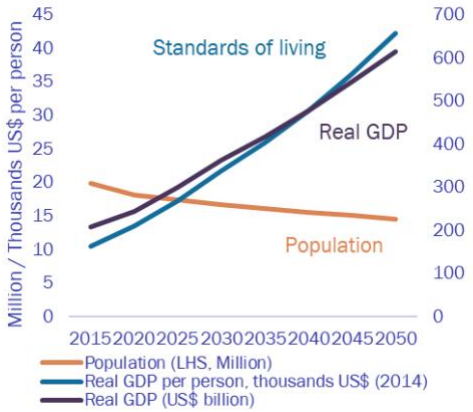
Source: World Bank calculations and projections, World Bank EU Regular Economic Report 8 (2022)

[15] Potential growth refers to growth of potential output—which is the level of output that can be sustained at full employment and capacity utilization. It differs from actual growth, which deviates from its potential rate as a result of temporary or cyclical factors.

It is possible to minimize the economic impacts of the resilient net zero pathway

Even through the green transition, Romania can benefit from above EU average GDP growth rates[16] over the next decades, and potentially nearly triple its standards of living again by 2050[17]. Like other EU member states, Romania is facing the challenge of a shrinking and aging population, which is projected to drop from 18 million in 2020 to 14.6 million by 2050—a fall of about 20 percent, due to demographic factors and sustained migration (Figure 37) (see Romania SCD Update 2023 for more detail). This entails two challenges: first, enticing the currently inactive population into the labor force (for instance, current labor force participation rates are lower for women than for men); second, upgrading human capital to mitigate widening skills gaps (see section 4.2). By 2050, living standards in Romania (i.e., per capita income in real terms) are projected to almost triple, from US$13,500 (constant) to US$42,200 (Figure). However, achieving such growth and ensuring that it is inclusive will require substantive complementary policies. For instance, such projections hinge on an assumption of further increases in average years of schooling, which are crucial to progress in labor productivity to maintain high GDP growth rates, along with capital accumulation.

Figure 37: …is consistent with standards of living tripling over the next decades



Source: World Bank simulations.

Along with this strong economic growth, the structural transformation of the economy is expected to continue (Figure 38). The policies, regulations, and investments needed to meet decarbonization targets will induce structural change in the Romanian economy. Services—whose contribution to GDP is much lower than in the rest of the EU (see the forthcoming CPSD)[18]—are projected to become more prominent, reaching 57 percent of total value added in 2050 from 48 percent in 2015 and easing the path to decarbonization, due to their comparatively low emission intensity. Services sub-sectors expected to grow, in both absolute terms and as a share of the economy, include transport (where Romania has potential considering its currently less developed state compared to the rest of the EU) and communications (capturing the thriving ICT sector), among other services (Figure 39). In agriculture, livestock production—an emission-intensive sector—is projected to decline to just under 2 percent of value added by 2050, as a result of changes in consumer preferences (e.g., lower demand for meat), while the contribution of export-oriented crop production to value added will remain at around 4 percent. The share of the secondary sector in value added will drop somewhat from over 44 in 2015 to around 38 percent in 2050, but will remain relatively high, reflecting the development of competitive industrial sectors in Romania since its integration into the EU (see Box for Romania's potential in green value chains). The stability of the secondary sector reflects additional that construction and utilities follow closely overall economic growth, contributing 13 percent to value added in 2050.

From a macroeconomic perspective, the impacts of the decarbonization—or its pace—are limited, provided complementary policies underpinning the simulations are undertaken. The cumulative cost (forgone GDP) of bringing the Romanian economy to net zero is forecast at around 2 percent of the 2050 GDP—therefore relatively small, considering that the 2050 GDP is set to be more than twice as

[16] For the purpose of this CCDR, the average growth rate projected for 2023-2050 is around 2.8 percent, which is conservative compared with: i) the 3.8 percent rate observed in 2000-2021, reflecting slower future growth as living standards converge; and ii) potential growth of 5.2 percent over 2023-2030 if structural reforms are undertaken; it is also broadly comparable to iii) the 2.1 percent average over 2023-2050 that underpins Romania's Long-Term Strategy simulations. As indicated earlier in the report, the scenarios in this report provide an illustration and are subject to high degree of uncertainty.

[17] The projections indicate that real GDP increases will grow by 2.3-fold between 2022 and 2050, while and the real GDP per capita increase by 2.9 times-fold during the same time period; the population is forecast to declines from 18 million in 2022 to 14.6 million in 2050.

[18] As well as Nayyar, Hallward-Driemeier, and Davies, 2021.

high as current levels (Figure 40). Furthermore, much of the cost will be incurred in the last decade of the simulation horizon, when hard-to-abate sectoral emissions will have to be tackled—likely through carbon capture and storage. The uncertain cost of mitigating those emissions is a key determinant of the macro impact of the transition as 2050 approaches; if they were more limited than assumed, the economy-wide costs could also be lower. Differences across the choice of pace scenarios are marginal, but their development over time suggests that Romania is unlikely to reap major benefits from decarbonizing faster than mandated by EU targets (Figure 41). However, the relatively low costs of decarbonization and related macro-impacts also hinge on relatively strong economic assumptions that would require considerable complementary policy action, as discussed later in this chapter.

Figure 38: The structural transformation of Romania's economy is set to continue…

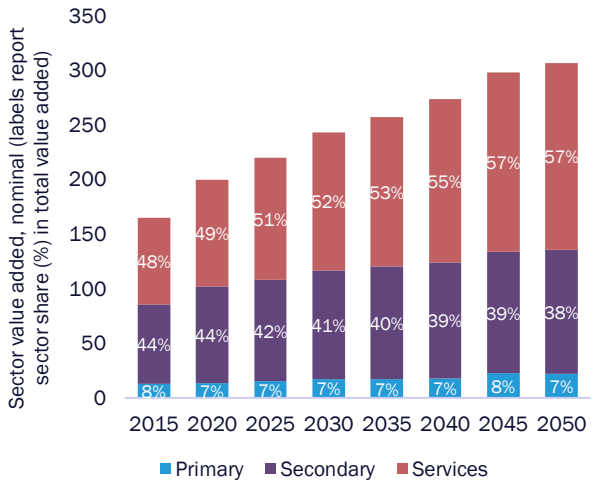
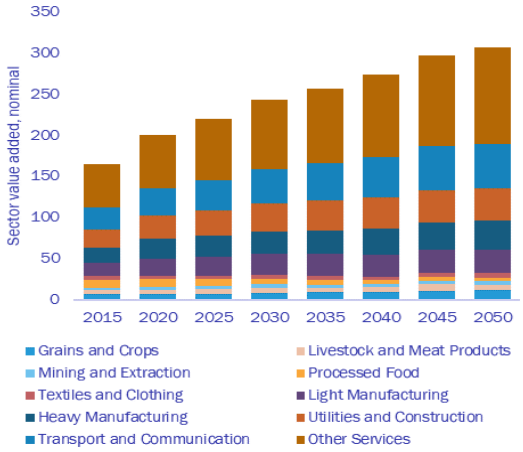


Figure 39: …with services including transport and ICT growing substantially



Source: World Bank simulations using CGEBox in coordination with other models. Results shown for linear scenario
Note: Bars show the output value by sector; data labels show sector output as percentage of total output.

Figure 40: The cumulative impact of decarbonization on Romania's economy is projected to be modest…

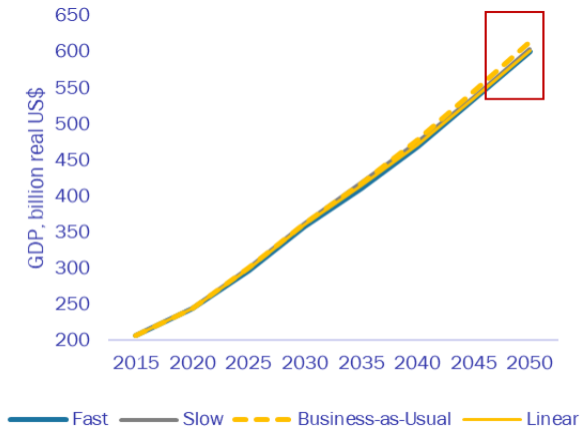
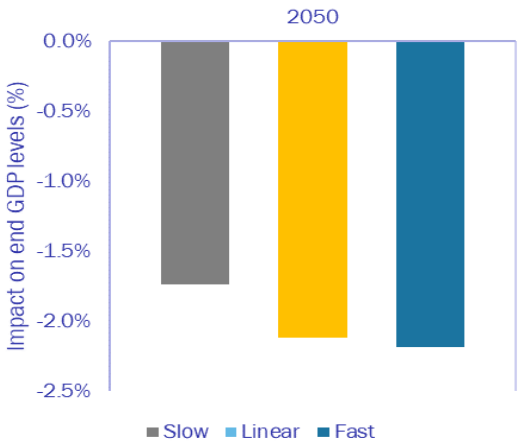


Figure 41: …also with limited differences across the pace scenarios



Source: World Bank simulations using CGEBox in coordination with other models.

Much of this finding derives from the cost-competitiveness of the existing technologies for energy decarbonization and the assumption of efficient multi-sector carbon pricing. The decarbonization scenario assumes a highly efficient market-based decarbonization policy by taxing all climate-change-relevant emissions and emitters, combined with government programs which foster energy savings,

especially in buildings and transport. From the economic perspective, the investment needs from greening the energy system are not that different from development investment needs for any (browner) energy system to cater for Romania's growing economy and improving living standards (see section 4.3). Given the competitiveness of renewables under the given fossil price projections, electrification of transport, buildings and the power sector are mostly cost-efficient or relatively cheap in the long run (the savings cover investments).

The modeling highlights important choices to be made relatively soon and additional decisions around fifteen years out. From the economic perspective, the energy efficiency measures, additional energy production to cater for electrification of the economy, and the substantially higher efficiency of electrifying transportation systems effectively pay to a large extent for themselves. Furthermore, the revenues from the carbon pricing are recycled back into the economy. But the latter is only relevant as long as larger emission quantities are taxed. When approaching the net-zero target, emission tax income shrinks and cannot finance, for instance, targeted support to poorer households which see increases in their CPI (see section 4.2). Nevertheless, alternative tax revenues could be raised and used once the emission tax base is eroded (for instance, by reverting the direct taxation decreases).

For the former the question is that of financing—how households, governments and the private sector finance the investment needs with high up-front costs, where financing constraints present trade-offs; as well as the implementation feasibility. Many of the technological steps assumed by the modelling entail high upfront costs—e.g., the rollout of heat pumps or EVs at the consumer level, which require specific financial tools and informed decision-making, at a time when many Romanian households struggle with high inflation (see EU Regular Economic Reports). Implementation feasibility is also a question, both from the political economy side, and from a practical one. For instance, reliable supply chains and an appropriately skilled workforce are required to install the renewable capacity, along with the public sector planning capacity to deliver complex transportation and transmission systems. Please see Chapter 4.3 on financing the green transition.

Although their overall macroeconomic impact is set to be muted, decarbonization and its associated policies will affect certain sectors more profoundly, particularly in 2040–2050. In terms of value added, sectors such as oil refining (–70 percent), gas distribution (–81 percent), and production of chemicals (–27 percent) are forecasted to shrink considerably already by 2040 (relative to a BAU scenario of moderate mitigation efforts). Changes to private and public transport globally, such as greater use of public transport and bikes, will reduce output by 6 percent in automotive manufacturing, and by 14 recent in automotive parts production. However, production of other machinery is set to grow by around 50 percent, driven by the electrification of the economy. This relatively high effect in one sector is uncertain as the cost-breakdown related, for instance, to renovate buildings and to install heat-pumps is rather stylized in the macro-model and not informed by detailed sectoral modelling. In 2040–2050, a decade characterized by the need for stronger reductions in sectors with hard and expensive to abate emissions, associated uncertainty and corresponding sharp increases in the price of carbon, a substantial contraction in emission-intensive sectors (e.g., cement production, which is poised to drop by 30 percent) will drive a fall in overall GDP. However, services are not expected to be significantly affected, with the exception of transport.

The rather rapid reduction in some sectors in the last decade also implies stronger changes in employment and a rise in non-productive (abatement) investments crowding out household consumption. Workers will have to relocate, especially in some manufacturing sectors. Investments related to process emission abatement are at around 5 percent of total investment demand in 2040, they do not increase the productive capacity of the economy but remove emissions. Their share rises to around 11 percent in 2050, crowding out especially final demand by households. The faster pace of decarbonization, with frontloaded unproductive investments also risk crowding out household

consumption. Findings related to process abatement remain stylized. For instance, assuming that abatement is investment-based neglects that some abatement options might require a change in intermediate input or labor use, only, Equally, employment in power generation, despite higher output, is shown as falling by the macro model compared to the BaU. This reflects that solar and wind-powered electricity generation have very limited labor requirement once installed, compared to fossil alternatives. The employment effect of installing the renewable capacity is distributed implicitly over the lifetime of the renewables in the macro modelling. This might underestimate the employment effect during the green transition. Please see chapter 4.2 for more detailed discussion on labor and households.

4.1.2. Decarbonizing the economy while enhancing its competitiveness

Ultimately, Romania's competitiveness will hinge on its progress in productivity growth, which in turn depends on structural reforms

Economic competitiveness is among the key consideration when planning for the green transition. Indeed, without adequate countermeasures, the green transition could potentially increase production costs while deepening the shortage of skilled labor in the domestic market, among migratory outflows and rising internal demand for the more sophisticated skills that green jobs require. As discussed in section 4.3, carbon pricing will be instrumental in incentivizing the private sector to invest into more sustainable production processes.

Simulations[19] suggest a limited impact of decarbonization on Romania's external competitiveness. Due to the strong trade integration into the EU and into the EU Emission trading system (ETS), cost increases due to carbon taxation or other decarbonization policies in specific sectors, especially those with higher process emissions, will be experienced both by Romania and its major EU trading partners. In particular, for high-emitting sectors such as livestock or cement production, abatement costs across the EU are mostly linked to the cost of carbon capture and storage, which is assumed to be identical globally per unit of CO2 removed. The simulated impacts on Romanian exports, which focus on EU Member countries, are therefore limited, while decarbonization helps to reduce imports dependence on fossil fuels (oil, gas).

Ultimately, Romania's competitiveness will hinge on progress in productivity, but emerging policies can have an impact in the medium term, with imminent opportunities from green value chains (GVCs). As discussed above, Romania's productivity and growth path hinges on structural reforms. Yet, two emerging policies may impact Romania's competitiveness in the medium term: the EU's Carbon Border Adjustment Mechanism (CBAM, see Box 8) and the Green Deal Industrial Policy (see below and Annex 1). This section aims to shed some light on their potential effects on Romania's economy, which however will require more analysis. In addition, Romania can build on its strong industrial base to deepen its participation in green GVCs (Box 7).

