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UZBEKISTAN

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

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Table of Contents

LIST OF FIGURES

LIST OF BOXES

LIST OF TABLES

Acknowledgments

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Abbreviations

APEC	Asia-Pacific Economic Cooperation
ASP	Adaptive Social Protection
BCR	Benefit-Cost Ratio
CAPEX	Capital Expenditure
CAREC	Central Asia Regional Economic Cooperation Program
CBU	Central Bank of Uzbekistan
CCDR	Country Climate and Development Report
CCGT	Combined-Cycle Gas Turbine
CCS	Carbon Capture and Storage
CGE	Computable General Equilibrium
CNG	Compressed Natural Gas
CPAT	Climate Policy Assessment Tool
DRM	Disaster Risk Management
ESC	Employment Support Center
EV	Electric Vehicle
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GMP	Global Methane Pledge
GoU	Government of Uzbekistan
IEA	International Energy Agency
IFC	International Finance Corporation
ISO	International Organization for Standardization
LIFA	Low-Income Family Allowance
MANAGE	Mitigation, Adaptation, and New Technologies Applied General Equilibrium
MEF	Ministry of Economy and Finance
MEPR	Ministry for Employment and Poverty Reduction
NDC	Nationally Determined Contribution
NEGU	National Electric Grid of Uzbekistan
NZ2060	Net Zero 2060
OECD	Organization for Economic Cooperation and Development
R&D	Research and Development
STEM	Science, Technology, Engineering, and Math
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
Uzhydromet	Agency of Hydrometeorological Services

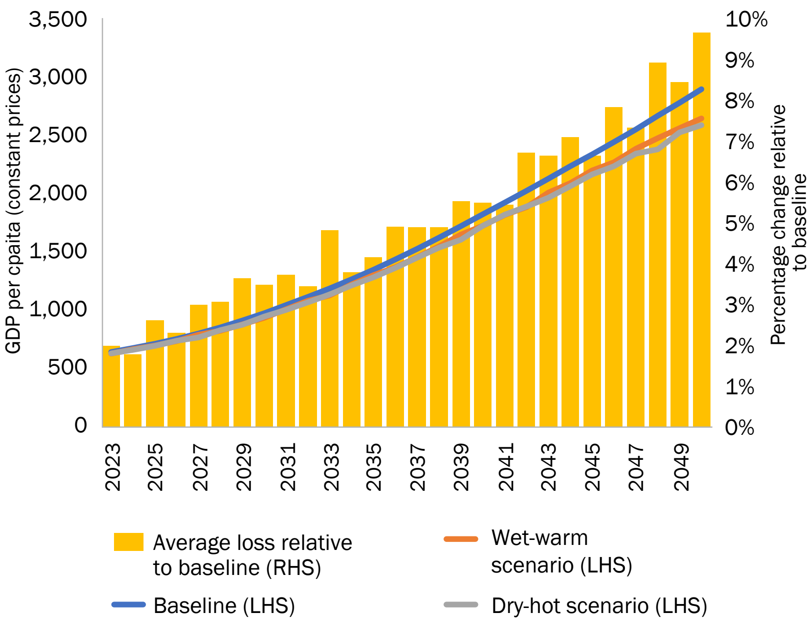
Executive Summary

This Country Climate and Development Report (CCDR) comes at a juncture when Uzbekistan needs to show results for the transformation path it has chosen. Uzbekistan, already Central Asia's most populous country, is expected to grow to more than 50 million people by 2050. A young and fast-growing population in need of skills and jobs, together with high reliance on dwindling natural resources, has motivated the pursuit of a transformative new development model. The sweeping reforms initiated by the President in 2016 and now under way, aim to convert Uzbekistan into an upper-middle-income country with a modern, private sector-led economy. Seven years in, policy frameworks are improving, but much remains to be done. Growth has been high, and poverty has fallen sharply, but job creation has been weak. After a first wave of landmark reforms, Uzbekistan must now complete a tougher phase of reforms to deliver lasting change for people, a task made more difficult by the challenge of climate change.

