Greening the Economy of Europe and Central Asia

Europe and Central Asia in Focus

Office of the Chief Economist

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Acknowledgments

This report has been prepared by the Office of the Chief Economist for the Europe and Central Asia region. The team has included Ivailo Izvorski, Michael Lokshin, Govinda Timilsina, and Iván Torre. The report draws on background papers prepared by Edward Barbier and Richard Damania. The team has received valuable inputs from Szilvia Doczi, Tom Farole, and Sergiy Kasyanenko, and constructive comments and suggestions from Charles Cormier and Sameh Wahba.

Abbreviations

CBAM	Carbon Border Adjustment Mechanism
CCDR	Country Climate Development Report
CO_2	carbon dioxide
EAP	East Asia and Pacific
ECA	Europe and Central Asia
EMDEs	emerging market and developing economies
ETS	emission trading system
EU	European Union
GDP	gross domestic product
GHG	greenhouse gas emission
IEA	International Energy Agency
kg	kilogram(s)
LAC	Latin America and the Caribbean
LNG	liquified natural gas
MENA	Middle East and North Africa
NDC	Nationally Determined Contribution
PM2.5	particulate matter with a diameter of 2.5 microns or less
PM10	particulate matter with a diameter of 10 microns or less
PV	solar photovoltaic
R&D	research and development
SIF	strategic investment fund
SO_2	sulphur dioxide
tCO_2e	ton of CO_2 equivalent

Overview

The impacts of climate change are already profoundly affecting the Europe and Central Asia (ECA) region. During the summer of 2023, Albania, Romania, and Türkiye recorded all-time high temperatures, and countries in the European Union (EU) experienced unusually strong heat waves. Wildfires broke out in Bulgaria, North Macedonia, and Türkiye, and a cyclone in the Mediterranean (Storm Daniel) caused significant flooding in Türkiye.

Beyond these immediate events, long-term impacts of climate change can be substantial. Projections for Uzbekistan indicate that by 2050, the country's GDP will be 10 percent smaller than in a scenario without the impact of climate change.[1]

Advancing policies, changing institutions, and adopting measures to mitigate and adapt to climate change are among the top priorities of governments around the world, ECA including. Tailored policies based on country conditions would contribute to global efforts to combat climate change, help ensure ECA's food and water security, and place the ECA countries on a path of more sustainable and greener long-term growth.

ECA is among the world's largest carbon emitters on a per capita basis. It emitted about 6.9 metric tons of carbon dioxide (CO_2) per inhabitant in 2020—60 percent more than the world average of 4.3 metric tons and more than all other regions except North America (Figure O.3). Emissions per capita in ECA rose 1 percent between 2000 and 2020, after declining 33 percent in the 1990s, when the countries of the region transitioned from planned to market economies. This broad stability in levels of per capita emissions since 2000 contrasts with both increases in other developing regions and declines in richer countries.[2]

ECA accounted for 9.5 percent of global emissions in 2020. This share is larger than its share of global GDP (8.4 percent) and of the global population (5.9 percent). Its emissions account for a larger share of global emissions than Northern, Southern, and Western Europe combined or any other developing region. Even excluding the Russian Federation, the largest emitter in ECA on a per capita basis (Figure O.3), ECA countries had carbon emissions of nearly 7 metric tons of CO_2 per inhabitant in 2020, above the world average (4.3 metric tons) and the levels in East Asia and the Pacific (nearly 6 tons), Latin America and the Caribbean (LAC) (2.2 metric tons), and South Asia (1.3 metric tons).

1. Uzbekistan Country Climate Development Report (World Bank, 2023c).
2. Per capita carbon emissions grew 22 percent in the Middle East and North Africa and 75 percent in South Asia over this period. They fell by about 30 percent in the United States and by 26 percent in the EU (World Development Indicators).

FIGURE O.1. Carbon emissions by world region

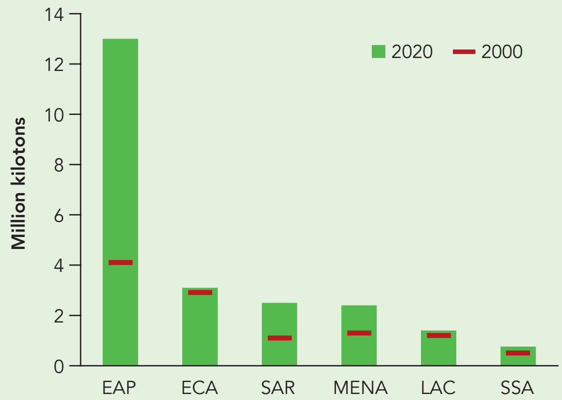


FIGURE O.2. Top 20 global emitters (excluding China and the United States)

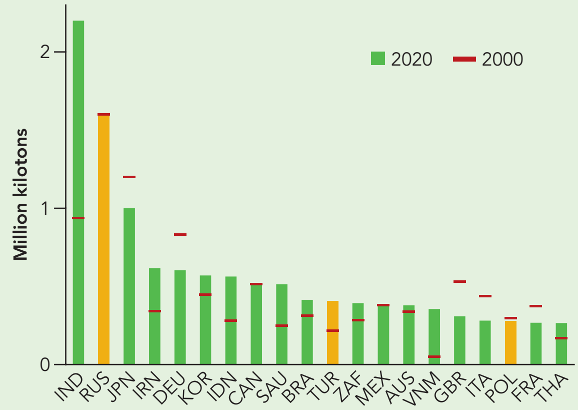


FIGURE O.3. Per capita carbon emissions in EMDEs

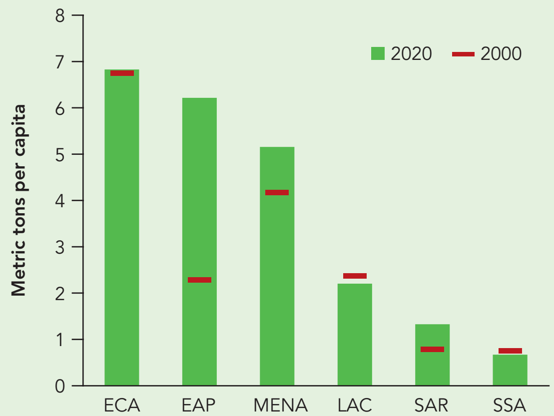


FIGURE O.4. Top 20 per capita carbon emitters

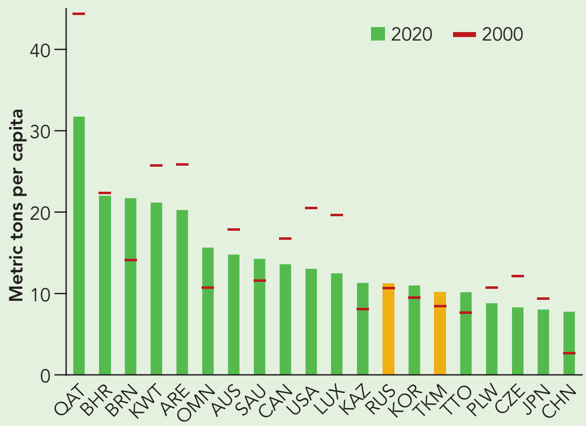


FIGURE O.5. Emissions intensity of GDP

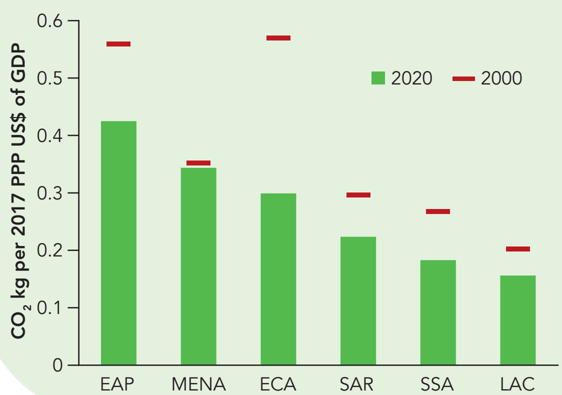


FIGURE O.6. Top 20 countries by emissions intensity of GDP

Source: World Bank, World Development Indicators.
Note: ECA countries shaded in yellow.

An important factor behind ECA's emissions is its heavy reliance on fossil fuels in energy consumption. Excluding fossil fuel–dependent Russia, oil accounts for 43 percent of the region's energy consumption, as a result of its pervasive use in transport and industry; natural gas accounts for 22 percent and coal 7 percent. Nearly 75 percent of ECA's energy consumption is based on fossil fuels. Natural gas alone accounted for 35 percent of electricity generation in 2020, far more than the global average of about 25 percent. Coal products contributed 28 percent to total electricity generation in ECA—less than the global average of about 36 percent but above the values for the United States (around 20 percent). Because of ECA's cold winters, heating accounts for 24 percent of regional energy demand and 22 percent of GHG emission, 83 percent of which is from fossil fuels (57 percent comes from natural gas and 24 percent from coal).

ECA countries are also net energy and hydrocarbon exporters, contributing indirectly to global emissions through their exports. ECA's share of global fossil energy extraction (16 percent) is much higher than its share of emissions (9.5 percent), a pattern also observed in other large extractive economies like those in the Middle East and North Africa. Within ECA, Russia is the largest extractor, accounting for 74 percent of the region's hydrocarbon production, or 12 percent of global emissions including both direct and indirect contributions.

Between 2000 and 2020, stronger economic growth led to a 7 percent increase in overall emissions in ECA, despite improved energy efficiency, greater reliance on renewable energy sources, and changes in economic structure (Figure O.1). Other regions of the world saw even larger increases: 15 percent in LAC, 82 percent in the Middle East and North Africa (MENA), and 137 percent in East Asia and Pacific (EAP). In contrast, emissions fell by 23 percent in North America and 30 percent in Western Europe.

Between 2000 and 2020, ECA's economy grew by about 108 percent and the region's emissions intensity fell by 50 percent, measured in CO_2 emissions per unit of GDP. This reduction is greater than the average for the Organisation for Economic Co-operation and Development (OECD) and all other world regions during the same period. ECA's emissions intensity amounted to about 0.3 kg of CO_2 per unit of GDP in 2020 (in 2017 US dollars at PPP), higher than that of South Asia and LAC, but lower than that of MENA (0.35 kg), EAP (0.42 kg), and Western Europe (0.13 kg) (Figure O.5).

One reason for the high carbon intensity and the continued high dependence on fossil fuels in ECA is the heavy subsidization of energy. Fossil fuel subsidies in ECA amounted to $110 billion in 2020 (3.6 percent of regional GDP). Russia accounted for $78 billion (5.2 of GDP). Azerbaijan, Kazakhstan, and Ukraine all provided energy subsidies in 2020 of more than 4 percent of GDP. By comparison, the EU countries excluding Poland spent $25 billion in fossil fuel subsidies in 2020 (0.2 percent GDP). In 2022, governments across both the European Union and ECA increased energy subsidies in response to the surge in energy prices. By mid-2023, their volume had been significantly reduced, however, and actual expenditure was lower than planned after the initial shock, thanks to the mild winter of 2022–23.

The jump in natural gas and wholesale electricity prices in 2022 resulted in the largest energy shock to the European Union and ECA since the 1970s. The steep price hike reflected mainly the heavy reliance on Russian natural gas and the coupling of Asian and European markets. All of these events occurred as the region recorded a solid post-pandemic economic recovery in 2021, accompanied by a large increase in energy demand but lower-than-usual natural gas reserves. As a result of the coupling of gas and electricity prices (because in many European countries, the last unit of electricity dispatched runs on natural gas), wholesale electricity prices also rose. The price hike negatively affected energy-dependent sectors of the economy, pushed inflation to multi-decade highs, and affected the mitigation policies of ECA countries.

The energy shock redefined the understanding of energy security, underscoring the need to diversify the sources of energy supply and substantially reduce dependence on imported fossil fuels. Energy security is now a top policy priority for many countries in the region and the world. It involves striking a balance between meeting current energy needs and ensuring future access to energy resources, ensuring the uninterrupted availability of energy supplies at an affordable price while respecting environmental concerns. According to this definition, energy security is not ensured for the 2023/24 winter, as shortages of natural gas are possible in countries with limited gas storage or poor access to LNG terminals.

Efforts to achieve energy security can be aligned with efforts to decarbonize economies and achieve stronger and sustainable long-term economic growth. The clean energy transition—which involves scaling up the development of domestic renewable energy, using energy efficiently, and supplementing these policies with effective energy trade policies—will help decarbonize the energy sector and make countries more energy secure. Adopting new technologies also creates an opportunity to boost economic growth rates, which have weakened in many countries. In fact, without decarbonizing the region, long-term economic prospects look challenging. No economic model based on fossil fuels is viable over the long term, largely because of global efforts toward net-zero emissions, which will lower demand for fossil fuel, with significant impacts on fossil fuel–exporting countries.

The rising adoption of greener technologies will improve competitiveness for early movers, as well as the growing trend toward carbon taxes on imports, such as the introduction from 2024 of the Carbon Border Adjustment Mechanism (CBAM) by the European Union. According to the International Energy Agency "the economic case for mature, clean energy technologies is strong. Energy security is also a key factor, particularly in fuel-importing countries, as are industrial strategies and the desire to create clean energy jobs."[3] Early findings of the World Bank's Country Climate Development Reports (CCDRs) find economic growth to be similar or, in some cases, faster in low-carbon development scenarios than in scenarios under current policies or commitments (reference scenarios),

3. IEA. World Energy Outlook 2023. https://www.iea.org/reports/world-energy-outlook-2023/executive-summary.

assuming policies are well designed and a supportive environment is in place. By 2050, the low-carbon development scenarios explored in CCDRs would reduce countries' GHGs by 73 percent from current levels.