Box 7: Romania's strengths and opportunities in green value chains: solar energy, wind energy, and electric vehicles

The global transition to a green economy offers unprecedented opportunities for growth, development, and technological upgrades. As more and more countries commit to net-zero emission targets and adopt climate-friendly policies, global demand is beginning to shift away from fossil-fuel based production toward cleaner technologies. Solar photovoltaic (PV), wind turbines, and electric vehicles (EVs) are some of the technologies set for immense growth, while many of their associated inputs and components are technologically sophisticated and entail major knowledge spillovers.

[19] CGEBox.

Thus, becoming a competitive producer in these sectors can help Romania climb up the value chain, further diversify its exports, and boost economic growth.

Romania is in a strong position to capitalize on the transition to the green economy. Romania has a diversified export portfolio, with well-developed manufacturing capabilities and competitive strengths in a range of products and technologies that will be in high demand as the world transitions to a green economy. Romania's ranking on the Green Complexity Index—which tracks the capacity of countries to competitively export products that are green (i.e., offer environmental benefits) and technologically complex—has been improving over time, up to 15th place out of 230 countries and territories assessed. Romania also ranks well on the Green Complexity Potential index (28th place), which suggests significant potential to build on its existing capabilities and unlock further opportunities for green and complex exports.

Romania's current strengths lie in the wind value chain. Analysis based on the World Bank's Green Transition Navigator[i] shows three advantages for Romania in the global shift to low-carbon energy generation.[ii] First, Romania exhibits export competitiveness in various technologically sophisticated subcomponents of the wind value chain, such as electric control and distribution boards (Figure 42). This implies that Romanian firms have acquired specialized capabilities, and can build on them to progress to new, differentiated products with higher margins and fewer competitors. Second, Romania's best-established products in the wind value chain benefit from favorable market dynamics, as evidenced by strong EU import demand and growing domestic supply, and most of them have gained market share relative to those produced in other countries over the last five years. Third, the wind products that Romania exports are close to the technological frontier and have improved in quality in recent years—which bodes well in view of future market developments.

Although Romania has few existing strengths in the solar value chain or in EVs, it can develop competitiveness in related products that align well with its current capabilities. This is especially true for solar subcomponents, such as machines for the manufacture of PV wafers. They are reasonably proximate to Romania's existing capabilities, technologically sophisticated (Figure 43), and both Romania's exports and EU27 demand for them have grown in recent years. While Romania does not currently have an obvious comparative advantage in this segment, it has the potential to gain competitiveness over time. However, further analysis is required to gain a better view of likely export destinations, existing competitors, and barriers to growth.

i. https://green-transition-navigator.org
ii. IEA (2021), https://www.iea.org/reports/net-zero-by-2050

Figure 42: Romania's current green strengths

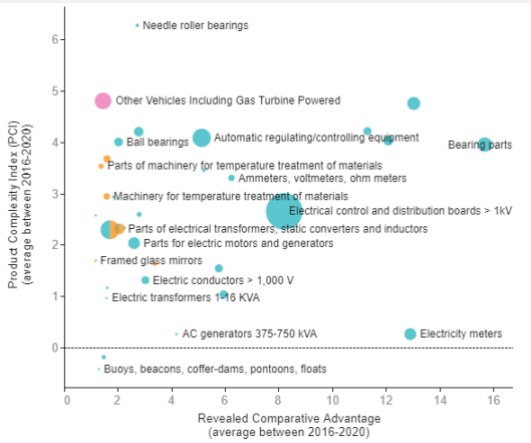
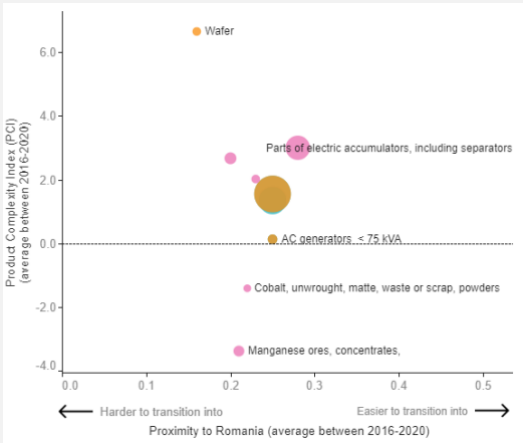


Figure 43: Romania's potential green opportunities



Source: World Bank Green Value Chain Explorer, using 2016-2020 data

Policies to mitigate asymmetric climate efforts present limited risks to Romania

The EU's proposed Carbon Border Adjustment Mechanism (CBAM) aims to mitigate the global asymmetry in climate efforts, which are much more ambitious in the EU than in its main external trade partners. The CBAM (see Box 8) will focus on the free allocation and compensation for indirect costs in sectors deemed at risk of carbon leakage. While the CBAM is yet to be implemented, countries around the EU have voiced concerns about how it will impact their production, exports, and broader competitiveness. With more than 70 percent of its exports going to the rest of the EU, Romania is not expected to suffer major disruption from the CBAM, whose costs fall on imports from outside the EU. However, more work is needed to fully gauge the likely impact of CBAM, especially in combination with carbon pricing policies and other climate-related measures.

The initial impact of CBAM on Romania's economy is expected to be limited, albeit uneven across sectors. Simulations[20] show that the CBAM may modestly increase the cost of production in Romania, as the tariff surcharge will raise the prices of several inputs. Absolute changes in output should be most pronounced in manufacturing, with a drop of up to €1 billion in value due to the higher cost of imported intermediate inputs. The fall in manufacturing output is predicted to almost fully cancel out the rise in output in energy-intensive and trade-exposed upstream sectors covered by the CBAM; as a result, aggregate output is forecast to increase by a modest 0.07 percent under the most likely CBAM scenario. Expected changes in Romanian exports echo this pattern. On the macroeconomic level, the introduction of CBAM is expected to boost real incomes in the EU as a whole (thanks to its positive impact on terms of trade), but to lower them marginally in Romania.

Box 8: The EU's CBAM: purpose and progress[i]

The Carbon Border Adjustment Mechanism (CBAM) puts a price on the import of certain products into the EU to reduce the risk of carbon leakage—i.e., of circumventing decarbonization efforts by shifting carbon-intensive production outside the EU. This mechanism will support a global reduction in emissions while maintaining compliance with World Trade Organization rules. The European Commission (EC) adopted the proposal for the CBAM on July 14, 2021, while the Council of the EU and the European Parliament reached a political agreement on its implementation on December 13, 2022.

The CBAM will require EU importers to buy carbon certificates, corresponding to the carbon price they would have paid if they had produced the imported goods domestically. The price of carbon certificates will be calculated as a weekly average of the auction price of EU ETS allowances, expressed in €/ton of emitted CO2. Alternatively, if a non-EU producer provides proof of payment of a carbon price corresponding to the carbon emitted in the production of the imported goods, the EU importer will be able to fully deduct the corresponding cost. Thus, the CBAM will incentivize non-EU countries to adopt greener production processes.

The CBAM will be phased in gradually and become fully operational in 2026. From October 2023, EU importers of certain goods at high risk of carbon leakage—cement, iron and steel, aluminum, fertilizers, and electricity—will have to report the emissions embedded in them, but no payment will be due. Once the system becomes fully operational in 2026, EU importers will need to declare the amount of emissions embedded in their imports of a range of products over the previous year and provide the corresponding amount of CBAM certificates. As the system matures, the EC will assess whether to expand the number of products and services covered under the CBAM.

i. This box first appeared in World Bank (2022 – EURER7) and was updated for this report based on: https://taxation-customs.ec.europa.eu/green-taxation-0/carbon-border-adjustment-mechanism_en.

[20] World Bank (2021). Implications of the Carbon Border Adjustment Mechanism for Romania. The study employs the Envisage Model, a recursive dynamic and global computable general equilibrium (CGE) model. This standalone exercise (not coordinated with the CGE analysis in 4.1.1) considered five alternative CBAM scenarios—with variations featuring: no export rebates; no country exemptions; use of EU average carbon intensity to determine emissions embedded in imports; and only direct (Scope 1) emissions.

Green industrial policies can support the transition, but entail international and political economy risks

Green competitiveness is broadly defined as the ability for firms and sectors to leverage environmental sustainability and climate resilience to maintain or enhance their market competitiveness. For firms, this means staying competitive in the face of both climate change, and the policies adopted at home and abroad to address it. Such policies can be difficult and/or costly to comply with, particularly for small and medium-sized enterprises (SMEs). At the same time, greener technologies, practices, and products can offer growth opportunities, through productivity gains or access to new markets.

Public support for greening and decarbonizing certain industries can be justified in some cases. Such support is often controversial, especially because of a perceived risk they it may undermine competitiveness. The available empirical evidence suggests that the impact of environmental policies on industrial competitiveness is limited, and largely touches on the most polluting or energy-intensive sectors, but the green transition can nonetheless be challenging for the private sector. Where tradeoffs between the greening and growth of industries undermine the transition, policies to provide technical and/or financial support and manage risks can be necessary to catalyze progress. Where investments expected to bring environmental and economic benefits are too risky for private finance, especially when they are at the 'frontier' (e.g., in terms of geography, technology, or business model), concessional finance can help rebalance risks and enable investment when markets fail to produce socially desirable outcomes. Support can also be required to address coordination issues between stakeholders.

Over the past decade, governments have shown a growing interest in green industrial policies to accelerate the green transition. In response to the Global Financial Crisis (GFC) of 2007-2008, China, Japan, Korea, the EU, and the US adopted green stimulus programs focusing on clean energy and transport, as well as on energy efficiency. Such programs succeeded in boosting economic recovery, but less so in catalyzing decarbonization in the short term. More recently, the US adopted the Inflation Reduction Act (IRA) in August 2022, which is expected to allocate US$370 billion in public funds over a decade to foster domestic production of clean energy and related infrastructure and equipment. In February 2023, the EC unveiled its proposed Green Deal Industrial Plan to boost the bloc's clean technology industry by (i) streamlining permitting procedures and developing standards to speed up the deployment of clean energy; (ii) increasing financing, including by channeling around US$270 billion in existing funds towards clean energy projects and temporarily relaxing state-aid rules; (iii) developing green skills and training programs; and (iv) maintaining a fair and open trade system for the green transition.[21]

While green industrial policies—if well designed and implemented—may help address market failures, they raise the risk of increased protectionism. The impacts of such policies can be both positive (through innovation and cost reduction) and negative (through local content requirements and trade-restricting provisions), with considerable uncertainty about their net outcome. Academic and policy literature on green industrial policies (IP) points towards a strong basis for them in economic theory[22] (with some empirical assessments[23]) due to various market failures (e.g., innovation and environmental externalities, information asymmetries, coordination failures) and specific characteristics of green industries and technologies. However, recent green IP packages in the US and Europe have stoked concern about rising protectionism in clean technology industries (see Annex 1).

[21] The Plan builds on the EU's new Industrial Strategy, unveiled in March 2020 along with a Circular Economy Action Plan, that made decarbonization, environmental sustainability, and circularity key pillars of the long-term competitiveness and resilience of Europe's manufacturing sector.

[22] Several other publications have explored implementation modalities, policy instruments, and country experiences for green IP (UNIDO 2011, PAGE 2016, PAGE 2017, PAGE 2018).

[23] https://www.nber.org/papers/w31538

4.2. An equitable and inclusive transition for workers and households

4.2.1. Potential welfare impacts of climate change mitigation and adaptation policies

Distributional analysis is underpinned by a comprehensive framework

Climate change and climate mitigation policies designed to reduce greenhouse gas emissions and address climate change can impact household welfare through different channels. To understand how climate and environmental shocks, and climate policies can affect households in Romania, this section follows a framework that considers seven key channels of transmission of climate and environmental risk and climate actions: 1) prices; 2) labor markets; 3) productivity; 4) infrastructure; 5) regulatory shifts and policies; 6) land use patterns; 7) safety nets. Understanding these channels is critical to properly designing and implementing climate mitigation policies to minimize adverse impacts on welfare and migration. While some of the impacts of climate risks and adaptation policies are described below, the main focus is on the role of climate mitigation policies, given its importance during the green transition. The resulting welfare outcomes consider monetary indicators, such as poverty and vulnerability; as well as non-monetary indicators, such as food security, human capital, and social cohesion. Moreover, migratory patterns can also be influenced.

Even without net-zero policies, poverty reduction in Romania is expected to slow down

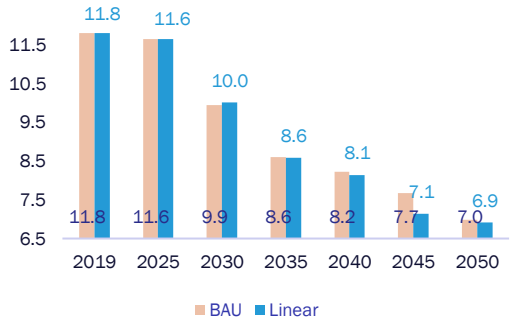
Demographic change will heavily influence Romania's labor market and poverty trends. As described in Chapter 1, Romania has achieved substantial poverty reduction, with the upper middle-income poverty rate (i.e., the share of the population living on US$6.85 per day at 2017 PPP) falling from 27.8 percent in 2015 to 10.7 in 2020; however, poverty and inequality rates in the country remain among the highest in the EU. Irrespective of net-zero policies, a declining and aging population is expected to significantly reduce the number of people employed, which will shrink by an estimated 18.7 percent by 2030, and by 42.6 percent by 2050. These projections highlight the challenges Romania may face in sustaining employment opportunities and economic growth, emphasizing the need to address the implications of demographic shifts on the labor market and the overall economy.

Even without net-zero policies (BAU), poverty reduction is expected to slow down—albeit less so in rural areas, with a narrowing urban-rural poverty gap. After the two recent shocks - COVID-19 pandemic and Russia' invasion of Ukraine, a slowdown in economic growth and demographic trends are expected to lead to a slower pace of poverty reduction. Pension, social insurance, and labor incomes remain the key contributors to poverty reduction. The anchored (in 2016) at-risk-of-poverty rate is anticipated to drop by 1.9 percentage points between 2019 and 2030, reaching about 9.9 percent; and to decelerate further, and fall further in the following two decades, ultimately reaching 7 percent in 2050 (Figure). Despite the slowdown, the number of individuals living in poverty is expected to decrease significantly, from 2.1 million in 2019 to slightly over 1 million in 2050. The deceleration in poverty reduction aligns with demographic patterns, as the working-age population and total employment are projected to decline at a faster rate due to fertility, population aging, and migration patterns. Real wage growth is also expected to slow down and align more closely with productivity growth. However, rural poverty is expected to decline at a relatively faster pace, reflecting the ongoing structural transformation from agriculture to the services sector. As a result, the large urban-rural poverty gaps are expected to narrow over time.