Climate change impacts loom large for Uzbekistan. Uzbekistan is already experiencing the deleterious effects of a changed climate. The ecological disaster of the drying Aral Sea—once the fourth-largest lake in the world—epitomizes the pressing development challenges in large parts of the country. Droughts, extreme heat, rainfall volatility, and dust storms are increasingly wreaking havoc on people and the economy. Air pollution is a growing environmental and health challenge. The annual costs of the damage to health from ambient $PM_{2.5}$[1] pollution in Uzbekistan, disproportionately borne by women, children, and vulnerable groups, have reached 6.5 percent of gross domestic product (GDP). Climate risks pose another source of vulnerability for the economy in addition to the already high costs of degradation of natural resources. Without action, climate change will continue to have severe impacts on Uzbekistan. Economic modeling reveals that climate change will lead to greater economic volatility and lower average growth, with the economy 10 percent smaller by 2050 than it would have been without climate damages (Figure ES1), resulting in significantly lower employment and higher poverty.

Without action on climate, Uzbekistan will not achieve its development vision. Uzbekistan is one of the most energy- and resource-intensive countries in the world. With this resource-intensive economic model, the expected rapid population and economic growth will drive a significant growth in emissions, placing excessive strains on key resources and ecosystems. This growth trajectory is not likely to materialize without strong attention to making growth sustainable. Moreover, unless action is taken on adaptation, climate change will have serious negative impacts on the people of Uzbekistan.

FIGURE ES1. HOWEVER CLIMATE CHANGE EVOLVES, ITS IMPACTS ON GDP ARE SIMILAR, SLOWING GROWTH



Source: World Bank analysis.
Note: Averages presented over both dry-hot and wet-warm scenarios.

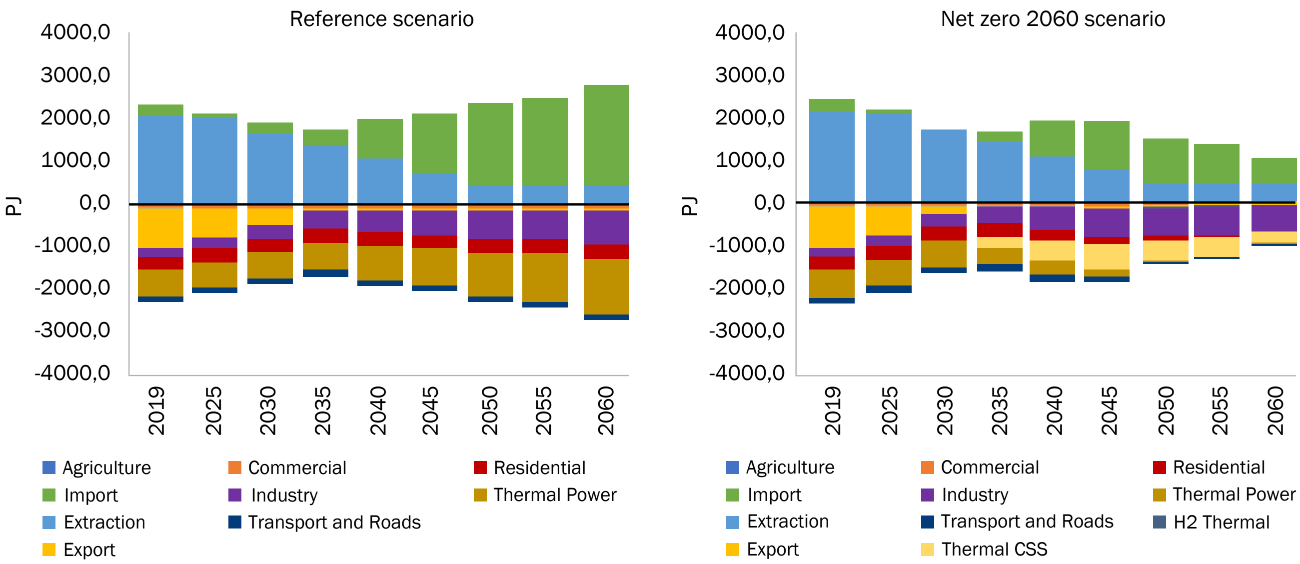
Climate risks are deeply intertwined with water security, food security, and land degradation in Uzbekistan. With irrigated agriculture accounting for 90 percent of water use, crop and food production systems are highly water intensive in an increasingly water-stressed environment. With rising temperatures, reduced precipitation, and retreating glaciers, Uzbekistan