A longer-term structural shift toward clean energy (mostly renewables and nuclear) is taking place in ECA. The IEA estimated in December 2022 that the natural gas supply gap for 2023 in Europe had already been halved through diversification away from Russian energy markets, energy-saving measures, and an accelerated deployment of renewables and heat pumps. World Bank modeling estimates indicate that between 2024 and 2030, ECA's energy consumption (excluding Russia) is set to rely more on renewables, coal, and nuclear energy.[4] A more aggressive coal phase-out would require more concerted policy actions. Natural gas consumption in the region has already peaked and is set to decline, but gas is expected to continue to play an important role in the clean energy transition because of its balancing properties. Increasingly competitive renewable energy generation enables countries to increase the share of domestic energy resources and reduce fossil fuel import dependencies.

The energy transition will require significant investments. According to a World Bank report :

> To finance a just transition that is consistent with both the goals of ensuring universal access to affordable, reliable, sustainable, and modern energy by 2030 and the 2015 Paris Agreement on Climate Change, developing countries will have to mobilize far more capital than they do today. Power sector investment in low-income countries (LICs) and middle-income countries (MICs), excluding China, must quadruple from an average of $240 billion annually in 2016–20 to $1 trillion in 2030 (World Bank 2023b, iv).

In ECA, Kazakhstan will require about $1,150 billion between 2025 and 2060[5] (6 percent of cumulative discounted GDP) to reach net-zero emissions by 2060.[6] Türkiye will require about $644 billion (around 4.8 percent of cumulative discounted GDP) to reach net zero by 2040. Uzbekistan will require $341 billion (3.8 percent of GDP per year) to reach net zero by 2060.[7] The countries in the Western Balkans would need to spend an additional $19.7 billion (1.4 percent of GDP) a year until 2050 to achieve economy-wide net-zero.[8]

The private sector will need to make about 70–80 percent of the total investment in decarbonization (this figure includes both capital investment and consumption (such as the acquisition of electric vehicles by households).[9] Govern-

4. ECA Energy Futures (World Bank forthcoming a).
5. This figure as well as similar figures for other countries, include both capital investment and consumption (such as the acquisition of private electric vehicles by households).
6. Figures from the Kazakhstan Country Climate and Development Report (World Bank, 2022a).
7. Figures from the Uzbekistan Country Climate and Development Report (World Bank, 2023b).
8. Figures from the Western Balkans Country Climate and Development Report (World Bank, forthcoming b).
9. See Ananthakrishnan and others (2023) IMF for the 80 percent figure: https://www.imf.org/en/Blogs/Articles/2023/10/02/emerging-economies-need-much-more-private-financing-for-climate-transition. See IEA (2021) for the 70 percent figure. https://www.iea.org/articles/the-cost-of-capital-in-clean-energy-transitions.

ments will need to implement national policies and carry out public investments to incentivize private investments and to help shift the financing of the green transition to market-based approaches.

Investments in energy infrastructure can allow countries to both mitigate and adapt to climate change. Investments that improve building energy efficiency reduce GHG emissions and prepare buildings to withstand the challenges posed by a changing climate. Decentralized renewable energy systems, such as solar and wind, can help ensure a more resilient energy supply in the face of extreme weather events or disasters, especially in remote and vulnerable regions. Energy storage enables the integration into the grid of more intermittent renewable energy sources while providing backup power during outages, ensuring resilience against extreme weather events or other disruptions. Transitioning from fossil fuels to renewables reduces GHG emissions and the amount of water needed for generation, making it particularly important in regions facing water scarcity. Demand response systems also improve energy efficiency and help prevent overloads during extreme weather events.

The transition to clean, affordable, and secure energy will require a range of policies to complement and facilitate required investments and support the shift of resources away from fossil fuels while protecting vulnerable populations. The following policies are particularly important:

1. **Pricing reforms that address market failures.** In several countries in ECA, the prices domestic consumers pay for electricity and natural gas do not cover costs. In Uzbekistan, as a result of ongoing government reforms, the retail tariffs of natural gas and electricity are projected to increase from 60 percent and 75 percent of the cost at the end of 2023, respectively, to full cost recovery by the end of 2026. Pricing reforms are complemented with support for vulnerable households.

2. **The reduction or phase-out of energy subsidies.** Subsidies for fossil fuels are among the greatest market disincentives for decarbonization and a green transition. The underpricing of fossil fuels occurs in two ways. First, the market prices paid for fossil fuels do not account for the various externalities, including the climate change damages from GHG emissions and local air pollutants that cause illness and deaths or result in other social costs. Second, in many countries, exploration, production, and consumption subsidies artificially lower the costs of supplying or the prices paid for fossil fuels and their key products: electricity, diesel, and gasoline. These subsidies mean that the playing field between fossil fuel and clean energy investments is not level, increasing the attractiveness of investing in and using these sources of energy rather than clean energy alternatives. Reducing fossil fuel subsidies also creates fiscal space, which governments can use to finance the transition to a low-carbon economy.

3. **Social policies to reduce energy poverty.** Removing fossil fuel subsidies will hurt poor households that consume subsidized energy. About one-third of the people living in ECA experience energy poverty, defined as spending 10 percent or more of average monthly outlays on energy bills.

This is typically due to high heating expenditures. It is therefore important that the removal of fossil fuel subsidies be implemented transparently, and with support to vulnerable households. To prevent energy poverty for vulnerable households when fuel and electricity prices rise, ECA countries should consider targeted assistance that varies by household income and energy use. Countries with low administrative capacity could scale up existing programs and provide top-up benefits to standard beneficiaries, such as the poor and other vulnerable groups the system already targets. Doing so would result in better adequacy of protection for the vulnerable groups, although it would not fully cushion the impact of higher energy prices.

4. **Tax instruments to facilitate the green transition.** Carbon pricing (a carbon tax or an emission trading system [ETS]) is the most common pricing policy used to help reduce GHG emissions, particularly in EU member states. Other countries have moved more slowly. Kazakhstan launched its ETS in 2013 but suspended the system in 2016–17 to tackle operational issues and reform allocation rules. It relaunched it in 2021, with World Bank support. Countries that are either planning or considering introducing an ETS include Albania, Bosnia and Herzegovina, Georgia, Moldova, Montenegro, North Macedonia, Serbia, Türkiye, and Ukraine. Carbon pricing policies should be implemented after a reduction in fossil fuel subsidies, not before.

5. **Regulatory policies, including mandates for energy efficiency, structural changes to energy demand in the heating sector through retrofitting and building codes for housing, and improved standards for appliances.** These policies should include efforts to unbundle integrated electricity and natural gas systems; focus on asset decommissioning; and improve the quality of and access to climate-related data, to help private and foreign investors make climate-related decisions. This would result in better governance and efficiency of utilities, as well as better emissions tracking. Better policy frameworks for public-private partnerships and independent power producers are also crucial to improve competition and ensure value for money.

6. **Decarbonization of transportation.** The most impactful measures are the adoption of electric vehicles and the increased use of public transport. Raising vehicle emission standards is also important.

7. **Structural reforms that strengthen macroeconomic fundamentals, deepen capital markets, and improve governance.** Given the massive amount of funding needed to implement the green transition and the long horizons for these investments to produce results, domestic and foreign investors need certainty that their property rights will be respected and the macroeconomic environment will be supportive of their engagement. A conducive macroeconomic and regulatory environment can help lower the cost of capital, thereby increasing the financial resources available.

8. **Investment in skills for a greener economy.** Sectoral investment policies will alter the nature of labor demand, shifting labor from sectors intensive in GHG emissions to low-carbon sectors ("green" jobs). As the skills required by the two types of jobs differ, workers will need to be retrained and training for new skills will need to be offered. Mitigating the transition costs will require active labor market programs for retraining workers whose skill sets are ill-matched to the requirements of green jobs and support for training new workers in appropriate skills.

To achieve the optimal mix of environmental, social, and economic objectives, climate change policies must be based on country-specific economic circumstances and structures. They should account for the costs of implementation and the attainment of local benefits (i.e., reduction of air pollution, water scarcity, and land degradation) as well as the tradeoffs between immediate environmental objectives (i.e., reduction of emissions) and long-term social benefits (e.g., reductions in poverty and inequality, improvements in livelihoods). Investing in sectors with larger employment and income multipliers for GHG reduction—such as healthcare, education, hotels and recreation, construction, and textiles and leather—meets economic, environmental, and gender equality objectives.

Regardless of ECA's success in reducing emissions (climate mitigation), climate adaptation will be needed in all countries. The cost of inaction is likely to be high. Uzbekistan, for example, faces a potential 10 percent of GDP loss in 2050 as a result of climate impacts (World Bank 2023c). The high fiscal costs of addressing disasters would absorb valuable resources and possibly boost government debt. Financial sectors will also be strained, as banks' balance sheets need to absorb increased costs and banks reprice risks. Some economies, such as Armenia, Georgia, the Kyrgyz Republic, Moldova, and Tajikistan—which contribute little to GHG emissions—can play an important role in exporting clean energy products. In Armenia, for example, large areas face drought risk, and some areas, particularly the Ararat and Shirak valleys, face flood risk. More than 40,000 people are affected by flooding each year, costing around $100 million in national GDP. In Georgia, the number of natural disasters (heavy precipitation, landslides, earthquakes, and floods) has almost tripled in recent years. Some disasters have been catastrophic, causing fatalities and leading to significant economic losses. Given its mountain terrain, geology, climate, and hydrological features, Tajikistan is highly prone to natural disasters and has a long history of severe floods, earthquakes, landslides, mudflows, avalanches, droughts, and heavy snowfalls. These countries should develop closer regional interlinkages and use externalities in research and implementation of adaptation policies.

Without much better adaptation mechanisms, climate change will have significant impacts on growth in the region. Increasing investments in adaptation and strengthening the capacity to implement adaptation and resilience plans and to cope with climate and other shocks requires a whole-of-economy approach that combines coordinated sectoral and economy-wide interventions and considers the interplay of investments, policies, institutions, and people. The whole-of-economy framework includes priority areas such as facilitating the adaptation of people and firms, protecting critical assets, and adapting land use, helping people and firms manage residual risks and natural disasters, and managing financial and macro-fiscal planning.

The World Bank's Adaptation Principles framework highlights the following factors:

- rapid and inclusive development to ensure that the poor have access to basic infrastructure and services that reduce their exposure to shocks and strengthen their ability to respond
- information and incentives (including fiscal and behavioral) to ensure that firms, farms, and households invest in adaptation
- investment and policies (including land-use plans) that incentivize adaptation by people and firms
- investment in human capital, including health and education, to ensure that everyone can achieve his or her potential and contribute to development and growth
- the management of financial and macro-fiscal risks of climate change and adaptation investments
- a robust institutional and legal framework for adaptation and resilience and a consistent system for monitoring progress.

In the context of ECA, nature-based solutions should be prioritized. They include waterway protection and enhancement, tree planting and biodiversity protection, and ecological conservation initiatives. These solutions are increasingly considered cost-effective investments for both adapting to and mitigating climate change activities. Water sector adaptation strategies are important. Adaptation measures to manage flood risks include early warning systems and protection against coastal and riverine flooding. Supply-side measures for adapting to water scarcity include building reservoirs, redirecting water, and desalinizing and recycling water.

Adaptation will require investment in R&D. The development of new crop varieties, for instance, will require the presence of strong local research institutions that understand the climate challenges facing the area in which particular varieties will be planted. Social protection systems will also need to be adaptive and be capable of adjusting benefit packages and temporarily ramping up the number of beneficiaries as needed based on post-shock needs.

Greening the Economy of Europe and Central Asia

The impacts of climate change are profoundly affecting the Europe and Central Asia (ECA) region. During the summer of 2023—the warmest summer in history—ECA experienced a particularly intense heat wave, with all-time high temperatures, significant wildfires, and devastating flooding in some parts of the region. Beyond these short-term consequences, the long-term impacts of climate change are projected to be substantial, with climate change impacts dampening future growth. Countries in the region urgently need to address the drivers and consequences of climate change. This note describes current trends in carbon emissions in ECA, the implications of the recent energy shock for the region's economies, and policies to promote a transition to a greener economy in the region and adapt to the impacts of climate change.

Carbon emissions and their drivers in the region

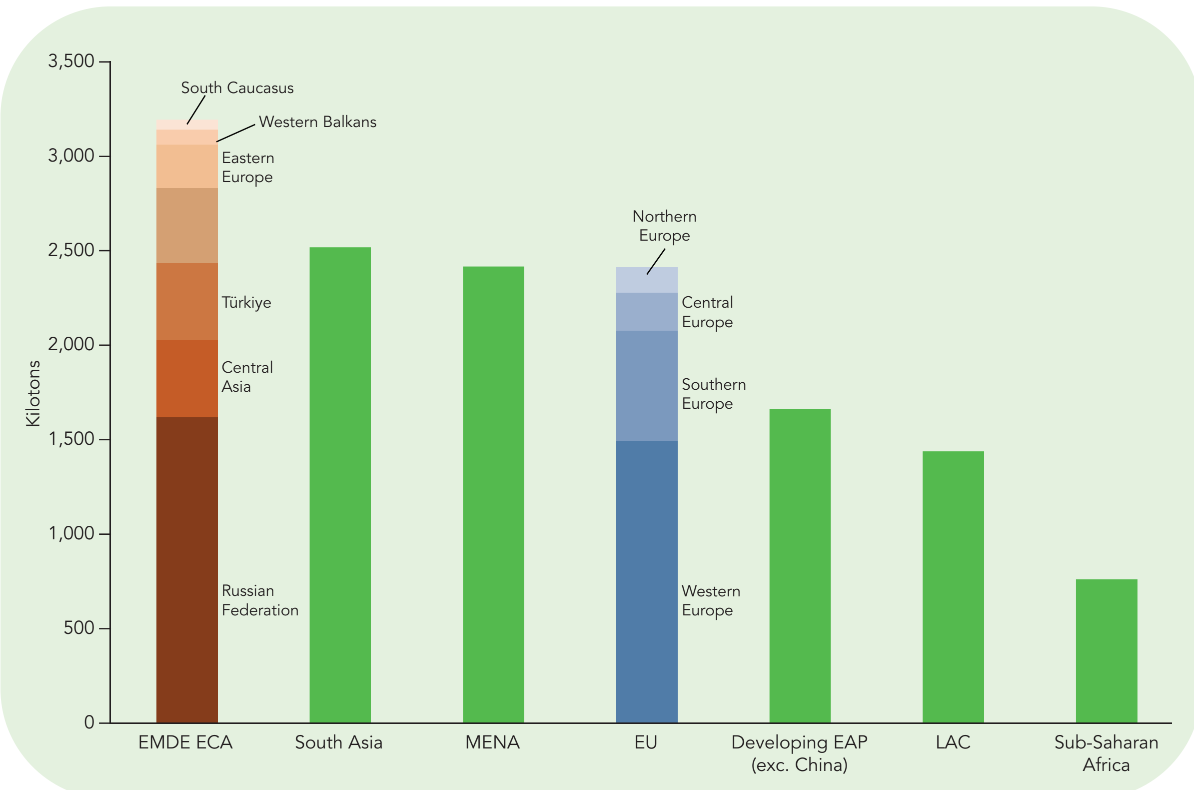
The emerging market and developing economies (EMDE) of the Europe and Central Asia (ECA) region are among the world's main emitters of greenhouse gases (GHGs). ECA countries accounted for 9.5 percent of global carbon dioxide (CO_2) emissions in 2020, more than all the countries in the European Union (EU) combined and more than any other developing region or country except China.[1] This share also exceeds EMDE ECA's share of the global population (5.9 percent) and global GDP (8.4 percent). The Russian Federation contributed more than half of all carbon emissions by EMDE ECA.