Decarbonization policies do not significantly affect the pace of national poverty reduction, highlighting the long-term advantages of the green transition

Policies to achieve Net0@2050 are not expected to have a significant impact on the overall rate of poverty reduction and may even accelerate it in the long-term (Figure 44). A simulation exercise aligned with the CGE macroeconomic model indicates that in the short-to-medium term (between 2019 and 2030), the poverty rate in the linear decarbonization scenario is projected to be only 0.1 percentage point higher than in the BAU scenario, indicating manageable short-term impacts. Even this marginally negative initial impact is expected to diminish over time as the economy begins to reap the benefits of decarbonization, leading to an acceleration in poverty reduction. By 2050, the poverty rate is expected to be even lower than in the BAU scenario, indicating that the long-term advantages of transitioning to a green economy along a linear path are likely to outweigh any negative effects, despite the short-term and medium-term challenges associated with the transition[24]. Such limited poverty impacts are consistent with the modest macroeconomic impacts of decarbonization; similarly, they hinge on specific modeling assumptions, considerable economic and social policy action, and ultimately are highly uncertain.

Figure 44: Projected Evolution of Poverty Rate (AROP, fixed at 2016), BAU vs linear decarbonization scenario



Source: World Bank estimates based on microsimulation; poverty measure is anchored at-risk-of-poverty Poverty rate (percent) at 2016

Decarbonization policies may slow down the poverty reduction for certain population groups, necessitating specific policymaker attention. Households with children and large households with more than five members face higher poverty rates, and by 2030, they may experience a slowdown in poverty reduction of 0.6 percentage points compared to the baseline. Additional challenges for these households include limited resources, inadequate social safety nets, and barriers to employment for individuals with disabilities. Priority attention should be given to these households to address their needs during the decarbonization process, such as targeted social safety nets, improved access to education, and job opportunities. Although poverty rates may persist or temporarily increase in the short term, long-term progress can be made in reducing poverty among these vulnerable groups.

Reaching net zero while reducing poverty is feasible, but requires careful consideration of the tradeoffs between poverty and environmental goals

While reaching net zero and reducing poverty is possible, it depends on a coordinated approach that carefully considers the tradeoffs between social and environmental goals; both must be addressed in a coordinated and integrated manner to achieve long-term sustainable development. Although the transition to green energy may bring about economic benefits and opportunities, it may entail challenges and potential risks, particularly for low-skilled workers and those employed in brown industries. High upfront financing requirements may prove more challenging to poorer households. However, whether the transition is swift, gradual, or steady, the approach to reducing poverty remains relatively consistent. It encompasses social protection, re-skilling and up-skilling programs, and the provision of alternative employment opportunities to ensure that the transition is socially inclusive and

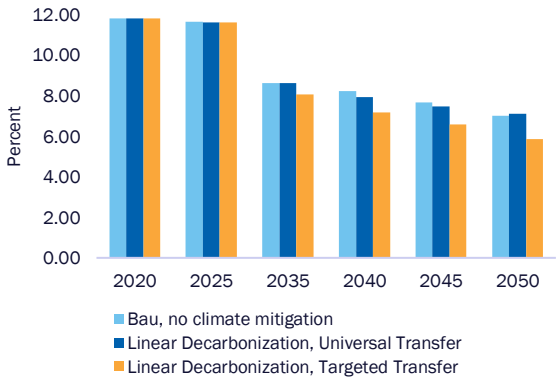
[24] *Caveats and limitations*: In addition to the modeling shortcomings of the CGE, the microsimulation model does not assess impacts on assets, household expenditure, and food and energy affordability. The focus is on the labor market channel, while the overall price channel, as all income measures from the CGE, is expressed in real terms. One important caveat of the CGE model is that it tends to neglect involuntary unemployment and labor market immobility across sectors, and assumes full employment. Thus, this approach may not fully capture real-world labor market dynamics when assessing the impacts of climate policy (Castellanos and Heltel, 2021), unless some labor some frictions are introduced in the model. Therefore, some of the short-term impacts estimated are likely to be on the lower bound. The macro model produces a vector of prices for 70 products using the GTAP classification. It does not produce projections of food or energy inflation, limiting its ability to assess how changes in relative prices (i.e., food vs. non-food) can affect affordability and household welfare, both monetary and non-monetary. This could be a critical transmission channel, as food inflation during the green transition can exacerbate food insecurity and disproportionately affect the poor, who allocate a larger share of their budgets to food. However, since public transfers, wages, and other income components are projected in the CGE in real terms, the overall impact of inflation is already incorporated. The lack of disaggregated income data by ethnicity (e.g., for the Roma) limits the ability to assess impacts accordingly.

does not leave certain individuals or communities behind. By ensuring that the transition is designed and implemented in a way that benefits all members of society, regardless of their skill level or socioeconomic status, it is possible to mitigate the risks and maximize the opportunities for poverty reduction. Considering the existing gender gaps, social safety nets and labor market measures should be gender-smart (please see Box 9).

Well-targeted social transfers can effectively reduce the tradeoffs between environmental and social goals

Well-funded and targeted social transfers may play a crucial role in facilitating the green transition. The CGE-Microsim results showcase that well-targeted transfers not only help mitigate risks in the short term, but could contribute to a more favorable long-term trajectory for poverty reduction in decarbonization (relative to the BAU) scenario, if sufficient fiscal resources (including from recycled carbon taxes and/or EU-level funds such as the Social Climate Fund) are allocated to them (Figure 45).[25] Targeted social transfers to the poorest 40 percent on the income distribution can effectively minimize welfare losses during the decarbonization process, and be significantly more efficient in reducing poverty than a universal transfer with the same fiscal resources. To illustrate this, a simulation of: (i) budget-neutral universal transfer to all households regardless of their income level, and compare it with: (ii) a targeted transfer to the bottom 40 percent.[26] The results indicate that not targeting social transfers may entail higher costs and risks in the short term.

Figure 45: Projected Poverty Incidence (AROP, 2016 anchored), BAU vs. Decarbonization scenario with Universal vs. Targeted Transfers



Source: World Bank estimates based on based in CGE-Microsimulation Model

Moreover, simulations also suggest that well-targeted transfers can lead to a better long-term path toward poverty reduction in net zero scenario than the BAU scenario which does not achieve net zero emissions. With the same fiscal budget (coming from recycled revenues), targeted transfers lead to significantly greater poverty reduction throughout the decarbonization transition, with yearly differences ranging from 0.3 to 1.4 percentage points. This is because universal transfers also benefit higher-income households that may not be directly impacted by the green transition, leading to a misallocation of resources. In contrast, targeted transfers ensure that resources are directed to households in greatest need, thereby mitigating risks and reducing costs in the short term. Particularly, large households with more than five members and households residing in the Nord-Est and South-Est regions experience notable benefits from targeted transfers. Under the linear decarbonization scenario, their poverty rates in 2050 can be up to 2.4 percentage points lower compared to the decarbonization scenario with a universal transfer of the same fiscal budget[27]. This evidence suggests that targeted social transfers can be an effective policy tool to facilitate the green transition and promote sustainable development while reducing poverty in the long run. Therefore, if well-targeted, social transfers can effectively reduce the tradeoffs between environmental and social goals.

[25] In the CGE model, public transfers are projected to increase by 18 percent in real terms by 2050. Given negative population growth, the per capita increase is even more pronounced.

[26] The model assumes that in the baseline year (2019), a universal transfer allocates 53.8 percent of resources to the bottom 40 percent, while the targeted transfer allocates 99.1 percent to them. Some inclusion errors are assumed over time, with the share of benefits going to the bottom 40 percent in a targeted transfer scenario declining to 90 percent by 2050.

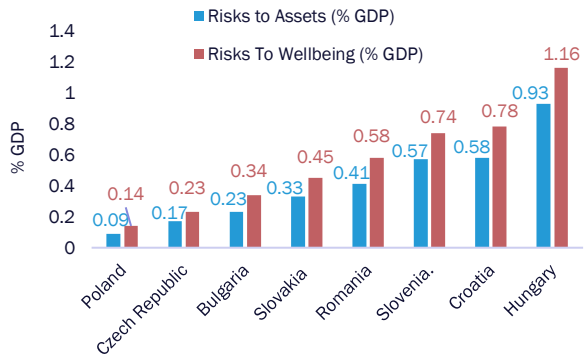
[27] This is likely an upper bound, as it assumes a well-targeted transfer to the bottom 40.

Potential welfare impacts of climate and environmental risks

The poor tend to be more exposed to natural hazards and climate risks, more vulnerable to climate shocks when they hit, and less capable of recovering due to low coping capacity. This vulnerability stems from the geographical distribution of climate change and the reliance of the poor on climate-sensitive sectors like agriculture and fishing. They often lack the assets—as well as social networks and safety nets—needed to effectively respond to climate change impacts, resulting in lower resilience. Climate change can exacerbate risks faced by the poorest, including impacts on ecosystems, water, agriculture, food security, health, displacement, conflict, and the economy, perpetuating poverty (OECD, 2022; Hallegatte et al., 2018).[28] Global estimates suggest that by 2030, between 68 million and 132 million people could be pushed into poverty due to climate change impacts (World Bank, 2020).

Compared to other EU countries, Romania faces a greater risk to assets and well-being loss due to high disaster risk, partly attributable to climate change. Based on recent data, the risk to assets from natural disasters in Romania is estimated at 0.41 percent of GDP, and the risk of well-being losses at 0.58 percent of GDP, both higher than in other Central Eastern European (CEE) countries (Hallegatte et al., 2016)[29] (Figure 46). Poor individuals are often disproportionately affected by natural disasters, experiencing greater wealth and income loss, and having lower resilience and limited coping capacity (Hallegatte et al., 2016). The same study suggests that implementing preventive measures in Romania could potentially reduce asset losses by up to 13 percent and well-being losses by 16 percent. By effectively managing disaster risks and combining it with other climate change policies, there is potential to alleviate poverty in countries like Romania by mitigating the disproportionate impact on vulnerable populations. (Hallegatte et al., 2016).

Figure 46: Risk to assets and well-being losses, CEE countries, circa 2015



Source: Hallegatte et al., 2016. Note: More recent estimates not available. CEE consists of Bulgaria, Czech Republic, Hungary, Croatia, Poland, Romania, Slovakia, and Slovenia.

Figure 47: Bivariate Map of Poverty (2011) and Vegetation Health Index (2021), Romania, NUTS 3

Source: World Bank estimates, FAO (2023), and Naqvi (2023). Notes: Ilfov province is missing in the FAO dataset.

Understanding whether municipalities at higher risk of poverty are also exposed to climate hazards and disaster risk is crucial to geographically targeted poverty alleviation programs and investments. On average, Romanian provinces with high poverty rates tend to have good vegetation health, which indicates lower vulnerability to droughts. However, certain provinces suffer from both high poverty rates and poor vegetation health (Figure 47, in red). This signals a need to explore policies that safeguard

[28] Furthermore, Roma communities located within areas with significant probability of flooding require a dedicated and often tailored engagement, given their poor access to information and minimal communication with or attention from official authorities, low levels of trust between Roma community members and local authorities, unique cultural norms, language and forms of community organization.

[29] Risk to assets is defined as the annual average of asset losses. Risks to wellbeing are measured as expected asset losses as a share of socioeconomic resilience. This latter is defined as the ratio of asset losses to wellbeing (consumption) losses.

the impoverished population in these provinces from natural hazards, and to invest in resilience measures and vegetation health improvements.

4.2.2. Reskilling and upskilling workers for the green transition

The green transition will disproportionately impact unskilled workers

The effects of climate change mitigation measures on overall employment are expected to be marginally negative in the short term, but slightly positive in the long term. CGE-Microsim results show that by 2030, overall employment is projected to decline at a faster rate in the decarbonization scenario, with mining, manufacturing, and electricity generation (among the key decarbonizing sectors), experiencing the sharpest drops in employment, followed by wholesale and retail trade, transport, and some services (banking and real estate). Agriculture, construction, public administration, and other services are expected to experience small effects. During this period, the pace of real wage growth is projected to be slower than in the BAU scenario. By 2050, however, the decarbonization path is expected to generate more employment overall, especially in services, with no difference in real wage growth.

As Romania's labor market shifts towards greener sectors, unskilled workers will suffer from a greater decline in employment opportunities than in the BAU scenario. In the short term, the decline in employment for unskilled workers can be attributed to the restructuring of carbon-intensive industries, resulting in reduced labor demand. However, positive employment gains are expected in the medium and long terms as decarbonization efforts create new job opportunities in renewable energy, energy efficiency, and green technologies. Skilled workers will be in high demand in these emerging sectors, emphasizing the importance of effective training programs to bridge the skills gap. Shifts in technology and in demand for skills may exacerbate the wage gap between skilled and unskilled workers.

The transformation of the Romanian labor market is expected to involve a shift in the mix of workers' skills across sectors. In both the decarbonization and BAU scenarios, the share of low-skilled workers in agriculture is expected to rise, while manufacturing, construction, and services will see an increase in medium-skilled and high-skilled workers. In the long run, the public administration, financial intermediation, education, and health sectors are anticipated to feature a higher share of high-skilled jobs.

Transition to the green economy will require significant upskilling and re-skilling of the workforce

Green jobs have started to emerge in Romania. World Bank analysis based on artificial intelligence (AI) and machine-learning (ML) tools[30] indicates that offers for green jobs account for 9 percent of all job postings on the Romanian labor market. The most common green occupations are in engineering, sales, and marketing related to renewable energy or energy efficiency, predominantly in Bucharest and Cluj-Napoca (Figure). Notably, most such vacancies have so far arisen in new and emerging occupations, rather than in greener forms of traditional occupations.

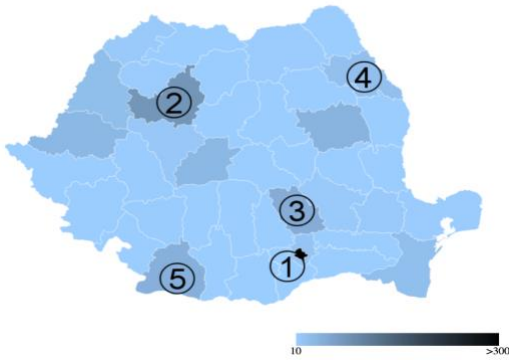
Employers that offer green jobs often demand a higher level of skills. STEM knowledge and abilities—which tend to require greater numeracy, literacy, and problem-solving skills than the Romanian average—are especially sought-after (Figure 50 A), in addition to language proficiency, active listening, and design skills. (Figure 50 B). Longer work experience is also highly valued in the market for green jobs (Figure 49). Moreover, a separate skills gap analysis—which used PIAAC data for countries similar[31] to Romania, and the classification of green and brown jobs from Elliott et al. (2021)—shows that workers

[30] The Romanian labor market was analyzed using ML to understand demand for green occupations, and AI to assess the required level of skills. Specifically, data from eJobs (a popular job listing website in Romania) was collected and translated into English, while a set of task statements from O*NET was employed to identify green tasks within eJobs postings. The Latent Semantic Indexing (LSI) model was then used to assess similarities between eJobs requirements and O*NET statements.

[31] The analysis relied on PIAAC data for countries similar to Romania, and on the classification of green and brown jobs from Elliott et al. (2021). As PIAAC data for Romania was not available, data from Slovakia, Greece, and Hungary was used as proxy.