[1] $PM_{2.5}$ = fine particulate matter of 2.5 microns or less in width.

is projected to be among the most water-stressed countries in the world. These climatic stresses already give rise to prolonged droughts, resulting in loss of livestock, reduced agricultural production, and decreased groundwater, thus threatening water supplies, food security, energy grids, and even the livability of some regions. Climate-smart agricultural practices and integrated approaches to management of water resources and landscapes will be crucial for sustainable growth. For adaptation to the adverse impacts of climate change, Uzbekistan would need to invest an additional US$46.7 billion over 2023–2060 (in present value terms) to address and mitigate the adverse climate impacts on labor productivity, roads and bridges, livestock, and irrigation sectors alone in the wet/warm scenario and US$59.8 billion in the dry/hot scenario.

The economy's heavy reliance on natural gas is a risk to the country's energy security. Uzbekistan's gas production is depleting while the country remains gas dependent, and net imports are growing over the years. Nevertheless, in the reference scenario, gas consumption is expected to increase with economic growth and become dependent on imports. The acute energy crisis of the winter of 2022/23 affecting heating and power highlights that it is in the best interest for the country to accelerate programs to reduce gas losses and use natural gas more efficiently and diversify away from natural gas, starting with sectors with viable alternatives, such as transport and heating. How the country will manage such a shift could have serious implications on its growth trajectory and energy security. To kick off the transition in the natural gas as soon as possible and in preparation for the winter of 2023/24, the government is working on a series of emergency preparedness measures to better manage demand-side and supply-side flexibility in the gas and power sectors, which could already accelerate the energy sector transition. This report estimates that natural gas consumption would decline by 40 percent in a net zero 2060 (NZ2060) scenario compared with the reference scenarios (Figure ES2).

FIGURE ES2. NATURAL GAS CONSUMPTION DECLINES BY 40 PERCENT IN NZ2060 SCENARIO COMPARED WITH THE REFERENCE SCENARIOS: NATURAL GAS DOMESTIC PRODUCTION, IMPORTS, AND USES

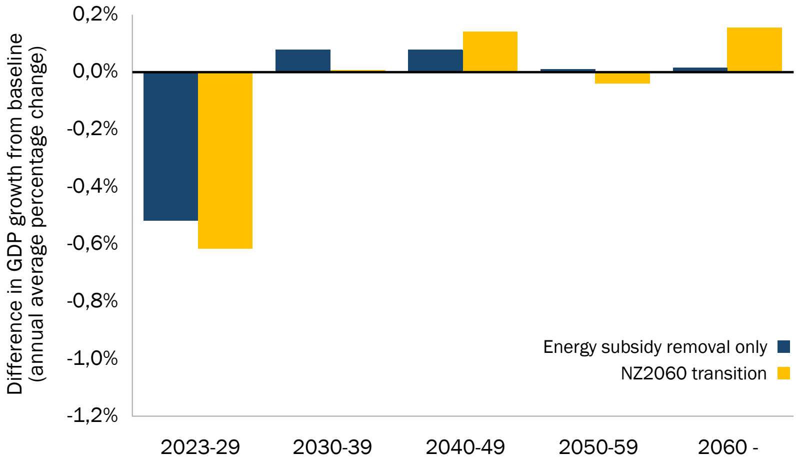


Source: World Bank analysis.

By pursuing carbon neutrality, Uzbekistan can strengthen energy security. A green transition led by behavioral change and targeted policies and investments will promote more efficient energy use and support energy security by reducing the reliance of the economy on imported natural gas, lowering the need for net energy import dependency to 8 percent by 2060 compared to a do-nothing scenario where energy import dependence could reach 66 percent by 2060. Modeling results show domestic renewables can provide 70 percent of domestic energy supply by 2060, and over 85 percent of supply when combined with hydrogen and domestic extraction and production.