1. In 2020, South Asia contributed 7.5 percent of global CO_2 emissions; the Middle East and North Africa 7.2 percent; developing East Asia and Pacific (excluding China, the Republic of Korea, and Japan) 5.0 percent; Latin America and the Caribbean 4.3 percent; and Sub-Saharan Africa 2.3 percent, according to the World Development Indicators database, accessed September 10, 2023.

ECA's share of global emissions increased by 7 percent between 2000 and 2020, because of stronger economic growth. (Figure 1). The increase occurred despite changes in production structures toward services, improved energy efficiency, greater reliance on renewable energy sources, and commitments to decarbonization. The increase followed a decade in which emissions fell by 32 percent, as countries in the region transitioned from planned to market economies. Other regions of the world saw even larger increases: 15 percent in Latin America and the Caribbean (LAC), 82 percent in the Middle East and North Africa (MENA), and 137 percent in East Asia and Pacific (EAP). In contrast, emissions fell 23 percent in North America and 30 percent in Western Europe.

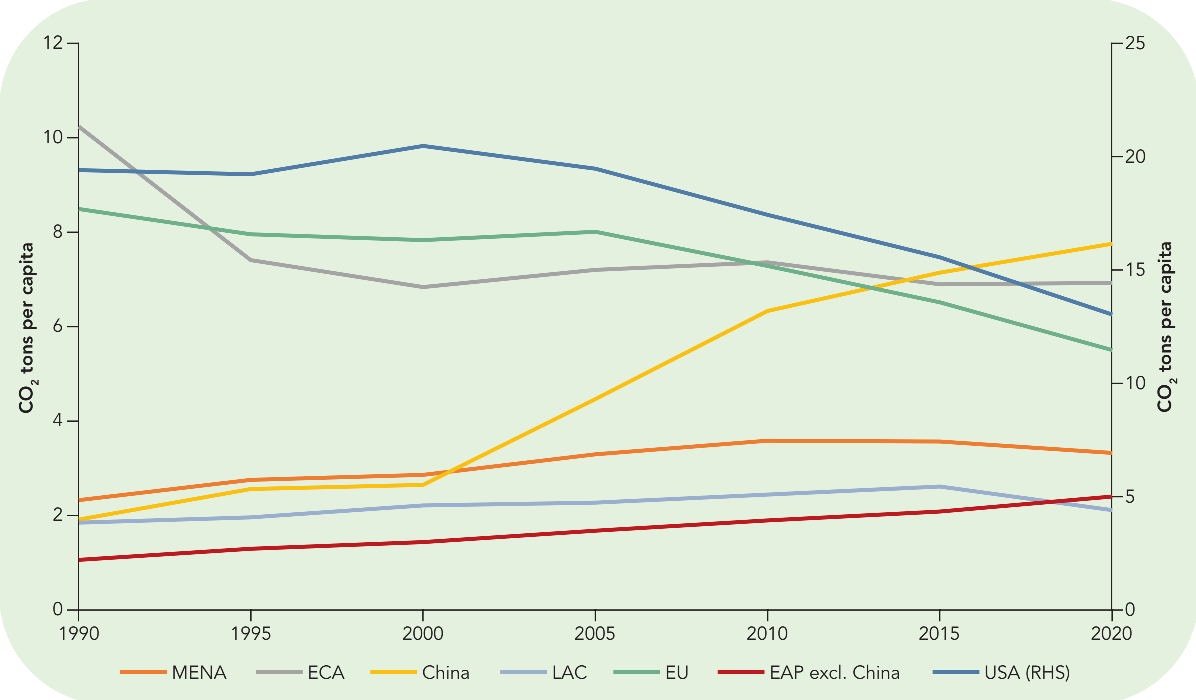
On a per capita basis, ECA is one of the world's leading carbon emitters, with emissions of about 6.9 metric tons of carbon dioxide per inhabitant in 2020, 60 percent above the world average of 4.3 metric tons and above all other regions except North America (Figure 2). Even excluding Russia (the largest emitter in ECA on a per capita basis), ECA countries emitted nearly 5 metric tons of carbon dioxide per capita in 2020, well above the world average and the levels in LAC, South Asia, and other developing regions. Emissions per capita in ECA rose 1 percent between 2000 and 2020, after declining by a third in the 1990s, when the region transitioned from a planned to a market economy. The stability in per

FIGURE 1. Carbon emissions by world region and subregion, 2020



Source: World Development Indicators database (https://databank.worldbank.org/source/world-development-indicators#), accessed September 10, 2023.

FIGURE 2. **Per capita carbon emissions by world region, 1990–2020**



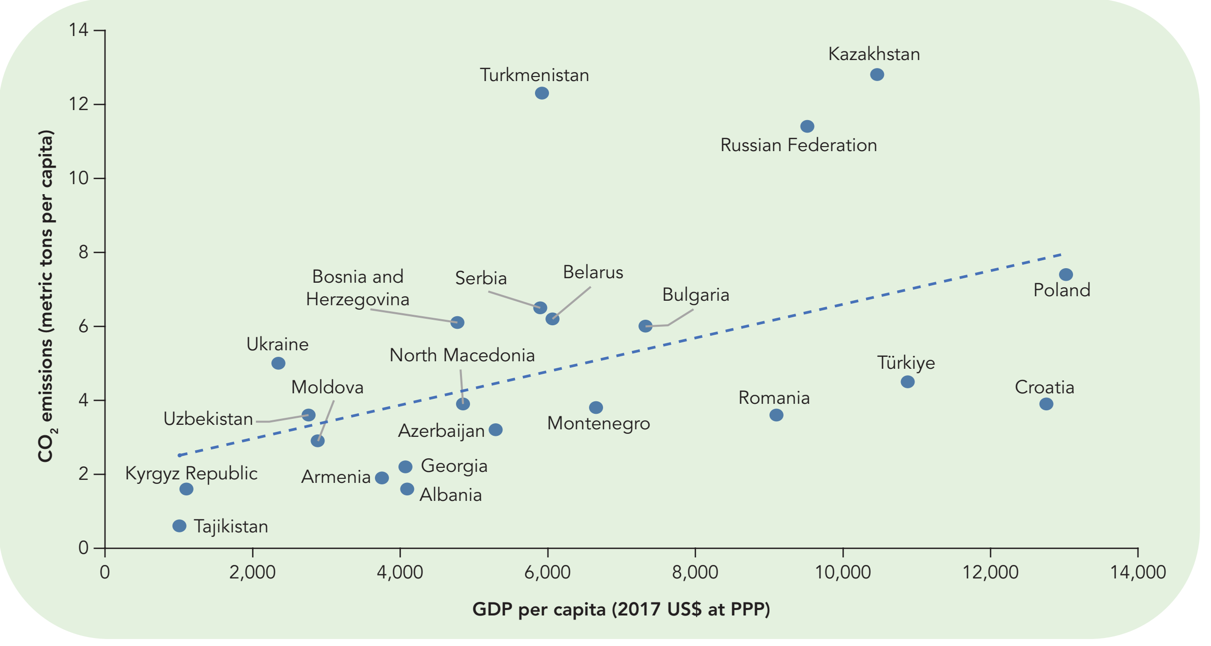
Source: World Development Indicators database (https://databank.worldbank.org/source/world-development-indicators#), accessed September 10, 2023.
Note: The graph plots the volume of carbon dioxide emissions in different subregions expressed in kilotons over the period 1990–2020.

capita emissions since 2000 contrasts with the increases in other developing regions. Per capita emissions in MENA rose 22 percent, for example, and emissions in South Asia rose 75 percent over this period. In contrast, per capita emissions in richer countries in North America and Western Europe have seen a decrease by more than a third between 2000 and 2020.

Per capita emissions vary significantly across the ECA region. National per capita emissions in Kazakhstan and Russia were almost six times as great as they were in Albania, Armenia, the Kyrgyz Republic, and Tajikistan in 2020. A colder climate, more dispersed population centers, and the legacy of the planned economy that did not consider resource costs are some of the factors explaining the very high per capita emissions in Kazakhstan and Russia. Per capita incomes among the EMDE in the region are positively and significantly correlated with average per capita carbon emissions (Figure 3). Between 2000 and 2020, per capita emissions declined in Eastern Europe, Central Europe, and Central Asia; they remained stagnant or increased slightly in Türkiye, Russia, and the countries of the South Caucasus (Figure 4).

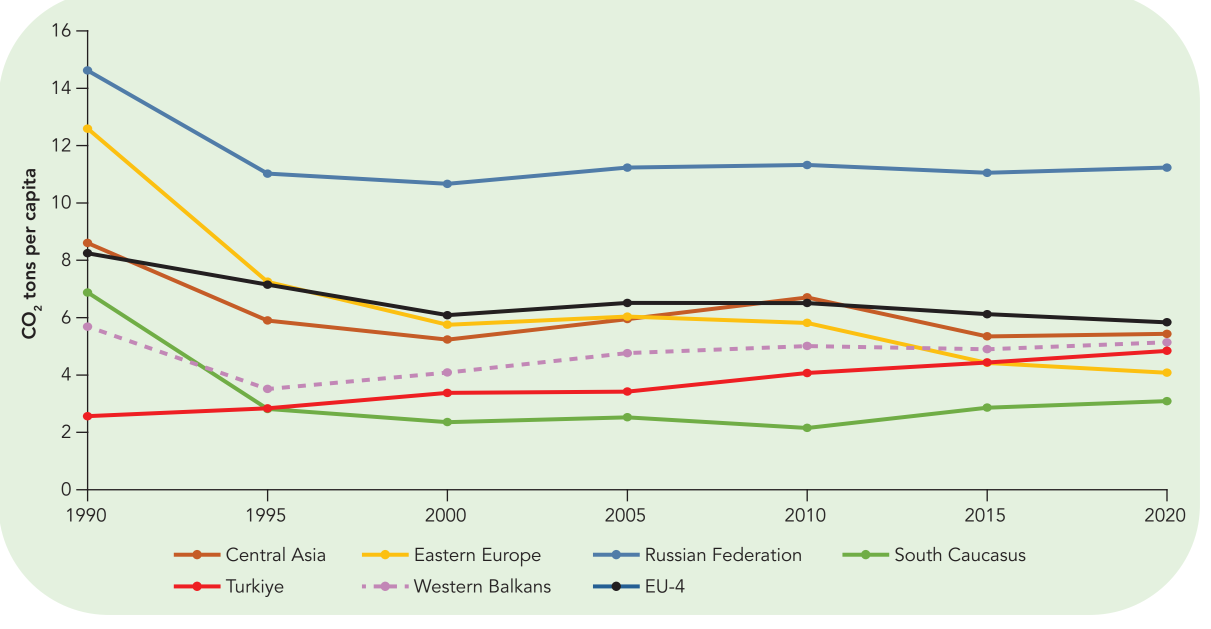
ECA's carbon emissions intensity amounted to about 0.3 kg of CO_2 per unit of GDP in 2020 (in 2017 US dollars at PPP), higher than that of South Asia and LAC, but lower than that of MENA (0.35 kg), and EAP (0.42 kg). The intensity of carbon emissions varies widely across ECA countries. Energy exporters, such as

FIGURE 3. Correlation between per capita carbon emissions and per capita GDP in Europe and Central Asia



Source: World Development Indicators database (https://databank.worldbank.org/source/world-development-indicators#), accessed September 10, 2023.
Note: Values are average for 2010–21. Data on Kosovo were not available.

FIGURE 4. Per capita carbon emissions in Europe and Central Asia, by subregion, 1990–2020



Source: World Development Indicators database (https://databank.worldbank.org/source/world-development-indicators#), accessed September 10, 2023.
Note: the graph plots the evolution of carbon dioxide emissions per capita (in metric tons) across different subregions over the period 1990–2020. EU-4: Bulgaria, Croatia, Romania, and Poland.