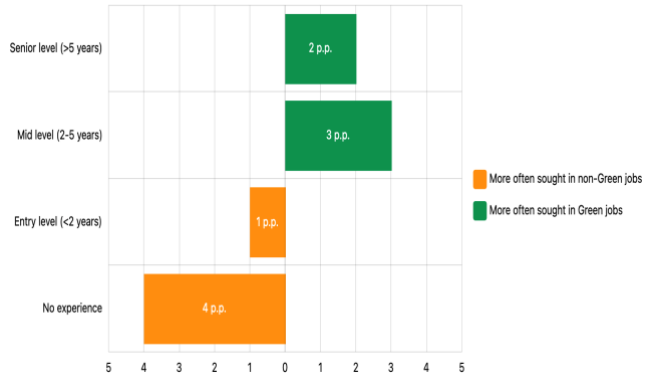
in green jobs not only have stronger foundational skills, but use them more intensively and frequently both at home and at work, and rely more often on soft skills.

Figure 48: Geographical spread of green job offers



Source: World Bank calculations based on AI/ML analysis.
Note: 1=Bucharest; 2=Cluj Napoca; 3=Prahova; 4=Iasi; and 5=Doij.

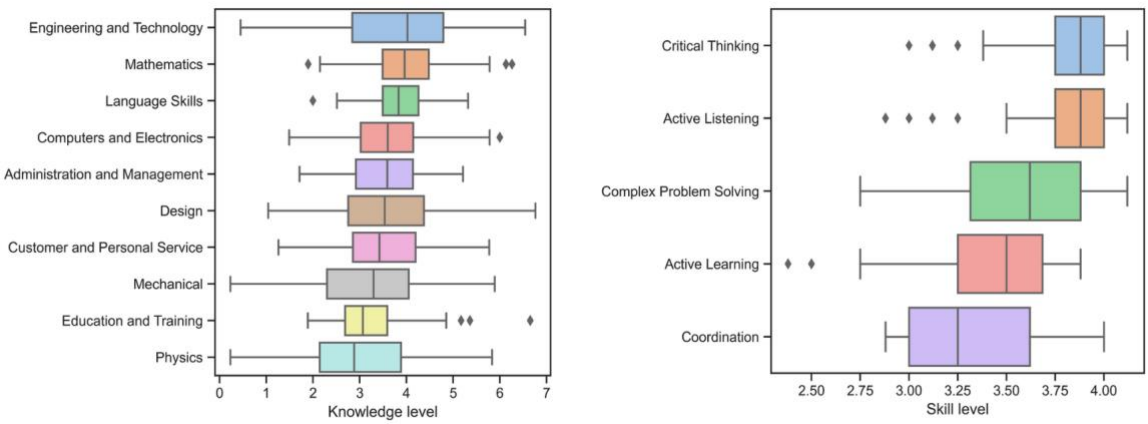
Figure 49: Differences in distribution of work experience requested for green and non-green jobs



Source: World Bank calculations based on AI/ML analysis.
Note: Mann-Whitney U statistic: 354110, p-value<0.001.

The demand for skills compatible with green jobs is highest in retail, construction, agriculture, and manufacturing. These industries offer the clearest pathways for workers to transition into green jobs, considering the similarity in duties across relevant roles**,** but the shift may not always be easy. In particular, women are currently underrepresented in all such industries, except in agriculture where they make up the majority of the informal workforce. Most of the identified green vacancies would require significant retraining and fundamentally new skills for most workers, highlighting the need for long-term reskilling programs and substantial investment in education and training, especially for women (see Box 9).

Figure 50: Top knowledge and soft skills requirements for identified green jobs



Source: World Bank calculations based on AI/ML analysis.
*Note: Skill levels min: 0, max: 5, Knowledge levels min: 0, max: 7. Knowledge definitions: O*NET. Skills definitions: O*NET.*

Comprehensive policies for human development are key to equip the workforce for the green transition

The green transition will prompt firms across the EU to invest in technology, and may further incentivize Romanians to emigrate. Throughout the EU, the EGD is expected to boost demand for

skilled workers and drive up investments among firms able to adapt to the paradigm change (World Bank, 2023). However, this process of capital deepening might not take place in Romania, where the capital investment lost as brown firms exit the market may not be fully offset by surviving firms. At the same time, demand for skills in the broader EU may incentivize qualified Romanian workers to emigrate, adding to the brain drain and to the country's already acute skills shortage (see SCD Update). Moreover, as this process unfolds, skilled labor will command increasingly high wages, and workers will react by trying to acquire the necessary skills. In the short to medium run, the EU's labor market will experience a contraction in unskilled labor supply, as workers attempt to reskill (World Bank, 2023). However, in Romania, a slight decline in demand for unskilled labor and the contraction in brown production will lead to a significant oversupply of unskilled labor.

Human development policies covering education, health, and social protection are necessary to enable the green transition, help workers adjust to it, and mitigate its unintended consequences. The ability of education systems to deliver not only the skills, but the research, development, and innovation (R&D+I) capacity for technological change, is essential to achieving the EGD goals. Similarly, productivity gains will depend on health systems serving workers as they also cater for an ageing population. Active Labor Market Policies (ALMPs) will have to help vulnerable population groups, in particular women and the Roma, adapt to the green economy and contribute to a new productive model, based on new technologies and a circular approach to production and consumption (World Bank 2023). An adaptive social protection system will ensure support for workers that lose their jobs but cannot transition to greener roles.

Box 9: Facilitating the labor market transitions for women

Workers in brown sectors need well designed reskilling and retraining programs to cope with the green transition. Vandeplas et al. (2022) find that Romania is one of the three most expensive EU countries when it comes to re- and upskilling workers, with a cost of between €600 and €750 per worker. Romania has implemented some measures to minimize the welfare impacts of the phasing out of coal mining, including: efforts to reskill the workforce; promoting entrepreneurship and SME diversification; creating business incubators and supporting start-ups; fighting energy poverty; and enabling access to essential public services. Romania is part of the EU's Just Transition Mechanism, through which it has allocated €2.14 billion across six counties to mitigate the negative effects of the transition.

Involving female entrepreneurs and business owners in the green agenda could accelerate the green transition and foster more inclusive and sustainable economic models. Only 40 percent of the Romanian self-employed were female as of 2020 (Robayo-Abril and Rude, forthcoming). Female entrepreneurs are more interested in "impact" or socially motivated entrepreneurship: 71.6 percent of women report that they started a business to make a difference, versus 60.3 percent of men (Global Entrepreneurship Monitoring, 2022).

Targeted interventions can expand the role of female entrepreneurs and business owners in the green transition:

- Financial literacy training for women can help reduce gender gaps in financial inclusion. Those in the financial sector should receive training on gender inequalities in start-up and business funding.
- Expanded access to entrepreneurship-related assets, such as land ownership or digital skills, and decoupling lending criteria from land ownership could enhance women's access to credit, especially in the primary sectors.
- Enhanced norm-based interventions can help mitigate harmful gender norms.

Investment in public childcare, fostering business models where work is compatible with care responsibilities, and applying gender-sensitive design to green transition training programs could incentivize female entrepreneurship.

4.3. Financing green growth: the roles of the public and private sectors

The whole-of-economy green transition will require substantial investments, based on multiple sources and types of financing. Estimates for the key sectors are presented in section 4.3.1. Mobilizing public and private finance hinges on putting in place appropriate institutional and governance frameworks and incentives, while enabling the financial sector to efficiently allocate capital toward the transition to net zero.

Although public financing will play a critical role, Romania faces substantive fiscal constraints, and incentivizing green investment from the private sector will be key. Government revenue in Romania is among the lowest in the EU (equal to less than 35 percent of GDP), in a context of major development needs. Moreover, fiscal deficits have been consistently high (with the structural fiscal deficit averaging 3.5 percent of GDP between 2010 and 2021), and fiscal consolidation will require both increasing revenues and rationalizing expenditures. Meanwhile, the borrowing space will be constrained, especially in the short term given high borrowing costs. Finally, although Romania has access to substantial EU funds to support both its development and climate objectives (Box 10), its low historical rates of absorption point to challenges, particularly on the institutional side. With reduced fiscal space, it will be critical to galvanize green private investment through price signals (manifested through carbon pricing in the form of ETS, carbon taxes, and/or fossil fuel subsidy reductions, and/or tax increases) that direct investors towards cleaner sectors and technologies (see Chapter 4.3.2).

On the private sector side, the financial industry remains less developed than the EU27 average,[32] and the green financial system is nascent. A systematic approach across the financial industry to tackle climate change and green development challenges is yet to emerge. The share of green assets in the portfolios of Romanian banks currently stands at about 3 percent, less than half the Euro area average.[33] At the same time, banks and the capital market have significant exposures to climate-related financial risks, both transition and physical. To support efficient climate and green transition, the financial sector also needs to accelerate fundamental reforms while integrate the climate and green considerations, including by furthering efforts to deepen the banking sector and develop local capital markets. This is discussed in Chapter 4.3.3.

4.3.1. Climate-resilient green transition will require substantial investment

Development and climate investment needs: estimates for key sectors

Romania faces substantial development and climate investments needs. Even putting decarbonization objectives aside, Romania still has considerable infrastructure gaps compared to the rest of the EU. Despite significant public investment (public investment averaged 4.2 percent of GDP between 2000 and 2020, above the EU27 average of 3.2 percent of GDP, but it was highly volatile), quality and coverage of infrastructure remain below EU standards. For example, Romania's transport network is among the shortest and least dense in the EU (please see Romania SCD Update and CPSD for more details). While economic modelling indicates that the bulk of decarbonization investments pay for themselves in the long term, the results hinge on assumptions of underlying market efficiency and carbon pricing policies. Romania's financial sector remains underdeveloped compared to the EU average (section 4.3.3); and the carbon pricing—both in Romania as well as in the rest of the EU (let alone the rest of the world) remains far from efficient.

The investment needs for green development in key sectors are estimated at US$356 billion by 2050 (2.9 percent of cumulative GDP), excluding running costs, and are more uncertain in other sectors

[32] See the Romania SCD Update for more details.

[33] Climate-related financial risks are typically broken down into transition risks and physical risks (see NGFS 2018). The former result from the adjustment to a lower-carbon economy due to changes in climate policy, technology, or market sentiment. The latter stem from climate- and weather-related events, such as droughts, floods, storms, and sea-level rise and/or increasing temperatures, resulting in damages to property and reduced productivity.

(Table 1). Out of this amount, US$298.1 billion correspond to investments already required in any (e.g., BAU) scenario. Most concrete and sizeable climate change mitigating (decarbonization) investments that also cover the development investment needs are associated with the power, transport, and buildings sectors, tentatively estimated at US$39.9 billion, US$230.6 billion, US$85.3 billion respectively, summarized in Tabl, under linear scenario (total of US$ 356 billion). As such, achieving more ambitious green targets in the net zero scenarios entails an additional US$58 billion in investments, of which US$7.1 billion focusing on the power sector, to cope with an estimated 15-20 percent increase in electricity demand by 2050 (as a result of natural growth and the electrification of the economy). Green power generation is the lowest-cost option in most scenarios and is expected to increase its share in the electricity matrix to complement nuclear power and achieve a zero-emission mix in 2050. The investment needs to address hard-to-abate emissions (e.g., from industrial processes and agriculture) are highly uncertain, and will ultimately depend on evolutions in technology and related costs (see below).

Accelerating investments in renewables, energy efficiency and sustainable transport are 'no regret options', especially considering energy security and climate change implications

Despite the large investment required, a more decarbonized economy would bring along sizeable benefits in terms of resilience to shocks in fossil-fuel prices, energy independence, and health externalities. A decarbonized power sector would require additional investments of about 30 percent in firm flexible generation (e.g., gas with CCUS, hydrogen) and additional operational expenses of about US$8.6 billion until 2050 to manage the variability of renewable energy sources, including use of gas in CCGT with CCUS for this purpose. These incremental costs would translate in a 3-8 percent increase in average electricity generation costs over the 2030–2040 decade. However, if fossil fuel prices grew by—for example—20 percent more than the estimated base scenario forecast,[34] incremental investments in the fast decarbonization scenario would be offset by larger reductions in fuel costs—resulting in average energy costs lower by 5 percent (without including externalities), and additional benefits in terms of energy security, reduced fossil fuel imports, and potentially increased exports of domestic natural gas. Moreover, energy efficiency investments in buildings are expected to reduce gas and biomass (firewood) expenses by US$8 billion and US$37.3 billion respectively, with the latter also easing the pressure on forests and carbon sinks. Finally, the decarbonization of the economy entails other positive economic externalities in terms of reduced air pollution (and fewer related health problems), traffic congestion, and road fatalities (see below).

A decarbonized power sector will require large investments in electricity infrastructure to integrate additional renewable energy, improve regional connectivity, and ensure electricity supply in a future context of reduced hydropower availability. Renewable energy generation needs to be developed in geographical areas where renewable resources are available. In Romania, power generation is highly concentrated in the east of the country, near the Black Sea—an area that is well endowed with renewable resources, hosts a nuclear plant in Cernavoda, and is expected to be at the receiving end of future offshore wind developments in the Black Sea and a submarine interconnection with Georgia. Thus, the transmission system will need to be strengthened to connect the new generation capacities in the east and the demand poles in the west, to enable the decarbonization of the sector. Moreover, additional investments in system flexibility for the provision of ancillary services and firm and back-up capacity will be required to ensure the system's security of supply standards, and reinforced international interconnection will improve energy security and facilitate the export of renewable energy when production exceeds the country demand. Transelectrica, Romania's Transmission System Operator, has committed to invest US$1.6 billion by 2031 to modernizing the existing electric transmission networks, integrating production from renewable sources—at least 7,000 MW—and from other new plants, and increasing the regional interconnection capacity to reach the 15 percent

[34] The base scenario forecasts an average gas price of US$13.5/MMBtu until 2030, dropping to US$8.2/MMBtu from 2031 to 2050.

threshold required at EU level. The INECP estimates the need for batteries in 400 MW by 2030, to ensure the stability of the system. However, larger investments will be required to achieve regional climate neutrality by 2050. Furthermore, the system will need to be resilient to climate change, and thus be designed to offset potential power capacity drops (hydro, thermal and nuclear) resulting from water availability limitations due to climate-change-driven more frequent and intense droughts. By 2050, investments in the range of US$5.2 billion will be required to update the power infrastructure, out of which US$2.3 billion will need to be deployed by 2030. This level of investment in infrastructure is in line with previous investment periods, though the executed investments in the transmission network reached less than 50 percent of planned investments, and the pace of executed investments need to match the plans to ensure systems' security.

Achieving emission-reduction targets in the transport sector will require investments for US$230.6 billion[35] over 2023-2050, equivalent to 1.9 percent of the cumulative GDP over the same period. The transport sector is key to achieve the decarbonization targets and development needs. To achieve emission goals, investment flows in the transport sector should peak in the mid-2030s, covering: (i) US$50.7 billion for rail transport, (ii) US$19.9 billion for charging infrastructure, (iii) US$135.4 billion for vehicle stock development, (iv) US$3.9 billion for active mobility infrastructure, and (v) US$20.7 billion for road infrastructure. In a fast decarbonization scenario, investments grow by a total of US$50.6 billion, and rise in all categories except the road network.