Economic modeling illustrates that net zero transition will raise growth prospects for Uzbekistan. Net zero transition brings economic benefits in terms of improved productivity and market opportunities. Reduced emissions are also associated with health benefits of reduced localized air pollution, which is monetarized and included in the macroeconomic estimates. But during the transition period, the high investment needs and a relatively rapid low-carbon transition leads to a temporary drop in economic efficiency of carbon-intensive factors of production and a crowding-out effect on other investment, particularly in the peak investment period between 2034 and 2040. Over the transition period, the positive and negative economic effects broadly offset each other, with the economy about the same size it would have been without decarbonization, but with annual growth higher going forward. The withdrawal of energy subsidies, a critical prerequisite for decarbonization and already existing government policy, leads to temporarily lower growth than could otherwise have been expected in the first few years, but it could be also associated with more air pollution benefits, especially by 2050 (Figure ES3).

FIGURE ES3. GDP GROWTH UNDER THE POLICY REFORM SCENARIOS SLOWS INITIALLY RELATIVE TO THE BASELINE BUT THEN ACCELERATES



Source: World Bank analysis.
Note: Impacts include the monetized benefit of reduced air pollution.

The report's findings and recommendations can be summed up in six key messages.

Message 1. Setting a path to carbon neutrality by 2060 is ambitious, but achievable, and will support Uzbekistan's near-term energy security needs and long-term growth prospects.

Current policies, including the Nationally Determined Contribution (NDC), are expected to result in a doubling of emissions as the economy grows, so greater ambition is needed to decarbonize the energy system, which in turn will also promote energy security. The government has been implementing decarbonization measures, especially in the power sector, but achieving carbon neutrality by 2060 requires even greater deployment of renewables and low-carbon technologies, infrastructure upgrades, and improvements in energy efficiency and well as achieving cost-recovery energy pricing. Modeling results indicate that, assuming the sector moves to cost-reflective pricing in the next few years, the power sector can largely decarbonize by 2050; commercial buildings can reach net zero before 2050, followed by residential buildings in 2055; and industry and transport would decarbonize last, by 2060. The trajectory of the carbon-neutral scenario shows that it is in the best national interest to prioritize natural gas for the power and industry sectors, moving away from its use in transport and heating, driven by economic and efficiency considerations, with fossil fuels (mainly natural gas with carbon capture and storage [CCS]) accounting for 19 percent of final consumption. Modeling also shows that in the transport sector, the key drivers of decarbonization are improvements in enforced fuel efficiency standards, shift to electricity and hydrogen (due to limited gas resources), electrification of passenger road and rail transport, use of hydrogen for freight, greater use of public transport, and urban design for walkable cities.

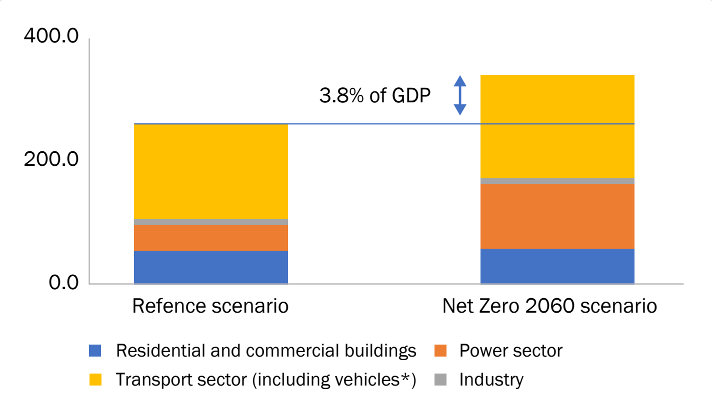
While coming with an initial cost for the economy, subsidy reforms and decarbonization can bring important benefits in the longer term. Subsidy reform will promote energy efficiency and conservation by encouraging consumers to use energy more wisely and spur competition and innovation in the energy sector by removing distortions in the market. This can lead to the development of new technologies and business models that could accelerate the transition. It will also improve the overall financial sustainability of the energy sector, promoting its creditworthiness and attractiveness for the private sector. Decarbonization will also bring substantial benefits across the infrastructure sector, estimated at over US$178 billion over 2023 to 2060 (including about US$112 billion of avoided economic cost of pollution; accidents and damage in the residential, power, industry and transport sectors; and US$66 billion of avoided fossil fuel imports) (box ES1).