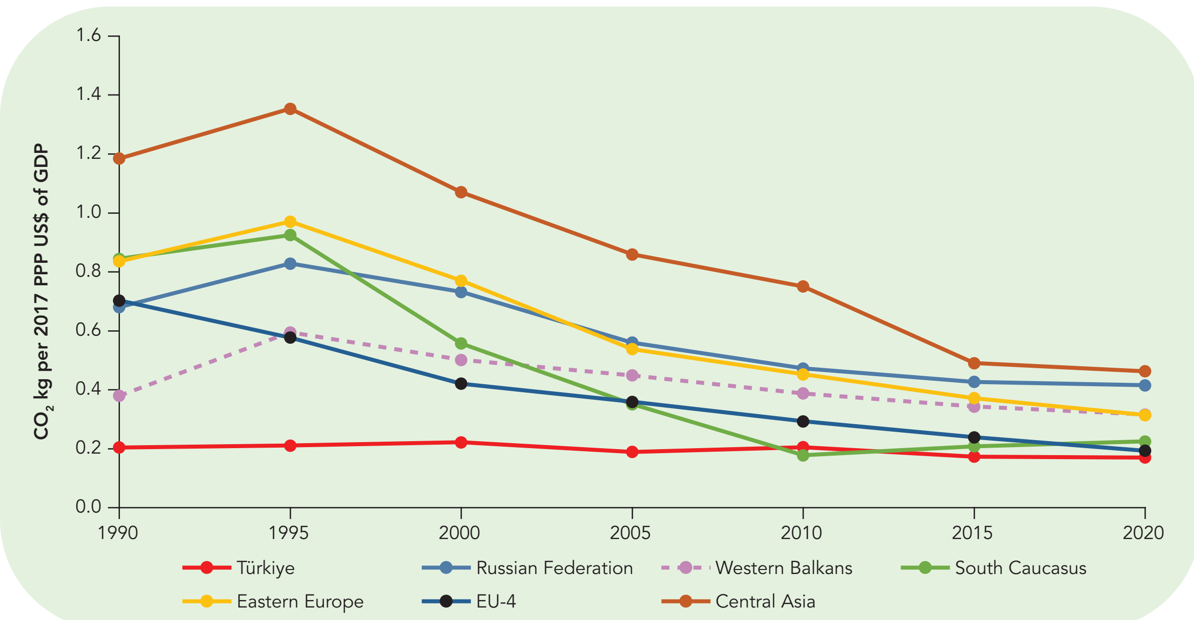
Russia, Kazakhstan, and Turkmenistan, tend to have higher carbon emissions per unit of GDP. Belarus, Bosnia and Herzegovina, Serbia, Ukraine, and Uzbekistan have emission intensities that also exceed ECA average.

Emissions and economic output have begun to diverge. Between 2000 and 2020, GDP in ECA grew by about 108 percent, and the region's emission intensity fell by half. This reduction was greater than the average for the OECD and all other world regions during this period. The historical trends of emission intensities also vary across ECA subregions (Figure 5). Carbon intensities significantly declined in Eastern Europe, Central Europe, Central Asia, the Western Balkans, the South Caucasus, and Russia. They remained flat or declined slightly in the rest of the region.

ECA's emissions are high partly because the region relies heavily on fossil fuels. Even after excluding fossil fuel–dependent Russia, oil accounts for 43 percent of the region's energy consumption, largely as a result of its pervasive use in transport and industry; natural gas accounts for 22 percent and coal 7 percent. Overall, almost 75 percent of ECA's energy consumption is based on fossil fuels (Figure 6).

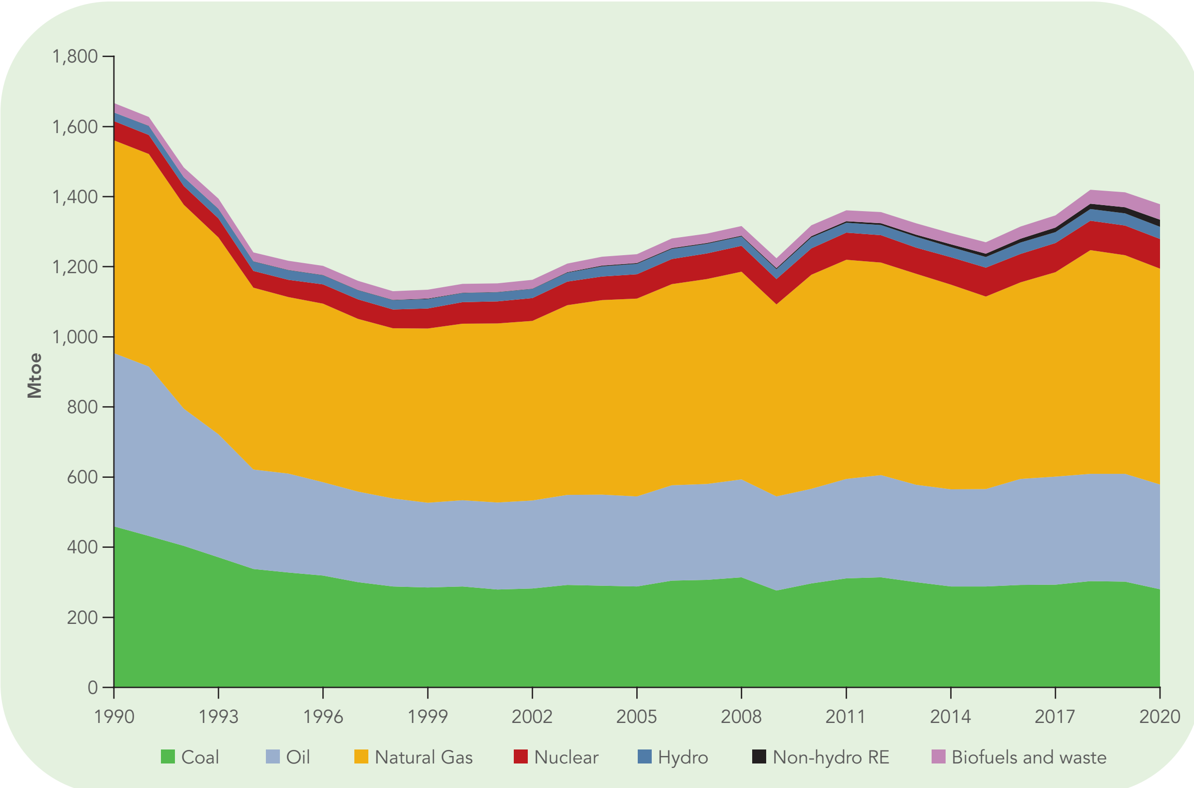
Coal is the largest source of carbon emissions in the region, accounting for 42 percent of emissions in ECA (excluding Russia). Without deliberate action, coal will continue to provide up to a third of the region's energy for decades, thus contributing markedly to carbon emissions (World Bank forthcoming a).

FIGURE 5. **Carbon emissions intensities in Europe and Central Asia, by subregion, 1990–2020**



Source: World Development Indicators database (https://databank.worldbank.org/source/world-development-indicators#), accessed September 10, 2023.
Note: the graph plots the evolution of carbon dioxide emission intensity (in kg of CO_2 per dollar of 2017 GDP PPP) over the period 1990–2020. EU-4: Bulgaria, Croatia, Romania, and Poland.

FIGURE 6. Total energy supply in Europe and Central Asia, by source, 1990–2020



Source: IEA energy balances.
Note: Non-hydro RE = non-hydroelectric renewable energies

About two-thirds of electricity generation in ECA countries is derived from natural gas and coal. Natural gas accounted for 35 percent of electricity generation in 2020, a much larger share than global average of about 25 percent. Coal contributed 28 percent, slightly below the global average of about 36 percent but above the levels in the United States (around 20 percent).

Because of ECA's cold climate, heating accounts for 24 percent of regional energy demand, 83 percent of which comes from fossil fuels (57 percent from natural gas, 24 percent from coal, and the rest from biomass). The heating sector is responsible for about 22 percent of the region's GHG emissions.

ECA countries that are net energy and hydrocarbon exporters also contribute indirectly to global emissions through their exports. ECA's share of global fossil energy extraction (16 percent) is much larger than its share of emissions (9.5 percent), a pattern also observed in other large extractive economies, including those in MENA. Within ECA, Russia is the largest extractor, accounting for 74 percent of the region's hydrocarbon output (12 percent of global emissions accounted for in this way**)**.

Large energy subsidies partly explain the region's high carbon intensity and continued dependence on fossil fuels. Fossil fuel subsidies in ECA amounted to about $110 billion in 2020 (3.6 percent of regional GDP). Russia accounted for $78 billion (5.2 of GDP). Azerbaijan, Kazakhstan, and Ukraine each provided energy subsidies in 2020 worth more than 4 percent of GDP. By comparison, the EU countries excluding Poland spent $25 billion on fossil fuel subsidies in 2020 (0.2 percent GDP). In 2022, governments across the European Union and ECA increased energy subsidies following the surge in energy price; by mid-2023, the volume of subsidies had been significantly reduced, however, and actual expenditure was less than original planned, thanks to the mild winter of 2022–23.[2]

Underpricing of fossil fuels results in additional costs. When the social costs of global warming, local pollution, congestion, road accidents, and lost revenue from underpricing are added in, the total costs of underpricing fossil fuels in the EMDEs in ECA exceeded $800 billion in 2020—almost 27 percent of regional GDP, or $2,023 per person (Table 1).

In terms of the absolute amount of fuel subsidies, resource-rich Russia leads all ECA economies, with $77.4 billion (5.2 percent of GDP) a year spent on fossil fuel subsidies in 2020 and $522.6 billion (34.8 percent of GDP) lost from total underpricing costs. Türkiye spent $4.1 billion (0.6 percent of GDP) on fossil fuel subsidies in 2020, and its underpricing of fossil fuels totaled $116.7 billion (15.9 percent of GDP). Fossil fuel subsidies accounted for 5.9 percent of GDP in Kazakhstan, 5.0 percent in Ukraine, 4.6 percent in Azerbaijan, and 3.5 percent in Bulgaria. The full costs of underpricing amounted to a staggering 33.6 percent of the GDP in Azerbaijan, 28.3 percent in Ukraine, 28.0 percent in Kazakhstan, and 9.5 percent in Bulgaria.

The 2022 energy price shock and its implications for energy security

The jump in natural gas and wholesale electricity prices in 2022 resulted in the largest energy shock to the European Union and ECA since the 1970s. The steep price hike reflected mainly the substantial reliance on Russian natural gas, and the coupling of Asian and European markets (Figure 7). These events occurred as the region recorded a solid post-pandemic economic recovery in 2021, accompanied by an increase in energy demand but lower-than-usual natural gas reserves. As a result of the coupling of gas and electricity prices (because in many European countries the last unit of electricity dispatched runs on natural gas), whole electricity prices also rose.[3] Those price increases negatively affected energy-dependent sectors of the economy, pushed inflation to multi-decade highs, and curbed the mitigation policies of ECA countries.

2. In Türkiye, eliminating the coal subsidy of about $475 million in 2020 to coal-fired plants could reduce GHG emissions by as much as 5 percent without a significant loss in GDP (World Bank 2022c)

3. Because most countries in the region still rely on fossil fuels to meet their power demand, the final price of electricity is often set by the price of coal or natural gas. If gas becomes more expensive, electricity bills inevitably rise, even if clean, cheaper sources also contribute to the total energy supply. Gas sets the price of electricity, because the electricity price in every half-hour period is set by the marginal cost of the last generating unit to be turned off to meet demand, which is invariably a gas power plant with high marginal costs.

TABLE 1. **Underpricing of fossil fuels in Europe and Central Asia, by country, 2020**

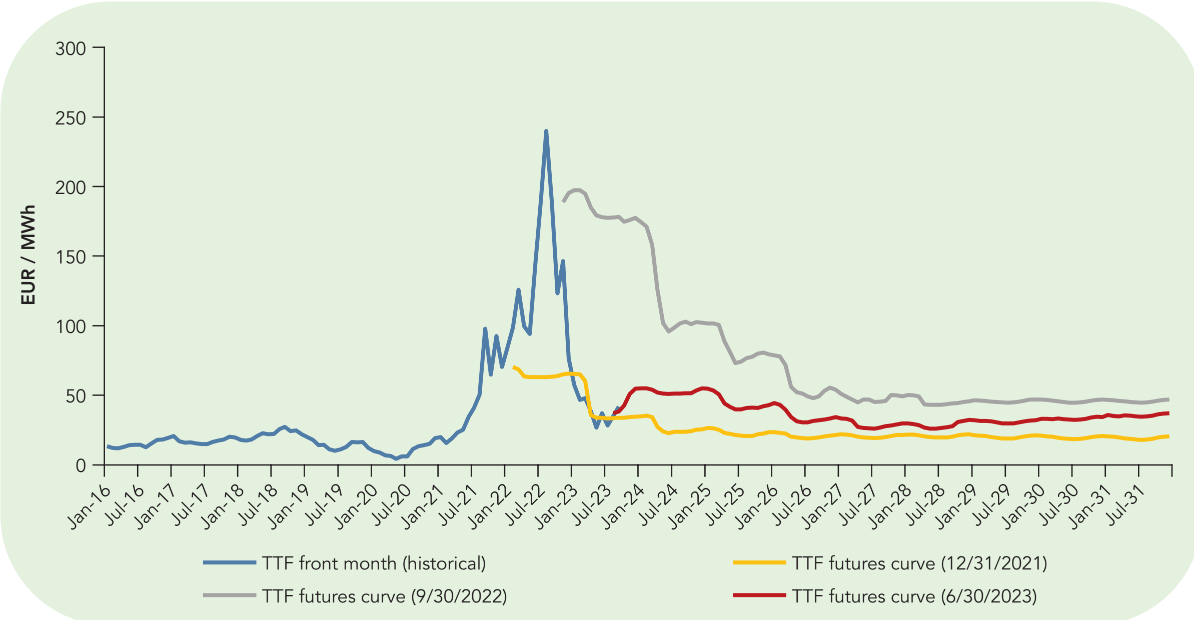
	Subsidies			Additional social costs	All underpricing			Domestic costs[a]		
Country	Billions of dollars	Percent of GDP	Dollars per capita	Billions of dollars	Billions of dollars	Percent of GDP	Dollars per capita	Billions of dollars	Percent of GDP	Dollars per capita
Russian Federation	77.4	5.2	527	445.3	522.6	34.8	3,560	430.9	28.7	2,935
Kazakhstan	9.9	5.9	526	37.1	47.0	28.0	2,489	27.2	16.2	1,443
United Kingdom	8.3	0.3	124	15.3	23.6	0.9	352	16.8	0.6	251
Ukraine	7.8	5.0	187	35.9	43.6	28.3	1,052	35.2	22.8	849
Poland	4.4	0.7	117	27.6	32 0	5.3	844	20.6	3.4	542
Türkiye	4.1	0.6	49	112.6	116.7	15.9	1,387	96.0	13.1	1,141
Germany	3.4	0.1	41	68.3	71.7	1.9	863	47.1	1.2	566
Italy	2.9	0.2	49	37.8	40.7	2.1	676	32.1	1.7	533
Bulgaria	2.5	3.5	357	4.1	6.6	9.5	956	5.1	7.2	732
Azerbaijan	2.0	4.6	200	12.6	14.6	33.6	1,445	12.9	29.7	1,274
Total 10 countries	122.7	1.0	219	796.6	919.3	7.8	1,644	723.8	6.1	1,294
All ECA and EU	138.9	0.6	151	975.6	1,114.6	5.0	1,211	867.5	3.9	942
ECA EMDE	109.7	3.6	274	700.4	810.1	26.9	2,023	646.4	21.5	1,614
Of which:										
Resource-rich	96.3	4.9	383	530.7	627.0	31.6	2,493	496.6	25.0	1,974
Other	13.4	1.3	90	169.7	183.1	17.9	1,229	149.8	14.6	1,006
Advanced economies	29.2	0.2	56	275.2	304.4	1.6	585.4	221.1	1.1	425
ECA percent of:										
Top 10 countries	88.3			81.6	82.5			83.4		
EMDE	79.0			71.8	72.7			74.5		
Resource-rich EMDE	69.3			54.4	56.3			57.2		

Sources: Barbier (2023); estimates of fossil fuel underpricing are from Parry, Black, and Vernon (2021).
Note: a. Domestic costs are fossil fuel subsidies plus domestic social costs (local pollution, congestion, road accidents, and lost tax revenues).