The private sector will have an eminent role in the decarbonization and will need to significantly contribute to finance relevant investments, complemented by substantial national and supranational (EU) funding. About 68 percent of the total investments needed in the period 2023-2050 is expected to be raised by the private sector, reaching 74–78 percent in the transport sector. In the electricity sector, the private sector share of investment is expected to reach 62 percent, but about 85 percent of additional investments for the linear decarbonization scenario (compared with BAU) would be privately sourced. Households are facing financing constraints due to the high upfront costs of green transition investments such as energy efficiency, heating and cooling conversions, and private vehicle transitioning. The financial sector and policymakers can design supportive policies to address this issue, but funding sources would need to be identified. Public sector investment would benefit from Romania's access to relevant funding opportunities from the EU to support both its development objectives and green transition (Box). While the national public sector would provide 30 percent of the funds needed in the period, the EU is expected to contribute with 8 percent of the funding requirements, including different sources—Cohesion Funds, Recovery and Resilience Facility, REPower EU, Modernization Fund. In a best-case scenario, the public funds (including the EU) would leverage and not crowd-out private sector investment.

Romania can benefit from strengthening its PPP framework. Romania has a legal framework for PPPs in place[36]. However, shortcomings on its design, added to limited institutional capacity and the preference for using available EU funds by public institutions (instead of seeking synergies with the private sector), has led to no major PPP projects being completed within the current legislative framework. A stronger PPP framework could increase private sector participation in financing, developing, upgrading, and operating low-carbon infrastructure in strategic sectors, such as transport, power and heating. Amendments to the PPP framework should be in line with international best practices, including increasing the ceiling of the public partner's contribution to construction financing (currently capped at 25 percent, even for EU funding) and strengthening local capacity, especially within the Ministry of Finance's Public Investment Management Unit (PIMU), which is responsible for the PPP platform and provides support to public entities that intend to start PPP projects. Achieving the scale of

[35] Present value at 6 percent discount rate.

[36] Romania's PPP framework is based on the Government Emergency Ordinance No. 39/2018, last amended through the Government Emergency Ordinance no. 7/2020.

private investment necessary for decarbonization will also require innovative financial instruments. Currently, EU structural funds are the preferred option for many infrastructure projects, crowding out investment from the private sector. Working closely with MDBs, Romania could potentially combine public resources with EU funding and PPPs to create de-risking instruments to crowd-in private investment in financially risky but strategically important projects. The creation of a credible portfolio of PPP projects that include availability payments based on climate performance could help increase the confidence of the private sector to co-invest in climate resilient infrastructure alongside the Government.

PPPs could help to bridge the investment gap in strategic sectors at the municipal level, however with careful considerations for implementation capacity to avoid creating contingent liabilities. With some improvements in the PPP framework, Romania could consider supporting selected pilot projects in utility-scale renewables, energy storage, and district heating, helping to strengthen energy independence and security of supply. Some of the pilots could be developed at the municipal level, with the help of international financial institutions and EU funds. Increasing private participation in infrastructure and services would be particularly valuable for municipalities with limiting capacity for large-scale investment due to their debt ceiling constraints. While municipal PPPs are allowed by law, municipalities have access to little centralized support in terms of regulation, case studies, or experience from pilot projects and PPPs. The World Bank and other MDBs can provide critical support on this regard, not only in terms of access to capital but also through technical assistance and capability building. However, while PPPs may be well suited to delivering discrete assets with limited complexity and risks (e.g., waste treatment plants, cogeneration facilities), this ought to be approached with very careful considerations of subnational implementation capacity not to create contingent liabilities.

Investment needs outside the key sectors discussed above are highly uncertain, particularly for industrial processes, district heating, and agriculture. Sectors with hard-to-abate emissions are those where electrification or other decarbonization technologies are not currently commercially available at competitive prices compared with traditional technologies. Some estimates of abatement costs in these sectors are possible, based on the current trajectory of their emissions and assumptions about abatement costs (around US$300 per ton of CO2e emissions through Direct Air Carbon Capture and Storage),[37] in addition to carbon sinks. On this basis, early estimates suggest a need for US$100 billion in non-productive, emission-reducing investment in the industrial sector, and for about US$13.5 billion in agriculture (by 2050). Some funding sources for agriculture can be identified, including FDI currently averaging US$2-3 billion annually, or US$ 7–9 billion through EU structural fund allocations (including CAP) over the 2021-2027; however, these flows do not necessarily present investments in the sectors development or decarbonization (for instance, EU CAP funds are mostly transfers).

Although the total investment needs in key decarbonizing sectors amount towards US$400 billion throughout 2023-2050, the estimated co-benefits from reduced air pollution, road accidents, congestion and road damage amount to more than US$22 billion. Air pollution is a significant concern in Romania—where it ranked eighth among the top-10 factors contributing to death and disability, and first among the environmental risks[38]—and can also have notable economic impacts. In the net zero scenario, total air pollution mortality could drop by 21 percent in 2030, and by 89 percent in 2050 relative to the BAU scenario. The present economic value of reduced air pollution mortality amounts to US$11.6 billion[39]. Notably, emissions reductions in the transport sector play a pivotal role in achieving

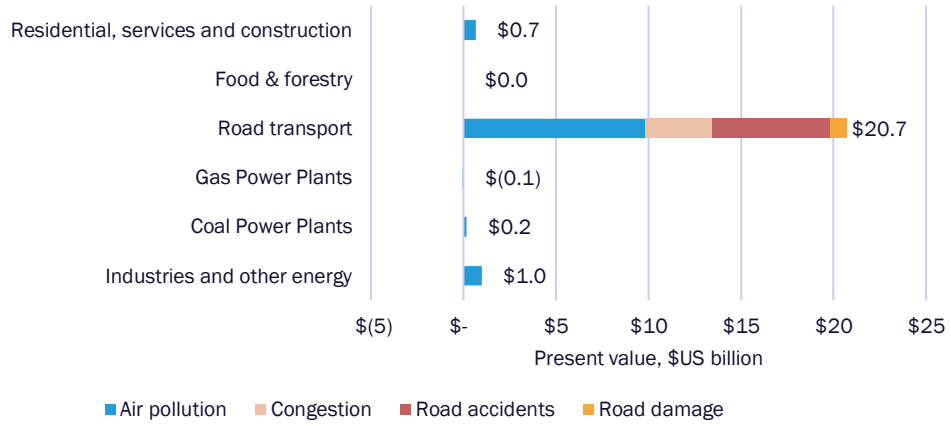
[37] These options are expected to be available in 2040-2050, with an expected downward impact on costs. As such, this section focuses on more credible estimates about key sectors where decarbonization is more imminent. For modeling purposes, technologies with more uncertain costs have been backloaded to the last decade of the period considered, to limit their influence on the outcomes of the analysis.

[38] The Lancet. (2020). Top 10 risks contributing to total number of DALYs in 2019 and percent change 2009–2019, all ages combined. Volume 396, Issue 10258, Pages 1223-1249. DOI: 10.1016/S0140-6736(20)30752-2

[39] The present value consider flows from 2022 to 2050 and a discount rate of 6 percent. The value used for statistical life was transferred from OECD countries to Romania.

these benefits (Figure 51). Moreover, the transport sector offers additional co-benefits, including a reduction in mortality from road accidents (amounting to US$6.4 billion), alleviated congestion (valued at US$3.5 billion), and decreased costs associated with road maintenance (totaling US$0.9 billion).

Figure 51: Present value of co-benefits (constant 2022 US$ billion, 2023-2050)



Source: World Bank CPAT

Table 1: Estimated Romania's development and climate mitigation investment needs in key decarbonizing sectors

US$, billions (discounted, 2022)	BAU						LINEAR					
	Total 2023–50	Of which (by period):		Of which (by funding source):			Total 2023–50	Of which (by period):		Of which (by funding source):		
		2023–30	2031–50	Public sector		Private sector		2023–30	2031–50	Public sector		Private sector
				National	EU					National	EU	
POWER												
New investments—Power generation and storage capacity	**27.3**	**16.1**	**11.2**	9.7	2.2	15.4	**33.5**	17.3	16.2	10.0	2.7	20.8
New investments—Power transmission and distribution networks	**4.2**	**2.2**	**2.1**	1.8	0.3	2.1	**5.2**	2.3	2.9	2.2	0.4	2.6
Other economic costs: operational and fuel costs	**43.2**	**17.2**	**26.0**			43.2	**51.8**	18.9	32.9			51.8
Other economic costs: decommissioning coal plants and mines (social & environmental costs)	**1.2**	**1.2**	**0.0**	0.9	0.3		**1.2**	1.2	0.0	0.9	0.3	
RESIDENTIAL												
Renovation of buildings for increased EE	**85.3**	**14.2**	**71.1**	14.8	23.3	47.2	85.3	15.1	70.3	15.3	23.1	47.0
Other economic costs (+)/savings (-): gas consumption	**-7.6**	**-0.6**	**-7.0**			-7.6	-8.0	-0.7	-7.3			-8.0
Other economic costs(+)/savings (-): biomass consumption	**-35.6**	**-1.2**	**-34.5**			-35.6	-37.3	-1.2	-36.1			-37.3
TRANSPORT												
New investment: new infrastructure, o/w:	**180.0**	**75.5**	**104.5**	40.4		139.7	230.6	82.8	147.8	60.5		170.1
Road network[1]	*30.2*	*16.2*	*14.0*	*27.9*		*2.3*	*20.7*	*11.4*	*9.3*	*19.1*		*1.6*
Rail transport[2]	*13.4*	*4.9*	*8.5*	*8.4*		*4.9*	*50.7*	*15.9*	*34.8*	*30.9*		*19.8*
Charging infrastructure	*6.0*	*0.5*	*5.5*	*0.2*		*5.8*	*19.9*	*3.0*	*16.8*	*0.6*		*19.3*
Road vehicle stock development	*130.5*	*54.0*	*76.6*	*3.9*		*126.6*	*135.4*	*50.1*	*85.3*	*6.0*		*129.4*
Additional investment on cycling infrastructure	*0.0*	*0.0*	*0.0*	*0.0*		*0.0*	*3.9*	*2.3*	*1.6*	*3.9*		*0.0*
Other economic costs: crude oil consumption	**48.7**	**23.6**	**25.0**	*0.0*		48.7	33.3	21.6	11.7	*0.0*		33.3
TOTAL INVESTMENTS AND ECONOMIC COSTS IN THESE SECTORS												
Investments (US$ billion, discounted)	**298.1**	**109.2**	**188.9**	**93.7**		**204.4**	**355.8**	**118.7**	**237.1**	**115.4**		**240.4**
Investments (% cumulative corresponding GDP)	***2.4%***	***4.3%***	***1.9%***	***0.0%***		***1.7%***	***2.9%***	***4.7%***	***2.5%***	***0.9%***		***2.0%***
Costs	**48.6**	**39.0**	**9.6**	**0.0**		**48.6**	**39.8**	**38.7**	**1.1**	**0.0**		**39.8**
Costs (% cumulative corresponding GDP)	***0.4%***	***1.5%***	***0.1%***	***0.0%***		***0.4%***	***0.3%***	***1.5%***	***0.0%***	***0.0%***		***0.3%***
TOTAL (US$ billion, discounted)	346.8	148.3	198.5	93.7		253.0	395.7	157.4	238.3	115.4		280.3
TOTAL (% cumulative corresponding GDP)	2.8%	5.8%	2.0%	0.8%		2.1%	3.2%	6.2%	2.5%	0.9%		2.3%

Box 10: EU funding in support of Romania's green transition

Romania has access to EU funds to boost sustainability, growth, and inclusion, equivalent to about 37 percent of its GDP over the next five years. Such funds are available from two sources: (i) the EU's Multiannual Financial Framework (MFF) 2021-2027; and (ii) the Next Generation EU Fund (NGEU) for 2021-2026.

The regular allocation of EU structural funds from the MFF amounts to 24 percent of Romania's GDP compared to 16 percent the previous MFF (Figure). It provides major resources to support the EGD's objectives of resilience, adaptation, and mitigation. In addition, Romania is eligible to receive the equivalent of 13 percent of its GDP—one of the highest shares in the EU—from the NGEU to support the green and digital transitions, as well as broader post-pandemic recovery. These special funds (a combination of grants and loans) are primarily distributed through the Recovery and Resilience Facility (RRF) for the purpose of implementing each member state's National Recovery and Resilience Plan (NRRP) (Figure 52). Under Romania's NRRP, about half of the country's RRF funds have been allocated to green measures (Table 2).

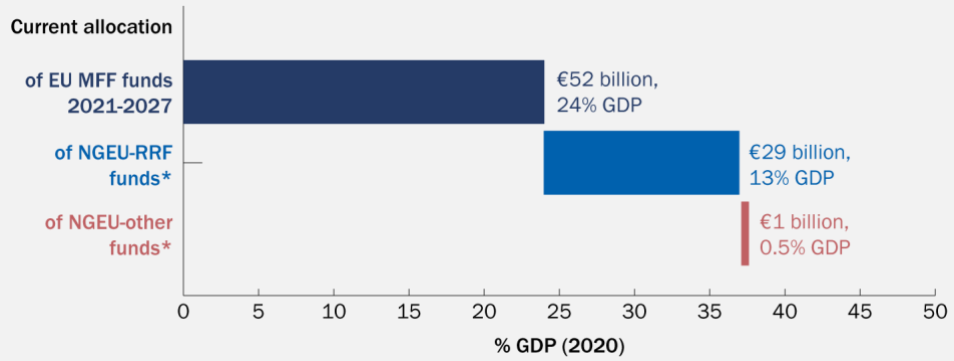
However, Romania's historical track record in absorbing and using EU funds highlights persistent institutional challenges, while private sector investment remains essential. Between 2014 and 2020, Romania was eligible for an overall funding envelope of €34.8 billion. However, by the end of the programming period (end 2020), it had only absorbed 56.7 percent of its allocation (though this continued to rise, reaching 82 percent by August 2023), due to institutional bottlenecks (e.g., low capacity, especially at the municipal level); complex processes; and the extended time usually required for completing investment projects. With both new mechanisms (e.g., the results-based NRRP disbursements) and thematic areas (digital, green, just transitions) being introduced, the government will need to build additional institutional capacity. Even if absorbed fully, supranational funds alone will not be sufficient, and complementary domestic investment will be necessary—particularly from the private sector.