BOX ES1. SIGNIFICANT INVESTMENT IN THE ENERGY SYSTEM IN THE DECARBONIZATION SCENARIO YIELDS HIGH BENEFITS

In the decarbonization scenario, significant co-benefits arise from reduced air pollution, amounting to more than US$100 billion by 2060. Air pollution is among the top 10 factors contributing to death and disability in Uzbekistan and the prime environmental risk. More than half of $PM_{2.5}$ air pollution is attributed to the burning of fossil fuels. Decarbonization could result in a drop of 19 percent in air pollution mortality attributed to fossil fuels by 2030, and 88 percent by 2060, and assuming no shift back to solid fuel use. The present economic value of reduced air pollution mortality totals US$106 billion.[2]

Significant decarbonization investments will deliver high economic benefits. Compared with the baseline scenario that does not include climate objectives, in the NZ2060 policy scenario, Uzbekistan would need to invest an additional US$79 billion (in present value terms) over 2023–2060. Significant investments are needed to replace aging energy infrastructure and promote decarbonization (US$341 billion). A large part of such investments will be carried out by the private sector, if the right enabling environment is in place.

FIGURE ES4. TOTAL DISCOUNTED ENERGY SYSTEM INVESTMENT NEEDS 2023–2060 (US$, BILLIONS)



Source: World Bank analysis.
Note: Vehicle cost includes the total value capital expenditure (CAPEX) and not only battery costs representing only around 25 to 40 percent of electric vehicle (EV) costs.

The investment in the energy system in the NZ60 scenario is 3.8 percent higher than the investment in the reference scenario. These higher investment costs in the NZ60 scenario can be justified by the benefits of air pollution reduction in the NZ60 scenario, equivalent to 5.4 percent of GDP (cumulative present value). The benefits outweigh the additional costs even without considering the economic value of the additional benefits such as the lower road congestion in the NZ60 than in the reference scenario (Figure ES4).

The government's ongoing energy efficiency and emergency measure programs provide an excellent foundation to improve energy security during the critical winter months in Central Asia, while further scaling up of the energy efficiency program is required for deeper decarbonization. In the NZ2060 scenario, energy efficiency measures and technology advances reduce end-use energy consumption by 16 percent by 2060 (compared to the reference scenario). Among other benefits, energy efficiency gains provide an important buffer against energy bill increases resulting from upcoming tariff reforms, notably for consumers in residential buildings. Uzbekistan should also prioritize ambitious energy efficiency programs across the energy sector value chain, as well as programs to reduce methane fugitive emission and gas losses, which are still very high by international standards.

Decarbonization is also important in agriculture, waste management and other sectors, and conversion of land to sustainable use can increase the capacity of soil and plants to store carbon. Controlling greenhouse gas (GHG) emissions in agriculture, which accounts for 19 percent of emissions, is essential to meet mitigation targets. Much of these emissions emanate from livestock activities. Improving feeding strategies, genetics, herd management, and animal housing could reduce emission intensity by 25–30 percent. However, the accompanying production gains could result in an increase in absolute emissions. Controlling herd growth would thus be necessary to reduce emissions relative to the reference scenario.

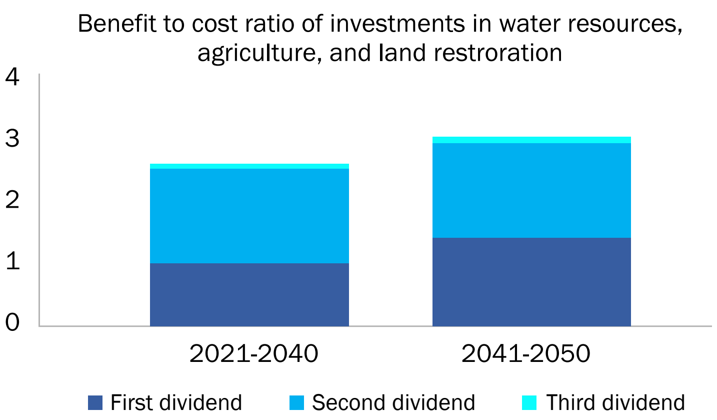
[2] The present value considers the period 2019 to 2060 and a discount rate of 7 percent. The value used for statistical life was transferred from OECD countries to Uzbekistan.

Message 2. Climate adaptation measures have strong induced economic and development benefits in Uzbekistan, making them worthwhile investments even without considering climate risks; the benefits of adaptation investments are two to three times higher than the costs.