The energy shock redefined the region's understanding of energy security and underscored the crucial importance of both diversifying the sources of energy supply and reducing reliance on imported fossil fuels. Energy security involves striking a balance between meeting current energy needs and ensuring future access to energy resources. It refers to the uninterrupted physical availability of energy supplies at an affordable price while respecting environmental concerns. According to this definition, energy security is not yet ensured for the 2023–24 winter, as gas shortages are possible in countries with limited gas storage or with poor access to LNG terminals. Storage cover is 12 percent in the Western Balkans; 19 percent in Bulgaria, Croatia, Poland, and Romania; and 25 percent in the European Union as a whole (World Bank forthcoming 2023a).

As a result of the energy shock, reestablishing energy security became a new objective for many countries in ECA. Efforts to improve energy security

FIGURE 7. Historical and futures prices of natural gas at the Dutch Title Transfer Facility, 2016–31



Source: ICE Endex.

can be aligned with efforts to decarbonize economies and achieve stronger long-term economic growth. The clean energy transition—which involves scaling up the development of domestic renewable energy, using energy efficiently, and supplementing these policies with effective energy trade policies—will help decarbonize the energy sector and make countries more energy secure. Adopting new technologies is also an opportunity to boost economic growth, which in many countries has languished to the lowest levels in three decades. In fact, without decarbonization, ECA's long-term economic prospects look challenging: no economic model based on fossil fuels makes economic sense over a longer horizon, primarily because global efforts toward net-zero emissions will reduce fossil fuel demand, with significant impacts on fossil fuel–exporting countries; the surging adoption of greener technologies will improve competitiveness for early movers; and the trend toward carbon taxes on imports, such as the introduction of the Carbon Border Adjustment Mechanism by the European Union, is growing.

The economic case for mature, clean energy technologies is strong, according to the International Energy Agency (IEA 2023b). Early findings of the World Bank's Country Climate Development Reports (CCDRs) indicate that economic growth is similar to or faster in low-carbon development scenarios than in the reference scenarios, assuming policies are well designed and a supportive environment is in place. By 2050, the low-carbon development scenarios explored in the CCDRs reduce countries' GHG emissions by 73 percent from current levels. In most countries, economic growth in these scenarios is expected to be similar to or even higher than in the reference scenario by 2030.

A longer-term structural shift toward clean energy (mostly renewables and nuclear) is taking place in ECA (despite the short-term shift to coal). In December 2022, the IEA estimated that the gas supply gap for 2023 in Europe had already been halved, through diversification from Russian energy markets, energy-saving measures, and the accelerated deployment of renewables and heat pumps. The energy crisis is far from over, however, as numerous measures to support households, including many subsidies, remain in place, and there is still substantial uncertainty about the long-term supply of natural gas.

World Bank modeling suggests that between 2024 and 2030, energy consumption in ECA excluding Russia will rely more on renewables, coal, and nuclear energy and less on oil and gas (World Bank forthcoming a). Phasing out coal will require stronger policy actions. Natural gas consumption in the region has already peaked and is set to decline, but gas is expected to continue to play an essential role in the clean energy transition because of its balancing properties. Increasingly competitive renewable energy generation enables countries to increase the share of domestic energy resources and to reduce their dependency on imported fossil fuel.

Policies to green the ECA economy

ECA countries have set short-term and long-term targets for reducing their GHG emissions. Short-term targets (to be achieved by 2030) are reflected in each country's Nationally Determined Contribution (NDC) under the Paris Climate Accord.[4] Long-term net-zero emissions targets are set for 2050, 2053, or 2060.

Most countries have set unconditional NDCs as the percentage reduction in emissions below the 1990 (base year) level. Some countries use different years for their base year: Turkmenistan and Uzbekistan used 2010, and Türkiye used 2012 (Table 2). Some countries set very high unconditional NDCs. They include North Macedonia (82 percent), Russia (70 percent), and Moldova (70 percent). EU member countries set NDCs of 55 percent. Countries with lower NDCs include Kazakhstan (15 percent), the Kyrgyz Republic (16 percent), Turkmenistan (20 percent), and Albania (21 percent).

The date for reaching a net-zero target varies across countries. Türkiye intends to do so by 2053 and Russia and Kazakhstan by 2060. Some countries, especially those in the Caucasus, Central Asia, and the Western Balkans, have not yet announced their net-zero emission target dates. All EU member countries, the United Kingdom, and the Kyrgyz Republic have announced that they intend to reach net zero by 2050.

Investments to green the economy

The energy transition will require substantial investments. According to a World Bank study (2023b, iv), "To finance a just transition that is consistent with

4. Unconditional NDCs are targets that countries commit to meet with their own resources. Conditional NDCs are targets they commit to meet if they receive international financial and technical support.

TABLE 2. Climate change mitigation targets and policies in Europe and Central Asia, by country

Country/subregion	NDC target (percent reduction from baseline)[a]		Net-zero emissions target year	Carbon tax	Emissions trading system	FiT for RET[b]	Removal of fossil fuel subsidy
	Unconditional	Conditional					
Central Asia							
Kazakhstan	15	25	2060		✓		
Kyrgyz Republic	16	44	2050				
Tajikistan	30–40	40–50	Not set				
Turkmenistan	20 (2010)	—	Not set				
Uzbekistan	35 (2010)	—	Not set				✓
Central Europe and Baltic Countries							
Bulgaria	55	—	2050		✓	✓	
Croatia	55	—	2050		✓	✓	
Czech Republic	55	—	2050		✓	✓	
Estonia	55	—	2050	✓	✓	✓	✓
Hungary	55	—	2050		✓	✓	
Latvia	55	—	2050	✓	✓	✓	
Lithuania	55	—	2050	✓	✓	✓	
Poland	55	—	Not set		✓	✓	
Romania	55	—	2050		✓	✓	
Slovak Republic	55	—	2050		✓	✓	
Slovenia	55	—	2050		✓	✓	
Eastern Europe							
Belarus	35	40	Not set			✓	
Moldova	70	—	Not set			✓	
Ukraine	65	—	2060	✓		✓	✓
Northern Europe							
Norway	50	—	2050	✓		✓	
Denmark	55	—	2050	✓	✓	✓	✓
Finland	55	—	2050	✓	✓	✓	✓
Sweden	55	—	2050	✓	✓	✓	
Russian Federation	70	—	2060			✓	✓
South Caucasus							
Armenia	40	—	Not set			✓	
Azerbaijan	35	—	Not set			✓	
Georgia	35	50–57	Not set			✓	
Southern Europe							
Cyprus	55	—	2050		✓	✓	
Greece	55	—	2050		✓	✓	
Italy	55	—	2050		✓	✓	
Malta	55	—	2050		✓	✓	
Portugal	55	—	2050	✓	✓	✓	
Spain	55	—	2050	✓	✓	✓	
Türkiye	41 (2012)	—	2053			✓	

(Continued next page)

TABLE 2 (continued)

Country/subregion	NDC target (percent reduction from baseline)[a] Unconditional	Conditional	Net-zero emissions target year	Carbon tax	Emissions trading system	FiT for RET[b]	Removal of fossil fuel subsidy
Western Balkans							
Albania	20.9 (2016)	—	Not set			✓	
Bosnia and Herzegovina	33.2	36.8	Not set			✓	
North Macedonia	82	—	Not set			✓	
Montenegro	35	—	Not set			✓	
Serbia	33.3	—	Not set			✓	
Western Europe							
Austria	55	—	2050		✓	✓	
Belgium	55	—	2050		✓	✓	
France	55	—	2050	✓	✓	✓	
Germany	55	—	2050	✓	✓	✓	
Ireland	55	—	2050	✓	✓	✓	
Luxembourg	55	—	2050	✓	✓	✓	
Netherlands	55	—	2050	✓	✓	✓	
United Kingdom	68	—	2050	✓	✓	✓	

Source: NDC Registry (https://unfccc. Int/NDCREG), accessed in September 2023; Timilsina (2022).
Note: — = No target.
a. Base year is 1990, except where otherwise indicated.
b. FiT for RET = feed-in tariff for renewable energy target.

both the goals of ensuring universal access to affordable, reliable, sustainable, and modern energy by 2030, and the 2015 Paris Agreement on Climate Change, developing countries will have to mobilize far more capital than they do today". Power sector investment in developing countries excluding China will have to quadruple, from an average of $240 billion a year in 2016–20 to $1 trillion a year in 2030. Kazakhstan will require about $1,150 billion of investment between 2025 and 2060 (6 percent of cumulative discounted GDP) to decarbonize its energy system to reach net zero by 2060 (World Bank 2022b).[5] Türkiye will require about $644 billion (around 4.8 percent of cumulative discounted GDP) through 2040 to reach net zero (World Bank 2022c). Uzbekistan will require $341 billion (3.8 percent of GDP per year) to reach decarbonization by 2060 (World Bank 2023c). The countries in the Western Balkans need to spend an additional $19.7 billion (1.4 percent of GDP a year) until 2050 to achieve net-zero (World Bank forthcoming b).

Public investment is likely to be substantial—and the four EU countries in ECA will benefit from access to funding for the National Recovery and Resilience Plans (NRRPs)— but the private sector will need to provide about 70–80 percent of the total global investment in decarbonization.[6] Governments will need to help shift the financing of the green transition to market-based approaches.

5. This figure as well as similar figures for other countries includes both capital investment and consumption (such as the acquisition of private electric vehicles by households).
6. See Ananthakrishnan and others (2023) for the 80 percent figure and IEA (2021) for the 70 percent figure.

To achieve the net-zero GHG emissions targets by 2050, the European Union approved its Green Deal in 2020. In addition to committing to invest in low-carbon energy and energy efficiency, it includes ambitious green goals for the construction, biodiversity, energy, transport, and food sectors (Box 1). The Green Deal Investment Plan is widely seen as the European Union's response to the Inflation Reduction Act (IRA), adopted by the United States in August 2022. The IRA will channel $369 billion to green investments in the United States by providing generous tax credits and other subsidies for US electric vehicles and renewables (Barbanell 2022; Kirkegaard 2023; Rodgers, Pullins, and Dunham 2022).

Investments in energy infrastructure also have the potential to support both climate mitigation and adaptation. Increasing energy efficiency in buildings reduces GHG emissions and prepares buildings to withstand the challenges posed by a changing climate. Renewable energy systems such as solar and wind can ensure a more resilient energy supply during extreme weather events or

BOX 1 The European Union's Green Deal Investment Plan

Launched February 1, 2023, the Green Deal Investment Plan is the central investment mechanism of the European Union's Green Deal. It is based on four pillars: a predictable and simplified regulatory environment, faster access to funding, the enhancement of skills, and open trade for resilient supply chains. The plan would make €250 billion ($272 billion) available from existing EU funds through a proposed European Sovereignty Fund that would provide tax breaks to European businesses investing in net-zero technologies.

Clean energy infrastructure investment is the key element of the EU Green Deal. It allocates just over $30 billion to clean electricity, heat generation and storage, and upgrading of transmission or hydrogen infrastructure. This spending is greatest in France, Germany, and the United Kingdom. Public support for research and development (R&D) on clean energy ($26 billion) and energy efficiency and upgrades ($25 billion) are also large components of green recovery packages. France, Spain, and Germany invest the most in clean R&D; France, the United Kingdom, and Germany allocate the largest amounts to increasing the efficiency and improving buildings Much less funding is allocated to restructuring agriculture, forestry, and fishing ($540 million) and worker retraining, and job creation ($333 million). Investments in nature—or "natural infrastructure"—receive $14.7 billion in green recovery packages. They include investments in public parks, green spaces, national parks, tree planting and biodiversity protection, ecological conservation initiatives, and ecological system services (O'Callaghan, Murdock, and Yao 2021).

Other initiatives in the plan include the following:

- The Net-Zero Industry Act would create a simplified regulatory framework for producing batteries, wind turbines, heat pumps, and solar and carbon capture and storage.
- The Critical Raw Materials Act would seek to ensure sufficient access to rare earths and other vital materials for manufacturing key technologies.
- The Temporary State Aid Crisis and Transition Framework would simplify and streamline the process of providing state aid for funding clean energy technologies through 2025.