Table 2: Allocation of Romania's NRRP Green Transition Funds across thematic priorities and sectors

Romania NRRP allocations	EUR Bn
Digital transformation	2.6
Green transition	16.3
Air and water quality (includes sewage)	2.3
Biodiversity (includes land restoration, marine & maritime)	1.2
Buildings' energy efficiency	1.1
Climate change adaptation projects	1.4
Electric mobility (charging stations + vehicles incentives)	0.0
Green tech innovation	1.3
Hydrogen	1.1
Other sustainable transport infrastructure (excludes highways and roads)	0.1
Public transport	7.6
Renewable energy sources (includes wind & solar and alternative fuels)	0.2
Social, economic, and institutional development	10.5
Total Romania NRRP (2021-2026) Allocation	**29.4**

Source: World Bank Calculations using Bruegel.org dataset

Figure 52: Over the next 5+ years, available EU funding will effectively double and cover new thematic areas, further straining capacity



*Source: World Bank, based on National and European Commission documents. Notes: MFF refers to the EU Multiannual Financial Framework, and includes allocations under Cohesion Policy, Common Agricultural Policy, and other MFF funding (incl. Just Transition Funds). 'NGEU-RRF' refers to Next Generation EU Recovery and Resilience Facility (grants and loans); 'NGEU-other' includes Just Transition Fund and React-EU Facilities. Legend: *computed as percentage of 2020 GDP.*

Adaptation and resilience: macro financial risks, cost of inaction and financing gaps

In addition to those for climate change mitigation, the investment needs for climate change adaptation are also sizeable, estimated at about US$160 billion by 2050 (1.3 percent of cumulative GDP). This figure is based on the sectoral estimates available for this CCDR (spanning investments in water and sanitation, agricultural land improvements and irrigation, urban infrastructure, and solid waste management), but it is highly uncertain. For instance, the forthcoming Romania National Strategy for Adaptation to Climate Change estimates adaption needs at €17 billion (about US$18 billion) for 2023-2030. Adaptation costs are even harder to differentiate from development financing needs than decarbonization investments.

Investments in climate change adaptation face a different set of market failures than those in mitigation. Major constraints to investment projects include uncertainty about the economic consequences of climate change impacts and the efficiency of adaptation technologies. Adaptation projects are often unattractive to the private sector because of underpriced risks, limited access to finance, and a lack of economies of scale. As a result, the public sector is currently almost the sole provider of adaptation finance—although there are opportunities for private capital, especially in early-warning systems, global mangrove protection, and climate-resilient infrastructure (Prasad et al, 2022).

The cost of inaction is high: Romania faces significant macro-fiscal risks due to geophysical and climate change-induced hazards, which are expected to become increasingly acute. Romania has experienced significant losses due to climatological and hydro-meteorological events, with an estimated €12 billion in losses (99 percent of which were not insured) and almost 1,322 fatalities since 1980.[40] It is among the top three EU countries for seismic risk (concentrated in the eastern regions), and flood risk (both fluvial and surface water). As articulated in Chapter 1, the average annual loss (AAL) from both floods and earthquakes exceeds 0.1 percent of the total value of the building stock, although extreme events can damage a much greater proportion of the building stock.

Disaster risk financing arrangements are limited in Romania, due to low penetration rates of insurance for public and residential assets, limited reserve funds, and a lack of risk transfer and contingency funding. Although the government has established a national reserve fund, a mandatory catastrophe insurance scheme, and access to the EU Solidarity Fund, the low insurance penetration rate (20 percent) poses a challenge to effectively managing disaster risks. As a result, the government faces a difficult decision in determining which households to support during disasters (e.g., only the poor, or all those uninsured), with significant implications for government liabilities. At the same time, the private insurance sector is yet to be tapped to complement public disaster risk financing.

Romania's net government liabilities are large as a share of GDP and may result in a funding gap in many disaster scenarios. In a high-liability scenario—in which the Romanian government is expected to reconstruct damaged housing for all uninsured households, reconstruct all public assets (with no public asset insurance in place), and cover emergency response costs[41]—the average total government liabilities in the event of a disaster could be as high as 0.2 percent of GDP.[42] It is essential to urgently implement catastrophe household insurance, as damage to residential buildings accounts for more 50 percent of the total loss from both floods and earthquakes, and damage to public and housing assets accounts for 78 percent of total government liabilities in the high-liability scenario.

[40] MunichRe NatCat database https://www.munichre.com/en/solutions/for-industry-clients/natcatservice.html.

[41] The 2021 World Bank report *Financial Risk and Opportunities to Build Resilience in Europe. Economics for Disaster Prevention and Preparedness* considered two scenarios with different levels of government liability (i.e., what share of the total estimated loss the government is expected to cover). The high-liability scenario is described in the text above. In the low-liability scenario, the government is expected to reconstruct damaged housing for low-income uninsured households, reconstruct all public assets (but one-third of those assets are insured), and cover emergency response costs.

[42] World Bank. 2021. Financial Risk and Opportunities to Build Resilience in Europe. Economics for Disaster Prevention and Preparedness.

4.3.2. Fiscal policies for decarbonization

Appropriate carbon pricing is critical to incentivize decarbonization

In the absence of carbon prices that reflect the social costs of fossil fuel usage, the private sector lacks sufficient incentives to invest in low-carbon solutions. Key carbon-pricing mechanisms include emissions trading systems, carbon taxes, and the reduction in fossil fuel subsidies. In the EU, some key emissions are covered by the Emissions Trading System (ETS, see Box 11).[43] However, Romania does not apply significant levies on emissions from non-ETS sectors. Crucially, without more incisive carbon taxes, the country's emissions are set to increase (World Bank 2022), especially in transport sector. Finally, fossil fuel subsidies absorb limited public resources, distort energy prices, and hamper the transition to a low-emission economy. Such subsidies were relatively modest in Romania before Russia's invasion of Ukraine,[44] but have risen significantly since (though they are expected to be time-bound), as part of government efforts to shield households and firms from soaring energy prices.

Box 11: The EU's Emissions Trading System (ETS) and other carbon pricing tools

The EU ETS is applicable to power generation and large industrial installations and covers 45 percent of the EU's total GHG emissions. Set up in 2005 as the world's first international emissions trading system, the EU ETS has only recently started delivering a meaningful price signal, following the introduction of the market stability reserve in January 2019.[i]

The remaining 55 percent of emissions in the EU are subject to national policies under the Effort Sharing Decision (ESD) and Effort Sharing Regulation (ESR). Environmental taxes are a key instrument under the ESD, but they have remained flat or even declined in certain member states in recent years.

Similarly to EU peers such as Croatia, Bulgaria, and Poland, Romania does not apply significant levies on emissions from non-ETS sectors, but it does tax energy use. Before Russia's invasion of Ukraine, energy taxes (mostly on motor fuel, but also on some commercial uses of energy) accounted for 7.1 percent of total tax revenues in Romania. However, in the wake of the invasion, energy subsidies have been on the rise in Romania (as elsewhere in the EU).

The World Bank's 2022 Green Fiscal Policies report laid out five lessons for Romania to consider in its approach to non-ETS carbon taxation:

1. Carbon taxes can be economically neutral and often beneficial, provided that their revenues are recycled to reduce other more distortive taxes, and/or to make compensatory transfers.
2. Carbon taxes reduce carbon emissions.
3. Reinforcing revenue neutrality can mitigate concerns about competitiveness.
4. Compensatory measures can help address distributional concerns.
5. It is beneficial for countries to align the tax burden in all sectors of the economy.

i. Until 2018, ETS prices remained muted because of interaction effects with other EU mitigation strategies and supply–demand imbalances. In 2023, they hit the €100 mark for the first time.

Carbon pricing—and carbon taxes in particular—can yield a double dividend: lower emissions, and support for growth and employment via recycling of the revenue raised. Increased carbon taxes in non-ETS sectors and the phase-out of fossil fuel subsidies can be accompanied by a recalibration of other taxes, along with targeted transfers to address concerns related to adjustment costs, growth, employment, competitiveness, and distributional effects. Specifically, public revenues from carbon taxes can: (i) be recycled by lowering other taxes, up to revenue neutrality—e.g., by reducing taxes on employment to yield additional growth impacts; (ii) fund investments in sustainability or other

[43] See the latest available: https://www.consilium.europa.eu/en/press/press-releases/2023/04/25/fit-for-55-council-adopts-key-pieces-of-legislation-delivering-on-2030-climate-targets/

[44] The value of Romania's fossil fuel subsidies amounted to 0.25 percent of GDP in 2019. They largely supported the acquisition of CO2 certificates by coal plants, SOE investment in gas production, and district heating.

development needs; and iii) fund recurrent expenditure, including for compensating those affected by higher carbon prices (as discussed in section 4.2).

Carbon taxes are a cost-effective enabler of environmental improvements. The EC and OECD found that environmental taxes can raise additional revenue at a lower cost than more traditional broad-based taxes (EC, 2013; OECD 2010, 2018), while a recent seminal study confirmed empirically that carbon taxes in Europe did not reduce output or employment, and may have boosted both (Metcalf and Stock, 2020). Other fiscal measures, such as feebates and subsidies to renewables, do not necessarily discourage emissions and tend to be less effective and efficient. Imposing carbon taxes on firm—or household-level emissions would be complex and unaffordable. Therefore, such taxes are typically built into fuel excise duties—based on the emission factors for fossil fuels—with exemptions and special arrangements often applied to energy-intensive industries. In the EU, carbon tax rates vary considerably by country, from €9 per ton of CO2 in Latvia to about €108 in Sweden.

Green public investment can help overcome market failures and unlock investment in green infrastructure and innovation

Public spending has a crucial role in correcting market failures that discourage private investment in green infrastructure. Green investment projects can entail higher upfront capital costs, higher risk (e.g., due to market and technological uncertainties), and longer investment and payback timelines compared with fossil-fuel-based investment alternatives. In addition, green private investment can be impeded by market failures that do not account for the benefits of resource-efficient infrastructure and technologies, or for the full costs of fossil-fuel use (OECD, 2013). In this context, green public investment and co-funding can help crowd-in the private sector by reducing risks, mitigating information asymmetries, and aligning incentives. Moreover, green investments can support the recovery from the pandemic as they boast higher multipliers than traditional fiscal stimuli (Hepburn et al., 2020; IMF, 2021); job multipliers are also greater for investments in renewable energy generation than in fossil fuels (Kammen, 2010). In Romania, the level of green investment from the public sector is close to the EU average and is set to increase significantly thanks to EU funding.[45]

The role of the green public investment will be paramount not only at the national, but also at subnational level, highlighting the additional coordination challenge, with some emerging innovations from Romania. Coordinated and integrated efforts at the local level are critical to the transition to climate neutrality, especially as urban and peri-urban areas generate nearly half of domestic GHG emissions. Economic activities and populations are also concentrated in urban areas. In the OECD[46] and EU subnational governments—states, regions, municipalities—account for 57 percent of total public investment in their countries, and 63 percent of total climate-significant public expenditure.[47] While green budgeting and climate-related public investment tracking is still emerging, Romania is leading with some key initiatives: three Romanian cities - Sector 2 of Bucharest, Cluj-Napoca, and Suceava—have been selected as part of the EC '100 Climate Neutral Cities by 2030' flagship mission. Cluj-Napoca is the first to draft a Climate Neutrality Action and Investment Plan, which it has submitted for the EC's approval. The plan includes not only a detailed account of the actions it plans to undertake through 2030 to achieve climate neutrality, but also a detailed costing of the proposed interventions, and an estimated potential emission reduction.

[45] EU funds under the Next Generation/Resilience and Recovery Facility require a minimum allocation of 37 percent to green investments—which Romania exceeds—with a broad scope spanning renewable energy generation, energy efficiency, sustainable transport, as well as wider environmental and climate-change adaptation projects.

[46] As of June 2023, Romania is a candidate.

[47] https://www.oecd.org/regional/multi-level-governance/mlgsngpublicfinance.htm; https://www.oecd.org/regional/subnationalexpendituretracking.htm

4.3.3. The role of private sector in financing the green transition

The financial sector has a major role to play in enabling Romania's green transition

Romania's financial sector holds good potential to mobilize private capital in support of the country's decarbonization and climate adaption but is still developing the systems and capacity to do so. Despite the low level of financial intermediation as compared to EU peer countries, Romania's financial sector has been sound and become increasingly diverse. Though banks continue to dominate the financial system, accounting for 76.5 percent of total financial system assets, the capital market, particularly the corporate bond market expanded noticeably in the past few years: the issuance of non-financial corporate debt grew at 50 percent per year on average in 2017-2022. Insurance companies and asset managers, albeit small, are active, representing 18 percent of total financial system assets. The financial sector can potentially offer a variety of financial products and solutions to businesses and households who are faced with increasing climate-related challenges and opportunities. Ongoing efforts to establish the country's first national development bank (Investment and Development Bank of Romania) also holds promise to unlock further private financing. However, Romanian banks are still building the necessary data architecture, but many of them—especially the subsidiaries of international groups—are making progress towards developing their approach to green finance. Large government financing needs, however, crowd out private sector intermediation. Government bonds dominate the Romanian debt market, the public equity market is small (albeit growing), and the penetration of private equity and venture capital (PEVC) is lower than the CEE average.

At the same time, the financial sector is exposed to climate-related transition and physical risks. Bank loans to high-emission sectors (energy, industrial production, agriculture) stood at more than €15.7 billion[48] at the end of September 2022, equivalent to about 21.4 percent of total loans. By market capitalization, 43.7 percent of securities on the regulated capital market—including public equities, listed corporate bonds, and investment fund shares—are directly exposed to the electricity sector and other energy-intensive industries. Sudden change of carbon price or breakthroughs of climate technologies can thus expose banks and other financial institutions to heightened credit and market risks. Romania's proneness to natural disasters (e.g., seasonal floods, droughts, and earthquakes) can also put financial system at risk. Changing climate conditions can potentially imperil several southeastern and northwestern counties, and directly expose between 30 and 45 percent of total financial credit to the risk of climate-induced physical damage.

Notwithstanding the opportunities and risks, Romania is yet to formulate an explicit approach to align its financial system with national climate goals. Creation of climate finance markets (e.g., green bond) requires an enabling policy environment, including setting up green and sustainability taxonomy and monitoring, reporting and verification (MRV) systems. Due to externalities associated with climate investments, financial institutions' integration of climate considerations often requires regulators to develop detailed guidance and set explicit supervisory expectations (e.g., through climate stress-testing and sustainability financial reporting requirements). While there have been efforts made, such as issuance of Bucharest Stock Exchange ESG reporting guidelines and preparation of sovereign sustainable bond, the vast majority of the financial sector has yet to adopt a conscious approach towards climate finance, possibly due to lack of awareness, knowledge and capacity. It is thus incumbent upon financial authorities to act and develop a systematic approach to bring the financial sector in line with the country's climate transition path, given the significant amount of private capital needed.

Demand-side constraints exacerbate supply-side issues, resulting in limited bankability for green projects, indicating the need for a cross-sectoral, coordinated approach to mobilize private resources. Aside from the supply-side issues, Romanian firms, including those operating in key decarbonization

[48] Converted from RON 78 billion.

sectors (e.g., energy and transport), tend to have a limited understanding of the risks and opportunities associated with climate change, contributing to a low green financing demand. Additionally, unavailability of corporate GHG emission data and the underdeveloped carbon pricing regimes also hinder financial institutions and private investor's ability to assess climate investment opportunities. Prospective energy transition and resilient transport projects in Romania tend to be large in size and long in tenor, thus not as financially attractive as conventional projects. Given the multi-faceted nature of the challenge, coordinated action across the Romanian authorities from different domains (e.g., environment, energy, transport and infrastructure, fiscal, financial) could help uncover potential demand, improve price signals, and employ policy levers to increase private investor appetite.