With the immense costs that climate change is likely to impose on the people and the economy of Uzbekistan, investment in adaptation can deliver a triple dividend. Without adaptation, Uzbekistan could see reductions of 3.5 percent in agricultural labor productivity, 16 percent in livestock productivity, 9 percent in hydropower potential, and 8 percent in cotton yields. Capital infrastructure damage from once-in-50-year floods could reach 2.6 percent of the total cost. In Uzbekistan as across the world, investment in building resilience to climate change has lagged the needs. Uzbekistan could reap triple dividends from investments in adaptation through avoided losses (first dividend), induced economic benefits (second dividend), and additional social and environmental benefits (third dividend). The second and third dividends are especially important since they accrue regardless of whether the climate risk materializes. A triple dividend analysis of investments in irrigation, drainage, climate-smart agriculture, and land restoration finds benefits that are two to three times higher than the costs under a range of possible future scenarios (Figure ES5). Since many of the adaptation investments will need to be made by private actors, such as investments by farmers in on-farm irrigation systems or soil conservation practices and machinery, realizing those benefits will require an enabling environment and policy reforms that promote such investments.

Reforming agriculture policies is a precondition for the adoption of climate-smart agriculture practices at scale. Since 2018, Uzbekistan has made major progress in reforming wheat and cotton production, which account for 70 percent of irrigated planted area, 70 percent of irrigation water, and 80 percent of public spending on agriculture. Investing in climate-smart agricultural and pastoral practices is costly (establishing orchards, purchasing high-quality seeds and more efficient irrigation equipment, procuring a larger volume and better quality of feedstock, learning new skills to utilize new technologies), so broader adoption of such practices requires raising farmers' incomes. Strengthening land tenure security and eliminating the crop placement system, which prevents farmers from planting crops based on market signals, are major items on the policy reform agenda. Continued reforms are essential for enabling a green transition in the agriculture sector.

FIGURE ES5. CLIMATE ADAPTATION INVESTMENTS IN UZBEKISTAN HAVE A HIGH TRIPLE DIVIDEND, 2021–2040 AND 2041–2050



Source: World Bank analysis.

Integrated landscape and watershed management present opportunities to restore degraded land and agricultural productivity. Integrated landscape management approaches and climate-smart technologies in areas with the highest adaptation potential are expected to boost crop values by about US$4.6 billion and production on natural pastures by US$100 million over 10 years. Some 1.8 billion cubic meters of water can be saved annually. Integrated landscape management and adaptation actions will reverse trends in land degradation, preserve carbon stock above and below the ground, control erosion better, enhance water regulation, and reduce landslide risk.

Ensuring water security will be critical for adaptation to climate risks. Better management of water resources will be a frontline for tackling climate challenges. Ensuring sustainable development will require more efficient use of increasingly scarce water resources as well as improved coordination among competing uses, especially since irrigation-dependent agriculture generates a quarter of GDP and employment in the country. But projections show greatly declining water availability by 2050, with water availability in the main rivers down by up to 15 percent by 2050. Meanwhile water demand from competing uses, both within and outside of Uzbekistan, will increase with economic development, adding further stress to water resources. Without appropriate action, these trends would lead to water shortages of 15 billion cubic meters by 2050. While the downside risks are high, large gains are also possible given the right interventions. Modernizing infrastructure and adopting a service-oriented approach to water management will be key. Investment costs for modernizing the irrigation and drainage system are estimated at US$6 billion from 2023 through 2030. Investments are also needed to increase on-farm water-use efficiency, crucial for climate adaptation.

However, climate action will also lead to unintended consequences for workers and families. A policy-induced shock will provide incentives for firms to introduce water-optimizing technologies, shift skills demand, and lead to job losses and wage inequality.[5] For instance, water-optimizing technologies needed in agriculture could lead to unintentional labor shedding and sectoral labor reallocation. Workers will need to reskill/upskill subject to how well their foundational skills allow them to learn new skills. Having the right human development policies in place will increase people's acceptance of the new green economy and ensure a sustainable green transition over the long run. Inevitably, in the short to medium run, job losses will put a strain on families' livelihoods. Adaptive social protection (ASP) systems will be crucial to abate some of the costs of the transition.