These proposals are in addition to existing green funding streams, including (a) Next Generation EU (the European Union's COVID-19 recovery program), which requires that member states allocate at least 37 percent of their received funds to the green transition, and (b) the Horizon Europe Program, which provides funding streams dedicated to Green Deal–related research and innovation.

Source: European Commission (2023).

disasters, especially in remote or vulnerable regions. Energy storage enables the integration into the grid of intermittent renewable energy sources while providing backup power during outages, increasing resilience against extreme weather events or other disruptions. Transitioning from oil and coal burning to natural gas for energy generation reduces GHG emissions and the amount of water needed for generation, making it more adaptable in regions facing water scarcity. Demand response systems improve energy efficiency and help prevent overloads during extreme weather events.

Pricing policies

Reforming fossil fuel subsidies

Subsidies for fossil fuels are among the greatest market disincentives for decarbonization and the green transition. The underpricing of fossil fuels occurs in two ways. First, market prices paid for fossil fuels do not include externalities, such as the climate change damages from GHG emissions and local air pollutants that cause illness and deaths or result in other social costs. Second, in many countries, exploration, production, and consumption subsidies artificially lower the costs of supplying fossil fuels or the prices paid for them and their key products (electricity, diesel, and gasoline). These subsidies mean that the playing field between fossil fuel and clean energy investments is not level, substantially increasing the attractiveness of investing in and using these sources of energy rather than clean energy alternatives.

Fossil fuel subsidies also tend to be inequitable, especially in EMDEs, where it is mainly wealthier, urban households that benefit from them (Arze del Granado, Coady, and Gillingham 2012; Barbier 2023; de Gouvello, Finon, and Guigon 2019; Timilsina and Pargal 2020).

Removing fossil fuel subsidies should be complemented by social protection policies to protect vulnerable households, without which energy subsidy reform will not enjoy widespread public support (World Bank 2023a). To prevent energy poverty for vulnerable households when the price of fuel and electricity rises, ECA countries could consider a tapered benefit approach in which the level of support is tied to household income and energy use characteristics. This approach could assist a broad group of low- and lower-middle-income households. The benefit could be designed to maintain the ratio of the cost of energy consumption to income at a level that prevents energy poverty. This approach combines information about household resources and an allowance for a basic minimal volume of energy consumption (normative consumption) that depends on household characteristics and the type of fuel used. When the ratio of the basic energy allowance to income exceeds a certain threshold, it triggers eligibility and determines the level of assistance. The remaining benefit parameters determine the level of mandatory out-of-pocket payments, based on a sliding scale that increases with income. Tapered assistance can be provided as cash, especially in rural areas. Such a design could perform well with appropriate targeting and administrative capacity. Countries with low administrative capacity could scale up existing programs, providing top-up benefits. Doing so would result in better adequacy of protection for the most vulnerable groups, although it would not fully cushion the impact of energy poverty. A lifeline tariff could be paired with an energy benefit top-up to existing benefits (World Bank 2022c).

Pricing carbon

Among the ECA EMDEs, very few have adopted carbon pricing. Yet, carbon pricing (a carbon tax or an emission trading system [ETS]) is the most common pricing policy used to reduce GHG emissions in ECA. Seventeen advanced European economies have adopted some form of carbon tax.[7] Austria, Germany, Switzerland, the United Kingdom, and the European Union have also developed ETSs. The European Union is exploring adopting a new scheme for additional economic sectors. A reform introduced in December 2022 includes a tighter cap on the existing scheme for electricity, industry, and aviation and a phase-in of the maritime sector beginning in 2024. A phase-out of the free allocation of allowances for the industrial sector will be accompanied by a phase-in of the Carbon Border Adjustment Mechanism (CBAM) by 2026.[8] The European Union also plans to introduce a new ETS for buildings, road transport, and process heat in industry in 2027 or, if energy prices remain high, in 2028.[9]

The CBAM aims to reduce the competitiveness risk of EU producers. It deters EU businesses from transferring production to countries with laxer emission constraints and then importing goods and services back to Europe (Böhringer and others 2022; Clausing and Wolfram 2023; Cosbey and others 2019; Hamer, Gambaro, and Basilisco 2022; Hufbauer and others 2022). CBAM levies are expected to be fully implemented by January 1, 2026. The mechanism may also be expanded to all products covered by the European ETS.

There is concern that the CBAM will impose an increasingly heavy burden on trading partners, including other ECA countries, as its coverage expands to a broader range of goods and services and the price of CBAM certificates rises (Hufbauer and others 2022). The CBAM for cement, iron and steel, aluminum, fertilizer, and electricity could significantly affect exports to the European Union by Russia, Serbia, Türkiye, Ukraine, and the United Kingdom (Hamer, Gambaro, and Basilisco 2022). For Türkiye, for example, although the European Union absorbs 49 percent of the country's exports, only 4 percent are likely to be covered by the CBAM. But 37 percent of Türkiye's iron and steel exports are to the European Union and will be covered by the CBAM (World Bank 2022c).

Kazakhstan and Montenegro have introduced ETSs. Kazakhstan launched its ETS in 2013; it suspended it in 2016–17 to tackle operational issues and reform allocation rules. Challenges included inadequate monitoring, reporting, and verification system for tracking GHG emissions; lack of liquidity; and the severe price volatility of allowances and trades (Howie and others 2020). In 2021, Kazakhstan sought to reform and relaunch its ETS, with the assistance of the World

7. The countries are Denmark, Estonia, Finland, France, Iceland, Ireland, Latvia, Luxembourg, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.
8. The CBAM is a levy imposed on imported goods in key energy-intensive and trade-exposed industries, such as aluminum, cement, iron and steel, fertilizers, hydrogen, and electricity.
9. See the World Bank's Carbon Pricing Dashboard (https://carbonpricingdashboard.worldbank.org/map_data), updated March 31, 2023.

Bank's Partnership for Market Readiness (Marteau 2021; PMR 2021; World Bank 2022a). Montenegro officially launched its ETS in 2022, but operation of the scheme was delayed and disrupted. The government is expected to relaunch the scheme in late 2023.

Some EMDEs are exploring adopting an ETS as part of their pre-accession alignment with the European Union or to preempt possible penalties imposed by the European Union's CBAM. Countries planning or considering introducing an ETS include Albania, Bosnia and Herzegovina, Georgia, Moldova, Montenegro, North Macedonia, Serbia, Türkiye, and Ukraine.[10] Türkiye has been working with the World Bank's Partnership for Market Readiness Program to develop a monitoring, reporting, and verification system in the energy, cement, and refinery sectors in preparation for establishing an ETS (PMR 2021), with the possible launch of a pilot scheme in 2024. Türkiye will need to implement an ETS scheme to attain a price of $211/ton of CO_2 by 2040 to achieve its 2053 net-zero commitment (World Bank Group 2022b).

Carbon pricing faces political and other barriers. Despite the overwhelming evidence of the harm caused by underpricing fossil fuels, many ECA governments resist ending subsidies and adopting carbon pricing. One of the biggest obstacles is the widespread perception among some policy makers that doing so is bad for economic growth. In fact, recent studies find that such reforms reduce neither GDP nor employment (Frey 2017; Martin, de Preux, and Wagner 2014; Metcalf 2019; Metcalf and Stock 2020; Muresianu 2023; Timilsina 2022). Metcalf and Stock (2020) examine the dynamic effect of carbon pricing on GDP growth and employment in countries participating in the EU ETS. They find a positive impact on employment growth immediately after and up to five years after implementation.

Once co-benefits are considered, the benefits of the carbon tax are much higher than its costs. Timilsina (2022) presents several cases in which other environmental benefits offset the costs of the carbon tax. Other researchers report such findings for China (Wei and others 2020); the European Union (Chen and others 2020; Vandyck and others 2018); and the United States (Saari and others 2015). These benefits occur because a carbon tax reduces the consumption of fossil fuels, which are also sources of other pollutants, such as particulate matter with a diameter of 2.5 microns or less (PM2.5); volatile organic compounds; sulfur dioxide (SO_2); oxides of nitrogen; and GHGs. Taheripour and others (2023) simulate two policy scenarios corresponding to the carbon prices necessary to reach the 2°C and 1.5°C global warming targets. The 2°C target is captured through a global carbon price of $75 per ton of CO_2 equivalent (tCO_2e); the 1.5°C target is achieved with a $150 per tCO_2e imposed on CO_2 emissions from fossil fuel–combusting activities, including by households.[11] At a global carbon price of

10. For details on the state of these plans, see the World Bank's Carbon Pricing Dashboard (https://carbonpricingdashboard.worldbank.org/map_data), updated March 31, 2023.

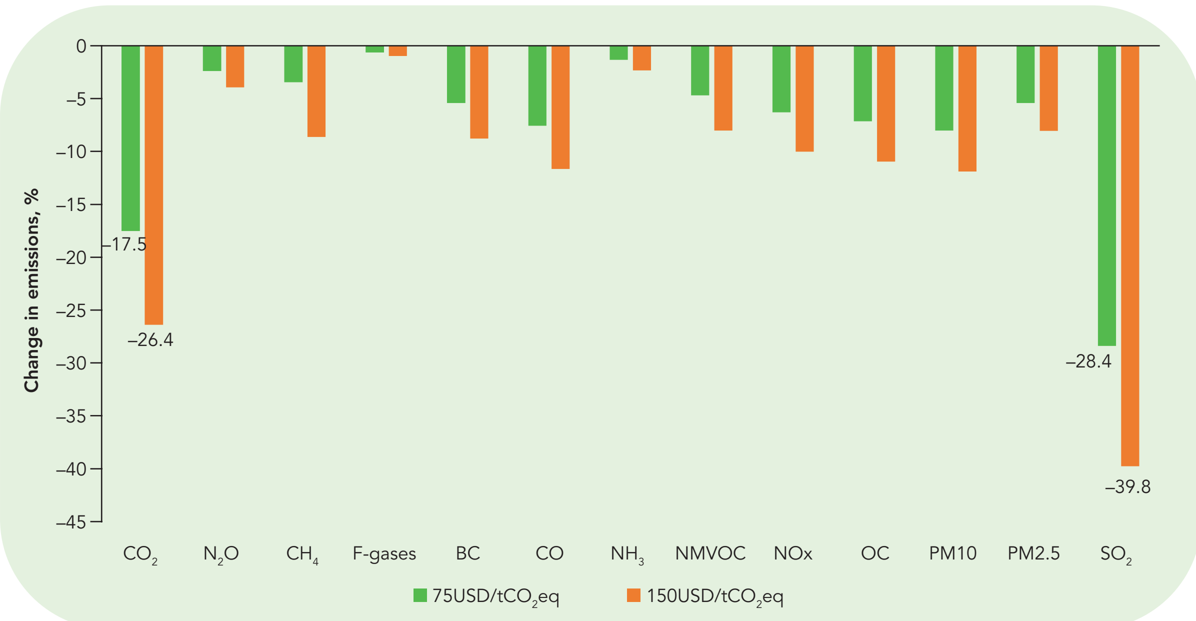
11. This level of carbon pricing is also close to the interpretations of the 2ºC–consistent mitigation efforts under the Paris Agreement (Chepeliev, Osorio-Rodarte, and Van Der Mensbrugghe 2021). A $150/$tCO_2e$, carbon price is consistent with the 95th percentile of the social cost of carbon (SCC) in the United States, which is $152 (US Government 2021). These rates are in line with previous studies' estimates of what is needed to achieve a 50 percent reduction in global GHG emissions with multi-gas mitigation coverage (Peña-Lévano, Taheripour, and Tyner 2019).

$75/tCO$_2$eq, CO_2 emissions in the ECA region (including the European Union) decline by 17.5 percent; at a $150/tCO$_2$eq price, the reduction is 26.4 percent (Figure 8). Other global economic models—such as the model of Böhringer and others (2021)—report similar results.

Reduction of sulfur dioxide (SO_2), a pollutant with harmful effects on human health and the environment, could be greater than the reduction of CO_2, which a carbon tax targets. A carbon tax of $150/tCO$_2$ could reduce SO_2 emissions by almost 40 percent from the baseline, as a result of reductions in coal power generation. The tax would disproportionately benefit countries that are heavily dependent on coal, such as Bulgaria, the Czech Republic, Hungary, Romania, Türkiye, and Ukraine. These countries would see 50 percent reductions of SO_2 at $75/tCO$_2$e and a reduction of more than 65 percent at $150/tCO$_2$e. A $150/tCO$_2$ tax would also reduce particulate matter (PM2.5 and PM10) by more than 10 percent from the baseline.

Reductions in these pollutants would reduce premature mortality. Taheripour and others (2023) estimate the number of lives saved each year in EMDE ECA at 39,000 at a carbon tax of $75/tCO$_2$e and 56,00 at a carbon tax of $150/tCO$_2$e. Most saved lives would be in countries with heavy reliance on coal. Russia and Ukraine would account for more than 70 percent of all saved lives in the region, with Ukraine benefitting the most, with 15,800–23,500 lives saved annually,

FIGURE 8. Simulated effect of pricing carbon at $75 and $150 per ton of CO_2 equivalent on emissions in Europe and Central Asia and the European Union, by type of emission



Source: Taheripour and others (2023).
Note: CO_2 = carbon dioxide; N_2O = nitrous oxide; CH_4 = methane; F-gases = fluorinated gases; BC = black carbon; CO = carbon monoxide; NH_3 = ammonia; NMVOC = non-methane volatile organic compounds; NOx = nitrogen oxides; OC = organic carbon; PM10 = particulate matter with a diameter of 10 microns or less; PM2.5 = particulate matter with a diameter of 2.5 microns or less; SO_2 = sulfur dioxide. The CO_2eq unit measures the environmental impact of one tonne of greenhouse gases in comparison to the impact of one tonne of CO_2.

depending on the scenario. Other countries that would experience significant reductions in mortality rates include Poland, Romania, and Türkiye, each saving at least 2,000–3,400 lives annually under the \$150/tCO_2e carbon price scenario.