Public and concessional funding can be better leveraged to expand the pool of private funding, including through blending structures. As noted above, public and EU funding will be important sources to support Romania's climate transition and adaptation, particularly for projects that have low financial return but high level of positive environmental externalities. Employing blending structures, such as risk-sharing designs (first-loss, subordination, partial guarantees, public capital capped returns etc.), public, supranational, MDB and other forms of concessional financing can catalyze additional private capital for decarbonization and climate risk reductions. Romania's domestic development financial institutions, especially the to-be-established national development bank, can be well situated to play an intermediating role. Continuing reforms on public-private partnership will also improve private capital participation in key decarbonization sectors.

Accelerating fundamental financial sector reforms can better support an efficient and cost-effective climate transition. The significant climate and development investment needs underline the importance of a deep financial system in mobilizing and allocating financial resources. Market-based solutions by financial institutions and financial market can contribute to an efficient and cost-effective green transformation. Apart from the issue of pricing carbon and climate-related risks, the inherent insufficient ability of Romania's financial sector to support the country's green infrastructure development and small climate innovators highlights the need to deepen the financial system. In this light, the Romanian authorities should step up efforts on fundamental financial sector reforms, to improve access to credit, increase capital market financing, and expand the private equity, venture capital and asset management markets, in synergy with green finance development.

5. Recommendations

Achieving net zero will require a concerted policy and investment approach in line with current trajectories. Given the existence of the supranational EU NDC and the EGD, the CCDR has not had to try and map out a pathway to net zero, but rather consider scenarios around the existing 2030 and 2050 targets, namely what are the advantages and disadvantages in getting to net zero either faster or slower within the 2050 timeframe. In the accelerated case, the results of the modeling and analysis demonstrate that the economy may well not suffer any major negative impacts, but the household impacts may be large. Additionally, given the uncertainty about technology costs and Rest of World (ROW) speed of decarbonization, the accelerated scenario contains elevated risks. On the other hand, a slower approach to achieving net zero will likely mean that Romania does not meet its climate obligations and will potentially be disadvantaged in the future low carbon global economy and at odds with other EU Member States. In simple terms, the main finding is that Romania needs to continue to progress to net zero, while appreciating that this will be much more challenging than meeting the Fitfor55 goals it has largely already met.

The recommendations of the CCDR highlight the synergies between development and climate change in Romania. As noted previously, the purpose of the CCDR is to consider the future development of Romania in the context of climate change. The report has sought to clarify the different development and climate challenges and to collate the different approaches, targets and instruments that already exist. This last chapter seeks to crystalize the policies and areas of focus that are critical for Romania over the coming five-to-ten-year period in order to remain on a path to net zero. These are differentiated between a) general policies that support development and deliver positive climate outcomes and b) specific policies and actions that should be prioritized to address climate challenges within the development context.

5.1. Medium term development focus

As highlighted in the recently released Systematic Country Diagnostic Update for Romania, there are four (out of the total of six) high level objectives which, if achieved over the next five to ten years, would mark an improvement in the wellbeing of the population, and especially of the poorest and most vulnerable. These are:

1. a predictable institutional and economic environment for people and businesses;
2. equal access to high-quality public services at the central and local levels;
3. better health and education outcomes for all;
4. favorable conditions for more and better private sector jobs;

All of these objectives provide the solid foundations for a green transition for the country, while also not involving any negative climate outcomes, such as carbon lock-in or stranded assets. In addition, there were two other objectives identified in the SCD, namely:

5. climate change mitigation for environmental sustainability of economic activity; and
6. resilience to shocks and adaptation to climate change, especially for vulnerable households.

Achieving these last two objectives is critical in both maintaining the current development successes in Romania, but also to achieving further growth and stability. The steps required to achieving these objectives are captured in the short-term priorities that follow.

5.2. Short to medium term climate change priorities

The main focus of the government should be on achieving the goals that it has already identified and agreed under Fitfor55 (Table 3). As highlighted, progress to date in meeting the 2030 targets has been good, although much of the success has been due to structural shifts in the economy and other variables, as opposed to the direct impact of policy implementation. ***While the remaining gap to the 2030 targets is small, it will require determined action.***

Table 3: Main short-to-medium term (2021-2030) targets, as set out in INECP

Sources of emission reductions	
1. Overall emission reduction targets (by ETS coverage)	*% reduction by 2030 compared to 2005*
ETS emissions (% reduction by 2030 compared to 2005)	-43.9%
Non-ETS emissions (% reduction by 2030 compared to 2005)	-2.0%
2. Sources of emission reductions	
Increasing overall share of RE:	*% RE in final energy consumption*
Overall share of RE (% RE in final energy consumption), of which:	30.7%
Electricity share of RE	49.4%
Transport share of RE	14.2%
Heating and Cooling share of RE	33.0%
Improving Energy Efficiency:	
Reduction in energy usage relative to baseline from PRIMES 2007 projection for 2030)	*% PRIMES 2007 baseline projection for 2030*
Primary energy consumption	-45.1%
Final Energy consumption	-40.4%
3. Primary vs Final Energy consumption	*Mtoe*
Primary Energy Consumption (Mtoe)	32.3
Final Energy Consumption (Mtoe)	25.7

Source: INECP; PRIMES refers to the Price Induced Market Equilibrium System Model used in EU Member States

The period to 2030 is also critical for ensuring that the policies and incentives are in place to enable the trajectory to Net0@2050. As noted in the following priorities, fundamental actions and policies are needed in order to leverage the initial decarbonization efforts into delivery at scale. Moreover, medium term success will be dependent on tackling sectors (e.g. transport and heating) and issues (e.g. urban heat and water scarcity) that are much harder to address. While the LTS contains specific sectoral targets, the priorities below seek to capture the overview of how and what will need to be done. More detailed specifics of each priority will be covered in the background notes to the CCDR and in subsequent consultation with the Government and will need to be sequenced with changes to overall EU policies.

Table 4: Short-to-medium term priorities

PRIORITY:	RECOMMENDATIONS:
Priority 1: Increase electrification and fuel shifts	• A dramatic increase in the electrification of the economy is essential to reduce the current inefficient use of carbon-based fuels and increase energy security. • This will require increased investment in renewable energy generation, driven by the private sector. From power capacity in 2022, additional 2,240 MW of wind and 3,640 MW of solar needs to be installed by 2030, which compares with the 340 MW onshore wind and 650 MW solar added capacity in the last decade, and almost no new RE capacity installed in the last 5 years. Incentivizing private sector investment in the sector requires streamlining administrative processes for the installation of new renewable capacity; increasing connectivity by urgently strengthening transmission infrastructure, both nationally (especially between the east coast and Bucharest) and internationally

(accelerating the construction of international interconnectors), to decrease connection times and increase predictability; limiting the participation of SOEs in inframarginal generation assets (hydropower and nuclear) and throughout across all segments of the value chain; increasing wholesale market competition by adding safeguards –establishing a clearing house– and increasing liquidity and transparency by eliminating obligation to electricity generators to sell at least 70 percent of the available energy they produce through bilateral contracts; integrating economic value of water in power wholesale market to optimize water use for electricity generation and increase transparency on investments required in water-reliant generation technologies; strengthening competition in the electricity balancing market by reducing current high market concentration (mainly SOE) and increasing transparency, raising entry barriers for new competitors; and redress emergency legislation approved to limit the impact of the energy crisis in energy prices which hinders competition (i.e., untargeted price caps, 100 percent tax on trade and profits from electricity exports).

- For major industry consumers and applications such as district heating, the development of alternative fuels, such as green hydrogen, will be critical in meeting EU requirements, but also producing low carbon goods for export markets. Specifically, the National Strategy for Hydrogen needs to be approved, and incentives for first movers in the nascent hydrogen industry deployed. The roll out of heat pumps and technologies using local resources for heat production (solar heat and geothermal) should be accelerated through incentivizing policies and financial instruments.
- Focused implementation of the Just Transition Mechanism will be important to not only meet EU goals, but also to provide sufficient time and opportunity for affected workers, businesses and communities to transition in a way that minimizes negative and maximizes positive impacts. The institutional arrangements to steer the Just Transition set out in the Decarbonization Law need to become more operational, institutional responsibilities clarified and monitored, and relevant policies and financial instruments deployed to implement the Territorial Just Transition Plans.

Priority 2:
Increase energy efficiency

- In addition to addressing supply side challenges, Romania needs to focus on increasing energy efficiency across the economy by providing incentives, establishment of financing instruments and reduction in existing policy disincentives. Not only will the resultant savings in energy be positive for consumers and companies, but they will also contribute to offsetting the increasing demand that will flow with growth and broader electrification of the economy.
- The annual renovation pace of the building stock needs to increase from current 0.5 percent to 3.4 percent and mobilize investments of over €1.6 billion per year, requiring attracting over €1 billion per year of private investment. The incentives for the renovation of the building stock need to urgently reduce the level of distortionary grant financing, spearheading grants for targeting non-EE investments and vulnerable population and leveraging financial instruments. Other measures to incentivize attracting private investment at scale would include the integration of repayment schemes for MABs and public buildings, financial incentives for ESCOs and energy performance contracting. Increasing technical capacity on EE of banks and financial institutions; and de-risking instruments for lending to MABs. This will also create more sustained demand, which will lead to the creation of a more sustainable EE renovation market and attract investments in capacity expansion in the construction industry.
- At policy level, accelerating the renovation of the building stock would require coherent long-term implementation plans with updated targets; investment estimates and milestones on integration of commercial finance; digitalize building energy data and allow public access to relevant databases; and continued improvement and update –following technological improvements—of the regulatory framework for RES prosumer schemes, HOA-MAB management regulations, energy service procurement, nZEB criteria and energy management.
- In the market, raising public awareness on building renovation; accelerating digitalization in building information management (unified building registry); standardizing technical solutions and electronic public procurement; and building capacity at HOAs, key market players (energy auditors, construction workers, architects) and of local authorities and regional intermediaries.
- Likewise, policies and investments will be needed in the industrial sector to enable and incentivize companies to tap into substantial energy efficiency gains, especially in SMEs.

Priority 3: Strengthen strategic management of water resources

- From energy production, to agriculture, to access to water and sanitation and many other sectors, the water challenge in Romania is already evident. Increasing water scarcity will exacerbate these challenges and have far reaching social and economic consequences. The inherent trade-offs and competing demands related to water require the introduction of an integrated approach to water management at the government level, as opposed to the current situation where water management and usage are split between multiple ministries and agencies.
- While some investments are identified in the National Basin Management Plan, the Flood Risk Management Plans and the NRRP, there is an urgent needed to assess the impacts of climate change on water availability in all river basins, updating the data on water demand considering the increased pressure from agriculture, energy and biodiversity conservation. These strategic planning assessments would identify relevant investments at river basin level.
- Investments need to be accelerated and upscaled to close the remaining water and sanitation access gap and significantly increasing water storage capacity. Priority investments include the rehabilitation of deteriorated dams and retrofitting for new multi-purpose dams to optimize the use of the existing built storage, and conservation and renaturation of wetlands and riparian ecosystems to increase natural storage capacity, while reducing both flood and drought risks while providing additional benefits for biodiversity.
- Drought risk management plans should be systematically implemented and updated at river basin level, to determine the vulnerability of different sectors to water scarcity and to identify effective measures to increase drought resilience, ranging from technologies of efficient water use in manufacturing, the reuse of wastewater in agriculture, and the diversification of water sources, in particular where water supply for human consumption is at risk.

Priority 4: Focus on building and protecting human capital

- Romania is already challenged by skills gaps and a lack of adequately trained labor force. The transition to a low-carbon economy risks exacerbating this situation and creating a major constraint to growth and meeting climate targets.
- Investment in closing skills gaps in the current labor force and evolving the current education system to prepare the next generation of workers for a green economy is urgently needed.
- In order to protect those who will be displaced by the transition, active labor market policies (ALMPs) and social protection systems (SPS) are needed to ensure that already existing inequalities are not exacerbated, including for women.
- On the one hand, meeting the change in skills demand will require ALMPs to offer reskilling options for workers that bridge the skills gap in an efficient manner: taking into account market demand, as well as skills similarity indices that indicate which job transition pathways reduce effort for workers and cost for the government.
- On the other hand, for those workers that cannot transition to a greener job, SPS systems should be flexible enough to offer early retirement options and adaptive enough to react to climatic shocks on people.

Priority 5: Accelerate decarbonization of transport

- Transport remains a hard-to-abate sector and failure to accelerate its decarbonization will make Net0@2050 unachievable for Romania. Key areas for action include:
- Promoting the shift to lower carbon-intensive modes of transport. For freight, a significant step-up is needed in renewal of rail infrastructure and rolling stock, prioritizing investments that truly reflect in improvements of the sector performance, as well as leveling better the playing field between road-based and rail transport, meeting the NRRP target of 10% shift from roads to rail by 2026, and targeting a 25% shift by 2050. For passengers, public transport and active modes should be prioritized in both planning and investment, especially in urban areas.
- Accelerate the electrification of the road vehicle fleet. This entails a mix of fiscal and tax incentives on fuel, circulation and registration of vehicles, bundled with regulatory action, targeting also the second-hand import market. Incentives and regulations should also target the early uptake of EVs in highly utilized fleets (public and private). Romania should aim at 50% of new registrations of passenger cars and vans being zero-emission by 2030 and 90% by 2035 (including second-hand imports). For trucks, outperforming the currently adopted CO_2 emission standards for new HDV is crucial to meet the sectoral decarbonization objective. This will require further analysis at EU-level to assess and enhance the readiness of the sector to develop and adopt more rapidly new technologies.

	Differentiated taxation and financing mechanisms should be implemented to accelerate TCO competitiveness of Zero-Emission Trucks (ZET). Romania should aim at 70% of new registrations of trucks being ZET by 2035 (including second-hand imports) and accelerating fleet renewal afterwards.
Priority 6: Improve alignment of fiscal incentives through efficient carbon pricing	• While protecting the vulnerable through better targeting, Romania first needs to reduce consumer subsidies for electricity and solid and liquid fuels. This will not only reduce the fiscal burden but also assist in demand contraction and incentivize increased energy efficiency. • Linked with this, the moving towards more efficient carbon pricing through gradually aligning environmental tax burden across the sectors of the economy, especially in sectors beyond EU ETS subject to domestic policies, to limit putting selected industries in a more advantageous position. Efficient carbon pricing would not only help incentivize high carbon sectors to accelerate their transition, but also generate revenues that can be used to finance adjustment costs and social safety nets for the vulnerable in the transition, promote further adoption of green technologies, fund broader development objectives, and support fiscal consolidation. • Balancing the investment needs with revenue neutrality can help mitigate concerns about competitiveness, however, further in-depth analysis is needed to understand the interaction of climate policies (especially the increased use of green industrial policies) and competitiveness at the global, regional, and national levels.
Priority 7: Deepen collaboration and coordination across all levels of government	• As outlined earlier, steps have already been taken to foster inter-ministerial collaboration and there are examples also emerging at regional and city levels of knowledge sharing and climate action occurring. • A successful transition will require a further deepening of planning and execution of climate action both across and throughout all administrative levels. • In addition, it will require establishing effective participatory engagement platforms for local governments and citizens to identify and invest in measures that mitigate risks and build community resilience and green livelihoods. • The importance of continuous monitoring of progress and re-assessment of options will be invaluable in continuing to meet (and exceed) targets and to adjust as current uncertainties become clearer and new ones develop.