Message 3. Accelerating the development of Uzbekistan's private sector is critical to absorb the costs and take advantage of the opportunities of the green transition.

The emerging private sector and foreign direct investment (FDI) inflows will be pivotal in driving overall development and the green transition. Uzbekistan has embarked on a bold path to reimagine its economy as one led by innovation, competition, and above all, a dynamic private sector. Reforms to support private sector development are critical to succeeding on a green transition path. Uzbekistan's business sector already shows signs of latent demand to go green, while FDI remains muted. The continuation of the government's economic reform agenda is key to bring increased FDI and improve the business environment for both domestic and foreign firms to invest, compete, and export in low-carbon markets.

Continued economic reforms offer the prospect of new, green markets for the country, while robust and inclusive growth can create fiscal space to build greater resilience to climate change. The public sector, businesses, and individuals can more easily absorb the costs of building resilience to climate change and transitioning to a low-carbon economy if incomes rise rapidly. Green markets can unleash faster growth if Uzbekistan can calibrate its policy frameworks to competitively engage. Analysis indicates that there is more than US$2 billion annually in potential exports for Uzbekistan to serve current green value chains, not counting future growth. Accelerating trade integration would increase competition, efficiency, and productivity and enable Uzbekistan firms to access external markets in a green transition. The frontier technologies of fast-growing green markets can support rapid growth in domestic productivity and exports.

Rolling back the pervasive role of the state via state-owned enterprises' privatization and ensuring robust, conducive competition and investment regulatory environments are key to increasing the FDI that is much needed for the green transition. Bringing more FDI into low-carbon sectors is a key priority as it brings both financial and technological know-how. To date, Uzbekistan has underperformed in attracting FDI, especially in green sectors. Uzbekistan's stock of FDI is far below regional averages and that of its neighbors. Stimulating investment in low-carbon activities requires transparent and stable regulations, a coherent government coordination framework, and stronger investor service delivery. The ongoing privatization of state enterprises and the establishment of public-private partnerships can also attract more FDI.

Message 4. Market incentives and financial market development will help bring in the private sector at scale and relieve burdens on public finances.

The government's fiscal position will quickly become unsustainable if the public sector must shoulder large green transition costs without creating fiscal space elsewhere. At 34 percent of GDP in 2022, Uzbekistan's public spending is already higher than that of most of its income-level peers, and the budget has limited capacity to take on major additional financing demands. Mobilizing funds for needed investments will require a mix of public and private financing. The temptation can be to rely more on public finances, which can be mobilized quickly and do not require the tough policy reforms that attract private investment, but such an approach would move the budget onto an unsustainable path. Under a scenario where half of the investment costs of the green transition is financed by the budget, the public debt-to-GDP ratio could exceed the benchmark for sustainable levels before 2050.

Adjusting prices, particularly by removing energy subsidies and introducing carbon pricing, is a keystone policy for triggering the green transition that will boost growth over the longer term despite short-term costs. Removing energy subsidies in the gas, electricity, and heating markets is an essential component of a green transition. Introducing carbon pricing through a carbon tax will also spur the investments needed to reach net zero emissions. These policies not only provide the market incentives to trigger behavioral change but also generate fiscal space which can be directed to reinforce these incentives and support the transition. Macroeconomic modelling suggests that these two policies combined can create as much as 5 percent of GDP worth of additional fiscal space over the transition period. These resources can be used to leverage private finance by providing smart subsidies for green investment, to support accelerated transition in difficult sector such as residential energy efficiency, and to finance essential low-carbon public goods, both physical infrastructure and the strengthening of education and labor market frameworks to build human capital for the green transition.

Given the scale of resources required, the private sector will need to be the primary financing source for the green transition. With many competing public spending needs, the government budget cannot accommodate all the investment needs of the transition. Ushering in greater private financing, both domestically and through FDI, and developing green finance, will be critical. Key policy areas to support green finance include constructing clear regulation and supervisory frameworks for green finance, rolling out new instruments that provide market-based incentives for green investments, and developing insurance and other instruments to better manage disaster- and climate-related risks.

Message 5. Mitigation and adaptation policies need to be complemented with carefully designed and well implemented social protection policy packages to protect vulnerable groups from harm and to win broad support for policy goals.