For carbon pricing policies to be effective, they should ideally be implemented after a reduction in fossil fuel subsidies, not before. Successful implementation of carbon pricing will also depend on the design of the pricing instruments. Acceptance of carbon pricing is likely to be greater if the instruments directly benefit the wider population. Those benefits depend on the design architecture, particularly how the savings from subsidy removal or revenues from carbon taxation are used. If the subsidy savings or carbon tax revenues are used to provide tangible benefits to vulnerable people—through, for example, cash transfers, other forms of income support, healthcare, or education—they are less likely to oppose such reforms (de Gouvello, Finon and Guigon 2019; Harring and others 2023; Sanchez, Wooders, and Bechauf 2020). Lump-sum cash transfers, vouchers, or fixed discounts on utility bills have proved effective in providing income support to households; they seem to be most effective in offsetting the distributional impacts of rising energy prices because of carbon pricing. Implementing such measures to fully offset the consumption losses of the bottom 20 (40) percent of households would have an average annual estimated cost of 0.4 (0.9) percent of GDP in European economies (Ari and others 2022).

Transparency, dissemination of information, and consultation with stakeholders can help smooth the implementation of carbon pricing. Adequate communication and stakeholder consultations help reduce distrust in government that may subvert the implementation of carbon pricing. An analysis of 20 OECD countries (16 from Europe) from 1990 to 2012 finds that more stringent climate policies are strongly linked to perceptions of low levels of corruption and trust in government (Rafaty 2018). Klenert and others (2018) find that countries with greater trust in government and lower corruption were more likely than other countries to adopt higher carbon pricing. An information campaign to improve knowledge of climate change and climate policies and explain the role of carbon pricing as well as consultations with stakeholders would help allay concerns about carbon taxation. The introduction of the carbon tax in Sweden in 1991 was accompanied by a general tax system reform to reduce inequities and considerable stakeholder consultation (Douenne and Fabre 2020; Ewald, Sterner, and Sterner 2022).

Regulatory policies

Regulatory policies can also help achieve emission-reduction targets. They include issuing mandates on energy efficiency; structurally changing energy demand in the heating sector, by retrofitting and establishing building codes for housing; and raising standards for appliances. Improvements in the quality of and access to climate-related data would help private and foreign investors make climate-related decisions. Policies should also include efforts to unbundle integrated electricity and natural gas systems, decommission inefficient assets, and improve the quality of and access to climate-related data to help private and foreign investors make climate-related decisions. These policies would result in better governance and efficiency of utilities as well as better emissions tracking. Better policy frameworks for public-private partnerships and independent power producers are also crucial to improve competition and ensure value for money.

Decarbonizing transport

Decarbonizing transport is very important in ECA, because, according to IEA data, transport is the source of about 17 percent of the region's carbon emissions (the share exceeds 30 percent in the smaller economies of the region). The most impactful measures for reducing emissions from transport are the adoption of electric vehicles and increases in the use of public transport in urban settings. Improving vehicle emission standards is also important.

Given its greater energy efficiency, electric mobility is typically advantageous in carbon terms even before the power grid is fully decarbonized (Briceno-Garmendia and others, 2023). Because of their much higher energy efficiency, electric vehicles are almost always less carbon intensive than their conventional counterparts per vehicle-kilometer traveled. In Kazakhstan and Poland, for instance, carbon emissions per vehicle-kilometer could be cut by as much as half by switching from gasoline to electric power even with the current fossil fuel–intensive electricity supply.

Electric vehicles also reduce local air pollutants such as nitrogen oxides, sulfur oxides, and particulate matter with a diameter of 10 microns or less. In Kazakhstan, Poland, Türkiye, and Ukraine, for instance, the environmental benefits associated with reducing local air pollution are even more significant than those associated with reducing carbon dioxide emissions (Briceno-Garmendia and others 2023).

Complementary policies for a smoother transition

Structural reforms that strengthen macroeconomic fundamentals, deepen capital markets, and improve governance are an essential part of the policy mix to support the greening of ECA's economy. Given the size of the funds needed to implement the green transition and the long horizons for these investments to produce results, domestic and foreign investors need certainty that their property rights will be respected and that the macroeconomic environment will be supportive of their engagement. A conducive macroeconomic and regulatory environment can help lower the cost of capital, increasing the financial resources available.

Sovereign wealth funds are one vehicle for financing the green transition in natural resource–based ECA countries. Such funds can develop and finance strategic investment funds (SIFs) to promote low-carbon transitions by providing equity and other forms of capital to key green domestic sectors and investments where private sector financing is insufficient. Sovereign wealth funds can provide additional capital to SIFs or pool resources to scale up joint investments in low-carbon and clean energy infrastructure and other climate-related investments. Sovereign wealth funds and SIFs can also collaborate with other financial institutions, such as pension funds, banks, and insurance companies, to develop additional climate finance mechanisms.

Countries also need to invest in the skills needed in a greening economy. The green transition will alter the nature of labor demand, shifting labor from sectors intensive in GHG emissions ("brown" jobs) to low-carbon sectors ("green" jobs). The skills required by the two types of jobs differ. Green jobs tend to be more skill-intensive than brown jobs and require higher proficiency in all types of skills (numeracy, literacy, and problem-solving) than brown jobs. Mitigating the transition costs will require active labor market programs for retraining workers whose skill sets are ill-matched to the requirements of green jobs and support for training new workers in appropriate skills. Public employment services as well as mental and physical health services will be needed to respond to the labor market disruption during the green transition. In the medium term, education systems should provide all students with fungible skills to enable lifelong learning to perform different tasks in an increasingly dynamic labor market (Sanchez-Reaza, Ambasz, and Djukic 2023).

The inequality consequences of investment in green sectors also need to be addressed. The move toward green jobs will increase demand for high-skilled workers, and the phasing out of brown energy will adversely affect regions dependent on coal production and regions with energy-intensive industries. Investments in green sectors will accentuate the locational advantages of richer, more dynamic regions with large pools of highly skilled workers (Sanchez-Reaza, Ambasz, and Djukic 2023). The greening of the economy is thus likely to exacerbate regional and household inequality. Policies to address both issues will need to be considered.

Adapting to climate change

Regardless of ECA's success in reducing emissions (mitigating climate change), all countries in the region will need to adapt to it. The cost of inaction is likely to be high. In Uzbekistan, for example, GDP in 2050 is projected to be 10 percent lower than it would have been in the absence of climate impacts (World Bank 2023c). Losses could be 1.9 percent of GDP in the Western Balkans and 3.7 percent of GDP in the North Macedonia (World Bank forthcoming b). The fiscal costs of addressing disasters will absorb valuable resources, crowding out other spending and increasing government debt. Financial sectors will also be strained, as banks reprice risks.

Some economies such as Armenia, Georgia, the Kyrgyz Republic, Moldova, and Tajikistan—which contribute little to global GHG emissions—are heavily exposed to climate change. Large areas of Armenia face drought risk, and some areas, particularly the Ararat and Shirak valleys, face flood risk. Around 40,000 people are affected by flooding each year, costing around $100 million (World Bank and Asian Development Bank, 2021). In Georgia, the number of natural disasters, including heavy precipitation, landslides, earthquakes, and floods, nearly tripled in recent years (Government of Georgia 2017). Given its mountainous terrain, geology, climate, and hydrological features, Tajikistan is highly prone to natural disasters; it has a long history of severe floods, earthquakes, landslides, mudflows, avalanches, droughts, and heavy snowfalls (World Bank

2022d). These countries should develop closer regional interlinkages and use externalities in research and implementation of adaptation policies.

Other countries in ECA are also highly vulnerable to climate change (Box 2).

Some ECA countries are better prepared for climate adaptation than others. Higher readiness indicates better capacity to make effective use of investments for adaptation, thanks to more efficient government administration and more conducive business environments. Data on climate change readiness indicate that the countries of Eastern Europe, Armenia, Belarus, Georgia, and Russia are better prepared to take adaptation actions than other countries in the region. The countries of Central Asia, Moldova, and Ukraine have lower readiness scores (Table 3).

Climate change will have significant impacts on growth in the region unless adaptation capacities increase. Increasing investments in adaptation and strengthening the capacity to plan and implement adaptation and resilience plans and cope with climate and other shocks requires a whole-of-economy approach that combines coordinated sectoral and economy-wide interventions and considers the interplay of investments, policies, institutions, and people. The World Bank's whole-of-economy framework prioritizes the following actions:

- facilitating the adaptation of people and firms
- protecting critical assets
- adapting land use
- helping people and firms manage residual risks and natural disasters
- managing financial and macro-fiscal planning.

BOX 2 Climate change impacts and vulnerability in selected countries in Europe and Central Asia

Kazakhstan

Average annual temperatures in Kazakhstan were 0.3°C–1.4°C warmer in 1997–2010 than in 1971–2000, and they are projected to rise by 1.6°C–5.3°C by the 2090s. As a result, heat waves and severe droughts are expected to occur more frequently, exacerbating land degradation, desertification, and dust storms. Since 2000, more than half of Kazakhstan's land area experienced drought in two out of every five years. Climate impacts such as alterations in river flow patterns, shifts in precipitation, heat stress because of rising temperatures, and an increased occurrence of extreme weather events will reduce Kazakhstan's agricultural outputs, particularly wheat, its major agricultural export.

The irregular and unpredictable nature of climate change could also intensify extreme rainfall, causing more intense and frequent flooding and mudflows. The frequency of mudflows could increase by a factor of 10, posing risks for the 26 percent of the population that live in mountainous areas and other areas prone to mudflows. The rise in the level of the Caspian Sea could lead to coastal erosion.

Kazakhstan faces risks not only from climate change but also from global climate change mitigation measures. The country has experienced

(Continued next page)

BOX 2 (continued)

remarkable economic growth since the start of the 21st century, but the fossil fuel industry was responsible for most of that growth. Efforts by major economies to achieve net-zero emissions are expected to significantly reduce global demand for fossil fuels, leaving Kazakhstan's economy vulnerable to economic losses.

The emissions intensity of Kazakhstan's economy could erode the competitiveness of industries beyond oil and gas. Kazakhstan has an outsized GHG emissions footprint for a country of its economic size; it is the world's 20th-largest emitter in terms of emissions per capita. Emissions rose sharply as the economy expanded, roughly doubling between 2001 and 2018, with electricity and heating accounting for the lion's share of emissions. Demand for oil, gas, and goods produced using Kazakhstan's fossil fuel–intensive energy will likely decline as global climate policies, such as the European Union's CBAM, are implemented.

Türkiye

Türkiye's geographic, climatic, and socioeconomic conditions leave it highly vulnerable to the impacts of climate change. It is vulnerable in 9 out of 10 climate dimensions, a stark contrast to the median vulnerability of 2 out of 10 observed in other OECD countries.

Türkiye's heightened vulnerability partly reflects population exposure (including the fact that a large proportion of the population is exposed to floods and forest fires) and the significance of agriculture in the economy. Its transport system is much more vulnerable to climate change than transport systems in other countries with similar levels of income. Türkiye also grapples with food insecurity; escalating water stress; and an upsurge in unprecedented disaster events, exemplified by the devastating 2021 forest fire season, when 200 wildfires destroyed 1,700 square kilometers of forest in the country's worst-ever wildfire season.

Uzbekistan

Uzbekistan is one of the world's most vulnerable economies to climate change, because of its fragile ecosystems and location in the Aral Sea region, which is highly vulnerable to desertification from increasing dust storms propelled by increasing temperatures. This vulnerability explains why Uzbekistan's average temperature increased twice as much as the global average over the past 70 years, rising 0.29°C every decade since the early 1950s.

Climate change will reduce mountain snow reserves, triggering water scarcity in the spring and summer, when it is needed for irrigation. It will severely affect agriculture, which consumes 90 percent of the national water supply.

Uzbekistan's water productivity ranks among the bottom 20 countries in the world. The decline in agricultural activity will reduce incomes and increase poverty, as nearly one-third of employment is based on agriculture. The country's natural ecosystem has already been stressed by soil degradation, intensive grazing, unsustainable agricultural practices, poor water management, and the degradation of forest belts, all of which climate change will exacerbate.

Earthquakes and floods affect 1.4 million people a year in Uzbekistan, causing almost $3 billion in losses in the country. Severe drought is projected to have similar economic impacts.

Western Balkans

The Western Balkans has seen a surge in heat-related stressors—mainly higher temperatures and intensified droughts—which threaten to undermine stability and productivity in the subregion. The average summer temperature may surge by 7.5°C above pre-industrial levels, potentially resulting in a 5–10 percent increase in heat-related deaths by 2100. This warming will also take a toll on workers. In fact, labor heat stress is projected to be the largest source of economic damages in the Western Balkans, followed by drought (considering the effects on maize and wheat only) and then flooding. Within the Western Balkans, North Macedonia is expected to face the most severe impact, with flooding causing the greatest economic damage.

Sources: World Bank (2022a, 2022b, forthcoming b); MEDPRRU, World Bank, and UNDP (2022).