Annexes

Annex 1: Modelling and assumptions

Box A1: Macroeconomic modelling for Romania CCDR

Results presented in this chapter stem from CGEBox—the key economic model used for Romania CCDR. This modeling system is developed by the University of Bonn and the GTAP center (Britz and van der Mensbrugghe 2018), with recent extensions by the World Bank Its multi-regional character captures the global economy to consider the integration of Romania in the EU. The CGE model relies on a neoclassical structural modeling approach and mostly follows standard assumptions of the standard CGE literature. Accordingly, it does not consider price setting power, for instance, by SOEs in energy markets. Labor is assumed to move sluggish between sectors which might underestimate friction in labor markets. Other economic models are available and could be used in conjunction to further inform policy decisions, as they may provide alternatives angle in analysis.

An extended documentation and user guide for the model can be found in Britz 2022. The model is calibrated against the GTAP Power Data Base Version 10 (Chepliev 2020), which distinguishes 84 sectors and 66 products and captures 10 primary factors (land, irrigation Water, natural resources, capital, six labor types), and ten household type by income deciles for Romania. One of the key advantages compared to many other CCDRs is that Romania's decarbonization and development scenarios are not modelled in isolation, but together with the rest of the EU and the global economy. But this also implies that assumptions on the decarbonization policies for the Rest-of-the-World (RoW) need to be introduced.

The key growth projections are informed by auxiliary macroeconomic models: MFMod (which underpins World Bank Macro-Poverty Outlook), and Oxford Economics model (used for World Bank Global Economic Prospects reports, and selected analytical work, including the EU Regular Economic Report 8).[i] Provided Romania implements structural reforms, growth over the long term can be strong, slowing towards the end of the horizon as the living standards converges towards the EU average. For the purpose of the CCDR, the average growth rate projection for the period 2023-2050 is around 2.8 percent, relatively conservative compared to: (i) 3.7 percent observed 2000-2020, reflecting the slowing in the future as the living standard converge; (ii) potential growth of 5.2 percent over the next decade (2023-2030) if structural reforms are undertaken; and is broadly comparable—though slightly above—the (iii) 2.1 percent average over the 2023-2050 horizon underpinning Romania's Long-Term Strategy simulations. As indicated earlier in the report, the scenarios in this report provide an illustration and are subject to high degree of uncertainty.

i. In addition, ENVISAGE model is used for CBAM impact analysis presented in section 4.1.2.

Table A1: Key assumptions for macroeconomic and sectoral modelling

Key sectors / variables	Key Scenarios			
	Business as Usual (BaU)	**Linear Net0@2050**	**Slow Net0@2050**	**Fast Net0@2050**
	Captures existing decarbonization policies	Decarbonization pace is in line with key EU targets	Decarbonization action is delayed	Decarbonization action is frontloaded
GDP	Based on MFMod projections, drive total factor productivity, differentiated in first, second and tertiary sector	Endogenous, total factor productivity changes from BaU		
Demographics	UN projections for total population; share by age, gender and educational attainment from IASSA SSP2			

Labor stocks	Driven by changes in working age population (aged 15-64) by gender. Changes in educational attainment drive change in composition by skill. Employment shares are kept constant.			
BOT/BOP	Endogenous: virtual global investor distributes global savings such as to maximize expected returns to capital (endogenous foreign savings, FDI). FDI implies that part of future capital income accrues to foreign investors. Composition of bi-lateral trade endogenously based on Armington mechanism.			
Drivers of growth	Capital accumulation from productive investment after depreciation: Foreign savings endogenous (see above). Private saving rate of Romania exogenously falling over time to consider aging population; changes in Labor stocks; changes in productivity			
Drivers of sector output and employment	Non-linear Engel curve change budget shares and imply shifts to higher demand for services with increasing incomes (strongest in RoW). As total factor productivity changes are higher in primary and secondary sectors, this implies increasing factor use including labour in service sectors. Relatively stable employment in agriculture in Romania as more labour-intensive agricultural sectors expands and the agriculture is export oriented.			
Transport Romania	GDP and projection driven changes in transport service demand, moderate energy saving technical progress, limited electrification of	Full electrification of rail, passenger and light freight road transport by 2050; accompnying changes in transport modes (more bicycle, public), considers current age composition of fleet	As in linear	Accelerated adoption of electric vehicles and changes of transport mode ("ultra", i.e. not deemed very likely), higher energy efficiency of electric vehicles
Electrification transport EU and Row	25% in private and other road transport in 2050, linearly increasing from benchmark	90% in private and 95% in other road transport in 2050, linearly increasing from benchmark		
Energy demand for heating Romania **Changes in share of renovated buildings, related costs and energy savings**		Median speed of building renovation program and related cost. Renovated buildings are equipped with heat-pumps	Slower speed of renovation program in early year, above median speed towards end (same share of buildings renovated in 2050)	Higher speed of renovation program in early year, below median speed towards end (same share of buildings renovated in 2050)
Energy demand household for non-transport	-0.3% reduction annually per capita			
Power generation Romania **(Mix driven by energy system model)**	Already decided changes: phasing out of coal by 2030, new nuclear power addition and planned new renewable capacity up to 2030. Moderate reduction in emissions. Electricity demand following raise in electrification of transport, heating and other sectors. New power capacity at benchmark prices (CAPEX reduction over time) and capacity factors. CCUS and hydrogen technologies are implemented towards the end of the period, reflecting current uncertainties on cost evolution and time to become commercially viable and most economic abatement alternative.	Progressive electrification of the economy (at linear pace). This electrification pace results in increasing electricity demand from transport and heating sectors, requiring additional investments in Renewables between 2030-2040. Increasing electricity demand from transport, heating and other sectors are moderated by a progressive improvement in energy efficiency. By 2040 (halfway to 2050), this scenario would require additional 27% power capacity than the BAU to meet a peak demand 22% higher than BAU, with also a 22% higher power generation than BAU. This additional capacity compared with BAU (+8	Slow electrification of the economy after 2030 with accelerated electrification by 2040. This trend results in lower energy efficiency improvements between 2030-2040 and rapid improvements after 2040. Same trend in the electrification of transport and other sectors: slow between 2030-2040 and fast after 2040. This demand pace results in a slower decarbonization of the electricity matrix to meet the demand, and lower investments in capacity and networks in the period 2030-2040 compared to the period 2040-2050. Till 2040, the scenario would evolve similarly to BAU and then by 2050, similar to fast and linear scenarios.	Fast electrification of the economy after 2030 with slower electrification by 2040. This trend results in higher energy efficiency improvements between 2030-2040 and slower improvements after 2040, benefiting from the efforts done in the previous decade. Same trend in the electrification of transport and other sectors: fast between 2030-2040 and slower after 2040. This demand pace results in a faster decarbonization of the electricity matrix to meet the demand, and larger investments in capacity and networks in the period 2030-2040 compared to the period 2040-2050. By 2040 (halfway to 2050), this scenario would require additional

		GW) would mainly correspond to renewable energy (+4.3GW solar, +3GW gas CCSU +0.4GW wind, +0.3GW other RES). Additionally, this scenario would require over 1.3 GW of batteries installed, over BAU. If gas with CCSU wouldn't become commercially viable at predicted cost reductions, the alternative would be a combination of more renewable energy and batteries. By 2050, all three scenarios (slow, fast and linear) would converge, as Net0@2050 is the final objective in all of them.		46% power capacity than the BAU to meet a peak demand 26% higher than BAU, with also a 37% higher power generation than BAU. This additional capacity compared with BAU (+13.6 GW) would mainly correspond to renewable energy (+6.0 GW solar, +3.9 GW gas CCSU +3.1GW wind, +0.6GW other RES). Additionally, this scenario would require over 0.1 GW of batteries installed, over BAU. If gas with CCSU wouldn't become commercially viable at predicted cost reductions, the alternative would be a combination of more renewable energy and batteries. By 2050, all three scenarios (slow, fast and linear) would converge, as Net0@2050 is the final objective in all of them.
Power generation EU	2/3 of the change rates used in NZ scenarios	Increasing shares of renewables (+7% for wind and solar, 0.7% for hydro, +3% for other annually), strongly falling shares for coal and oil (-9% annually), falling for gas (-5% annually)		
Power generation ROW	Endogenous cost minimization based on GTAP-Power production function nesting, additive functional form guarantees physical balancing			
Emission ceiling	—	Linearly falling to 10% of benchmark emissions for EU as an aggregate (including Romania), comprises all emissions and emitters. Defines EU wide carbon tax applied to all emissions. Similarly, ceiling linearly falling to 40% for Rest-of-the-World.		
Carbon pricing	Moderately increasing for EU; low, but increasing for ROW	Endogenously driven by emission ceilings		
Land-use change related sinks (higher carbon stocks in forests)	—	10% of benchmark emissions		
Emission abatement	Endogenous cost minimization of energy mix (coal, gas, oil, electricity) for sectors and final households and of capital-energy mix for sectors based on carbon taxes, step-wise linearization of integral under Marginal Abatement Cost Curves from literature for group of sectors to define endogenous cost-minimal emission process emissions factors; some substitution in private housing and transport demand bundle between fuels and heating/transport equipment. Substitution of more emission incentive products by less intensive ones by sectors and households according to production / final demand functions			
Carbon tax Revenue recycling	50% to reduce direct taxes, 30% to reduce factor taxes (labour, capital, land). Remaining 20% increase government revenues to stabilize budget (financing, for instance, of public costs to finance improved transport network)			
Household transfers	Changes per capita driven by (1) 50% of change in CPI, (2) 50% of change in wage index. Resulting per capita transfer are updated by (1) 50% of general population growth and (2) 50% of the growth rate of the population older then 64 years.			
Government account	Deficit closed by new government bonds with endogenous interest rates, debt stock accumulation			
Change in meat reduction	-30% preference shift until 2050 for EU, lower for RoW			

Land use change	Crop land and related total land change from FAO2050 study, drives general productivity shifters in agriculture	Endogenous revenue maximization at productivity shifters from baseline
Crop yields	From FAO2050 study, driven by productivity shifters	Cost minimal at productivity shifters from baseline
Climate change damages	—	Assumed zero in supportive context

Box A2: Green industrial policies—stimulus programs and long-term strategies for green industries

Green stimulus programs adopted in response to the Global Financial Crisis (GFC) boosted economic recovery, but were less successful to catalyze decarbonization in the short term. In response to the GFC, China, Japan, Korea, the EU and the United States adopted green stimulus programs in 2008/2008, focusing on clean energy and transport, as well as on energy efficiency. Assessments of these programs suggest they had positive impacts on GDP and employment overall and helped countries build up new green industries, although impacts on decarbonization were mixed. Based HICs' experiences, the GFC provides useful lessons learned on the design and implementation of green stimulus programs:

i. Scaling up existing policies is generally more effective when possible, and successful programs focused on enhancing policy/regulatory frameworks and investment incentives to mobilize private capital;
ii. Stimulus funding is more appropriate for sufficiently mature technologies (e.g., solar and wind power, energy efficiency), as support for technologies that were less mature at the time was less successful (e.g., algae biofuels, hydrogen);
iii. Efforts to build competitive export industries in clean technologies must be anchored in comparative advantages;
iv. Support for complex large infrastructure projects (e.g., CCUS, concentrated solar power) produced limited results and the structural barriers posed by such projects should be carefully considered;
v. Program design should minimize rebound effects, limit market distortions and ensure the additionality of public funding;
vi. Looking at policies' wider benefits and social equity aspects is essential;
vii. Transparency about green stimulus expenditures is key, and monitoring and evaluation should be built in programs; and
viii. The effectiveness of green stimulus partly depends on having sound policies to fix underlying environmental externalities.

In the wake of the COVID-19 pandemic, many countries committed to a "green recovery" and adopted targeted measures as part of stimulus packages. Despite measurement difficulties, such green measures were estimated to amount to around US$336 billion by March 2021 in a group of 43 countries tracked by the OECD's Green Recovery Database. However, they were evenly matched by spending on measures having mixed or negative environmental impacts, and only accounted for about 17 percent of total recovery spending in these countries. About 60 percent of the measures were sector-specific (mostly energy and surface transport), which lean towards environmentally positive measures, while 24 percent were economy wide and 13 percent were specific to cities or sub-national regions. On the other hand, measures targeting other key sectors for decarbonization, such as heavy industries and aviation, were assessed as having mostly mixed or negative environmental impacts.

More recently, the United States and the EU have led a new wave of green industrial policies, which could accelerate the low-carbon transition but also raises the risks of increased protectionism and a subsidy war. Along with other recent laws aiming to revive manufacturing through industrial policy,

the US' Inflation Reduction Act (IRA) adopted in August 2022 will allocate US$370 billion in public funds over a decade to foster the domestic production of clean energy and related infrastructure and equipment. This includes grants, guarantees, tax credits for private companies and incentives for households, largely conditioned on using technologies made in the US (or in some cases in countries with which it shares a free trade agreement). While these measures are expected to help reduce America's emissions to 60 percent of their level in 2005 by 2030, they could also lead to oversupply in some sectors (e.g., solar panels). The IRA has also triggered complaints about the protectionism of its local content requirements from other green technologies manufacturers, such as the EU, Japan and Korea, and heightened the risk of a subsidy war to attract green investment. In February 2023, the European Commission unveiled its proposed "Green Deal Industrial Plan" to boost the bloc's clean technology industry by (i) streamlining permitting procedures and developing standards to speed up the deployment of clean energy, (ii) increasing financing, including by channeling around US$270 billion in existing funds towards clean energy projects and by temporarily relaxing state-aid rules, (iii) developing green skills and training programs, and (iv) maintaining a fair and open trade system for the green transition. The Plan builds on the EU's new Industrial Strategy, unveiled in March 2020 along with a Circular Economy Action Plan, that made decarbonization, environmental sustainability and circularity key pillars of the long-term competitiveness and resilience of Europe's manufacturing sector.[i] These policies have both potential positive impacts (through innovation and cost reductions) and negative ones (through local content requirements and trade-restricting provisions), with considerable uncertainty and more analysis needed to understand the likely impacts.

i. The strategy notably aims to (i) implement EU-wide projects on specific technologies (e.g. green hydrogen); (ii) accelerate the decarbonization of energy-intensive sectors (e.g. steel, cement) and make chemicals more sustainable; (iii) support transition in carbon-intensive regions; (iv) foster energy efficiency and renewables; (v) develop industrial ecosystems, including linkages with academia; and (vi) review state aid rules for energy and environmental projects, as well as options for carbon border adjustment (EC 2020a). The promotion of circularity is also a key element of the strategy to reduce industries' environmental impacts, boost competitiveness, alleviate competition for scarce resources and reduce production costs, as well as to deliver consumer value and create jobs (EC 2020b).

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