The World Bank's Adaptation Principles framework highlights the importance of the following factors:

- rapid and inclusive development to ensure that the poor have access to basic infrastructure and services that reduce their exposure to shocks and strengthen their ability to respond to them
- information and incentives (including fiscal and behavioral) to ensure that firms, farms, and households invest in adaptation

TABLE 3. Climate change vulnerability, readiness, and adaptiveness scores in Europe and Central Asia, by country, 2019

Country/subregion	Climate change vulnerability index	Climate change readiness index	Climate change adaptiveness index[a]
Average for emerging market and developing countries in ECA	0.37	0.45	54.1
Central Asia	0.37	0.37	50.1
Kazakhstan	0.34	0.52	58.7
Kyrgyz Rep.	0.34	0.39	52.5
Tajikistan	0.39	0.33	46.9
Turkmenistan	0.40	0.24	42.2
Uzbekistan	0.38	0.38	50.2
Central Europe	0.34	0.54	59.7
Bulgaria	0.34	0.47	56.5
Croatia	0.37	0.50	56.7
Czech Republic	0.29	0.56	63.3
Estonia	0.34	0.62	64.0
Hungary	0.35	0.50	57.4
Latvia	0.38	0.58	60.0
Lithuania	0.36	0.60	61.7
Poland	0.32	0.55	61.5
Romania	0.39	0.43	51.7
Slovak Republic	0.35	0.51	58.1
Slovenia	0.30	0.61	65.8
Eastern Europe	0.37	0.46	54.5
Belarus	0.33	0.52	59.7
Moldova	0.41	0.43	50.7
Ukraine	0.37	0.43	53.0
Northern Europe	0.31	0.70	69.5
Denmark	0.34	0.77	71.6
Finland	0.28	0.75	73.3
Sweden	0.29	0.73	72.2
Russian Federation	0.33	0.55	60.9

(Continued next page)

TABLE 3 (continued)

Country/subregion	Climate change vulnerability index	Climate change readiness index	Climate change adaptiveness index[a]
South Caucasus	0.39	0.51	56.1
Armenia	0.38	0.51	56.5
Azerbaijan	0.40	0.45	52.6
Georgia	0.39	0.57	59.0
Southern Europe	0.32	0.53	60.8
Cyprus	0.35	0.52	58.8
Greece	0.32	0.52	60.3
Italy	0.31	0.52	60.5
Malta	0.32	0.50	59.1
Portugal	0.32	0.58	63.2
Spain	0.29	0.54	62.7
Türkiye	0.35	0.48	56.5
Western Balkans	0.38	0.44	52.7
Albania	0.41	0.41	50.1
Bosnia and Herzegovina	0.36	0.37	50.2
North Macedonia	0.36	0.47	55.4
Montenegro	0.35	0.48	56.2
Serbia	0.42	0.45	51.6
Western Europe	0.30	0.66	68.2
Austria	0.27	0.70	71.5
Belgium	0.32	0.60	63.7
France	0.29	0.67	68.9
Germany	0.28	0.70	70.6
Ireland	0.32	0.60	64.2
Luxembourg	0.29	0.67	68.9
Netherlands	0.34	0.69	67.7
United Kingdom	0.29	0.69	70.2

Source: Notre Dame Global Adaptation Initiative dataset (https://gain.nd.edu/our-work/country-index/methodology/indicators/).
Note: Adaptiveness index = (readiness index– vulnerability index + 1) * 50.

- protection of public infrastructure and assets through investment and policies (including land use plans) that incentivize adaptation by people and firms
- investment in human capital, including health and education, to ensure that everyone can achieve his or her potential and contribute to development and growth
- the management of financial and macro-fiscal risks of climate change and adaptation investments
- a robust institutional and legal framework for adaptation and resilience and a consistent system for monitoring progress.

New approaches for adaptation have evolved over the last few decades by extending or modifying existing approaches (Table 4). Some adaptation measures have the potential to reduce poverty, but many can exacerbate social

TABLE 4. Key climate change adaptation measures for Europe and Central Asia

Sector/ impact type	Policy or measure
Water	
Coastal flooding and erosion	• Modification of existing water laws or introduction of new laws to strengthen climate change adaptation • Creation of a flood management system with early warning and flood protection • Elevation of dikes along 23–32 percent of Europe's coastline by 2100, which could prevent at least 83 percent of coastal flood damages • Nature-based solutions, such as building coastal wetlands, which can reduce wave height and form habitat • Construction of elevated or floating houses
Riverine and pluvial flooding	• In highly dense places, construction of levees, which could reduce flood damage by 45 percent at 1.5°C warming and 70 percent at 3°C warming • Enhancement of natural areas that hold water (forest and river channel restoration and widening of riverbeds) and man-made solutions such as the creation of large retention ponds, establishment and promotion of local green spaces, and replacement of conventional roofs with green roofs • Investment in early warning systems, flood risk insurance, and behavior change
Water scarcity	• Water storage, diversification of water sources, transfer of water between places, and reuse of wastewater • Demand-side measures (e.g., water metering, water rationing, pricing, efficiency improvements)
Terrestrial and marine ecosystems	
Terrestrial	• Rehabilitation and restoration of land, particularly abandoned agricultural areas in Southern and Northern Europe • Support the resilience of species, the functional diversity of habitats, and the migration of species at the limit of their adaptive capacity • Reduction in the risk of forest fires, preparation for them, and management of their aftermath
Marine	• Integrated coastal zone management and marine spatial planning • Expansion of marine protected areas and their efficient monitoring and enforcement
Food ecosystem	
Crops and livestock	• Adjustment of the timing of planting and harvesting, modification of irrigation practices, and adoption of climate (particularly drought pest) resilient crop varieties • Adoption of improved irrigation techniques, reallocation of water resources, increase in water efficiency, and conservation of soil moisture. • Seasonal adjustments for crop cycles • Provision of shade for livestock in open barn areas, adjustment of feeding schedules, high-frequency rotational grazing and mixed livestock systems, and expansion of agroforestry
Infrastructure	
Energy systems	• Enhancement of transmission lines, water cooling, prevention of flooding with structures like dams, and efforts to ensure a steady fuel supply • Relocation of energy production to coastal areas, adjustment of spillways, and expansion of hydropower plant capabilities • Monitoring and forecasting of snowpack levels and river flows, to anticipate changes
Transport	• Updating of manuals, guidelines, and protocols to incorporate the effects of their operations • Implementation of cooling measures for transportation modes, particularly underground transit • Enhancement and renovation of infrastructure through increased investment in maintenance
Human development	
Health and well-being	• Promotion of green-blue spaces within densely populated regions of Europe to enhance microclimates, alleviate heatwave impacts, enhance air quality, and improve mental well-being • Adoption of heat prevention strategies, encouragement of personal and household adaptations, fostering of awareness about heat exposure, and enhancing of individual physical fitness
Education and social protection	• Investment in R&D and skills required to implement and develop new adaptation measures. • Social protection systems that can support households faced with unprecedented climatic shocks

Source: Adapted from Bednar-Friedl and others (2022).

disparities. For instance, disaster recovery initiatives may neglect low-income neighborhoods or marginalized communities. Using information technologies for risk communication and management may exclude people who lack digital literacy, smartphones, or computers.

Existing water sector adaptation strategies emphasize structural flood protection (e.g., restoration of floodplains, widening of riverbeds) and the securing of water resources. These measures reinforce practices that could inadvertently foster ongoing dependency. Adaptation measures to manage flood risks include early warning systems and protection against coastal and riverine flooding. Supply-side measures for adapting to water scarcity include building reservoirs, redirecting water, and desalinizing and recycling water. Demand-side approaches include water-saving initiatives, improved distribution regulations, and strategic land management. Adaptive solutions to address pluvial flooding include the integration of green roofs in building designs, in order to enhance water retention; the creation of green spaces, such as parks; and the upgrading of drainage systems and pumping infrastructure.

Nature-based solutions—restoring landscapes, halting land-use change, increasing soil carbon levels, enhancing wetlands and other ecosystems—should be prioritized. They include waterway protection and enhancement, tree planting and biodiversity protection, and ecological conservation initiatives. These solutions are increasingly considered cost-effective investments for both adapting to and mitigating climate change activities (Barbier 2020 and 2023; EASAC 2019; Fargione and others 2018; Griscom and others 2017). Priority should be given to ecologically fragile mountain zones, in order to reduce disaster and climate risks, especially from floods and droughts (Agostini and Kull 2020; Baeumler, Kerblat, and Ionascu 2021; Lvovsky and Abate 2021).

The employment potential of nature-based solutions is already significant and could increase. Around 420,000 people in the region are estimated to work in nature-based activities, 37 percent of them women. If investments in nature-based solutions in ECA tripled by 2030, an estimated 525,000 jobs (446,000 full-time equivalents) would be generated, with around half the employment in the agricultural and forestry sector (ILO, UNEP, and IUCN 2022).

Climate change adaptation in food and ecosystem products encompasses solutions for both production-oriented choices and market-driven alterations in consumer preferences. Strategies for adapting to drought conditions include adopting effective soil management practices, adjusting sowing and harvesting schedules to changing conditions, irrigating, and modifying crop varieties. Strategies for adapting to flooding include integrating agroforestry practices, breeding resilient plant and livestock species, and selecting different crops. Financial actions include easing access to government subsidies and reducing insurance premiums and interest rates to incentivize resilient agricultural methods.

Ecosystem- and nature-based solutions are growing in importance in urban areas, where they include green spaces, ponds, wetlands, green roofs for stormwater management, and vegetation for heat absorption. Most examples of transformative adaptation in urban settings are still at the experimental stage. Collaboration among diverse stakeholders, as observed in the Rotterdam Climate Change Adaptation Strategy, is a promising trend. Challenges remain in coordinating departments and transitioning from pilot initiatives to broader implementation, and citizen engagement remains underutilized.

Adaptation to climate change in the health sector is gradually expanding in ECA, building on existing infrastructure. Between 2012 and 2017, some 20 European countries introduced new governance mechanisms, such as interdepartmental coordinating bodies for health adaptation. For health adaptation plans to succeed, it is critical to adopt a household-centered approach, as decisions in one sector affect how households react in other sectors (Rigolini and others 2023).

Vulnerable groups often have a lower perception of health risks than other groups. Combined with the perceived high costs of preventive measures, lack of concern can impede the execution of health sector adaptation plans.

Health measures such as monitoring systems and early warnings are crucial for detecting and sharing emerging climate-related risks. Implementing health regulations and policies can help reduce risks.

Education and social protection policies are also important. Workers must have an adequate level of skills to implement adaptation actions; a poorly trained labor force will not be able to implement measures such as water-saving techniques, early-warning systems, and other measures.

Adaptation will require investment in R&D. The development of new crop varieties, for instance, will require the presence of strong local research institutions that understand the climate challenges facing the area in which particular varieties will be planted.

Social protection systems will also need to be adaptive. Social safety net programs should be capable of adjusting benefit packages and temporarily ramping up the number of beneficiaries as needed based on post-shock needs. They should also support the long-term adjustment of households' assets and livelihood portfolios of households so that they can prepare for shocks (Bowen and others 2020).

Conclusions

ECA can and should play an important role in addressing global climate change. EMDEs in ECA account for 9.5 percent of global emissions—more than Northern, Southern, and Western Europe combined, and more than ECA's share of global GDP and population. Together, EMDE ECA and the European Union are second only to East Asia and the Pacific in terms of overall carbon emissions.

The energy price shock has brought into sharp relief the importance of transitioning to a low-carbon economy for energy security. The disruptions in the energy market in 2022 prompted the European Union and several countries in ECA to seek to strengthen their energy independence and security by increasing energy efficiency, diversifying sources of primary energy supply, reduce fossil fuel use, and expand domestic energy production, especially from renewable energy sources.

The green transition will require massive investments and a mix of complementary policies. Public spending alone cannot effect the green transition, especially the long-term transformation many ECA countries need to put themselves on a trajectory toward net-zero carbon emissions (Barbier 2023). Green transitioning will require pricing reforms that address the market-based disincentives that deter more sustainable development, such as subsidies of fossil fuels and other environmentally harmful substances and the inadequate pricing of GHG emissions. Pricing policies, including the removal or reform of fossil fuel subsidies, will incentivize the private sector to implement decarbonization activities. Government spending, particularly on emerging or not yet commercially viable technologies or R&D, could complement these policies. Regulatory policies, such as mandates on energy efficiency and vehicle emissions standards, will also help achieve emission reduction targets. EU member states and some ECA countries have implemented all three types of policies, focusing on pricing policies to achieve their short- and long-term targets.

Policies that address adverse impacts on poor and vulnerable households and displaced workers must accompany pricing reforms. Such policies should be implemented gradually and transparently, and revenues generated through sector reforms should be used to help finance scaled-up safety nets or other complementary policies and investment programs that target vulnerable groups.

For the resource-rich countries of ECA, improving the management and distribution of resource revenues is essential to long-term economic development and the green transition. These countries should consider policy actions that improve fiscal management of their mineral and fossil fuel revenues while implementing structural reforms to reduce reliance on fossil fuels and ensure that they will not end up with stranded assets in the coming decades.

To achieve the optimal mix of environmental, social, and economic objectives, climate change policies must be based on country-specific economic structures. The potential tradeoffs between the costs of implementation and the attainment of local and immediate versus more global and long-term benefits of various policies should be assessed in every country. In low-income, low-emitting countries, green investment should target sectors that produce the greatest economy-wide employment or income impacts while causing minimum GHG emissions from the economy (health care, education, hotels and recreation, construction, and textiles and leather). Investing in these sectors helps meet economic, environmental, and gender objectives. Strategies to help advance the green transition and economic development must be fiscally sustainable, as many economies face increasing fiscal constraints, elevated debt levels, and restrictive monetary conditions. Policies must also consider the potential tradeoffs between the costs and speed of implementation of the green transition and the attainment of a mix of environment and development goals.

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Greening the Economy of Europe and Central Asia

The impacts of climate change are profoundly affecting the Europe and Central Asia (ECA) region. As a result of heavy reliance on fossil fuels and energy-intensive economies, the region's per capita carbon emissions are among the highest in the world—and its total emissions exceed those of Northern, Southern, and Western Europe combined.

The clean energy transition will require massive private and public investment and a range of policies to ensure that investment is effective. Pricing reforms, especially the reduction or phase-out of energy subsidies, are needed to motivate the private sector to implement decarbonization measures. Tax instruments are also necessary. Regulatory policies such as mandating energy efficiency and improved standards for appliances will also help achieve emission reduction targets. Structural policies that strengthen macroeconomic fundamentals, deepen capital markets, and improve governance are a fundamental part of the policy mix. Furthermore, social policies to reduce energy poverty will be essential.

Tailored policies based on country conditions would help place ECA on a path of sustainable and greener long-term growth. These policies should account for the costs of implementation and the tradeoffs between immediate environmental objectives and long-term social benefits.

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