The benefits of a green transition should be shared widely by supporting the inclusion of vulnerable groups in the green economy, protecting those affected by climate actions, and ensuring that benefits go to most of the population. The distributional impacts of climate change and climate policies will be uneven on the poor; workers with lower education and skills; and other vulnerable groups including women, people in rural areas, and people with disabilities. Active labor market programs could be redesigned to facilitate labor shifts by providing intermediation services to both jobseekers and employers in greener sectors and by tailoring training to provide technological and vocational skills required in green jobs. Removing energy subsidies, while required to make the energy sector economically viable, will lead to energy price increases, which will disproportionally affect the poorest households as they spend large proportions of their incomes on essentials like food, energy, and transport. Social protection policies can play a key role in mitigating the income losses due to the removal of energy subsidies on the poorest by providing targeted income support to poor households identified in the Social Protection Single Registry and to other vulnerable categories like single elderly households and people with disabilities. These social protection compensation measures can be financed with fiscal savings from ending energy subsidies and revenue stemming from implementing carbon taxes.

In addition to abating the costs of the transition, social protection systems can be made more adaptive and responsive, to foster people's resilience. Existing programs such as the Low-Income Family Allowance (LIFA) can be scaled up and better targeted to reach more of the poorest households. Anticipatory cash transfers could be introduced to enable the rollout of more climate-responsive support systems in cases of climate crises. To be effective, these programs require integrating information and response systems, merging beneficiary data (from disaster risk management systems) for effective targeting, establishing rapid payment mechanisms for transfers, and setting up early warning systems.

Message 6. Skill development and climate action at the local level will be essential to enable a just transition for the people of Uzbekistan.

The green transition is not expected to lead to a significant reduction in jobs overall, but the types of jobs will change. Macroeconomic modeling indicates that there will be a similar number of jobs under a net zero transition as in the reference scenario. But a major challenge is to ensure that workers have the right skills for the new jobs. Some of the biggest growth areas may already have a nascent labor pool, while filling other new jobs will require training people in dedicated skills. In the power sector, the net zero transition will be associated with more net jobs, with employment 30 percent higher by 2035. This includes new jobs in construction, installation, and operation and maintenance of new, greener technologies and considers the reduction in jobs in declining technologies. In addition to sectors such as renewable energy, which see massive job growth, higher value-added service sectors such as insurance and information and communication technologies and other service sectors such as hospitality are expected to create more jobs in the net zero scenario than in the baseline. Manufacturing also performs well, adding more jobs than in the baseline.

People need to be equipped with foundational and technical skills through formal education and training opportunities to fuel a green transition. In Uzbekistan, foundational skill gaps need to be filled by raising low average achievement levels according to standardized international testing of academic proficiency (50 percent in reading, 52 percent in math, and 59 percent in science among 4th grade students), and the share of students studying science, technology, engineering, and math needs to increase from a low base of 30 percent. Likewise, many more students in Uzbekistan need to enroll in higher education, especially in math and science. Youths and adults require reliable information to assist them in making smart career decisions, and they need more career guidance during the green transition.

Behavioral change is critical for a green transition and can be encouraged through a mix of interventions, including public awareness campaigns, education, and the introduction of new technologies and incentives. Receiving new information can be a catalyst for behavioral change and the adoption of new technologies (related to agricultural and livestock practices, energy mix and efficiency of use, and uptake of microfinance, for example). Education and social protection policies should incorporate incentives for behavioral changes that reduce carbon emissions. Concepts related to disaster risk management and climate change should be part of the curriculum beginning with preschool, and environmental awareness should be taught as a core skill, preferably in the context of solving real-world problems and encouraging creative thinking. Social protection programs can also support mitigation, including through incentives built into conditional cash incentives and advisory and training services.

Some people and communities will be affected more severely by climate change, and public awareness of the causes and consequences of climate change is especially low in rural communities.[3] Some impacts, such as drought-induced losses in productivity, reduced agricultural yields, diminished mobility due to degraded roads, land degradation, flooding, and mudslides, will disproportionally affect low-income people and communities already facing other economic and social challenges. While local communities are on the frontlines of climate impacts, their voice often goes unheard in the policy discussions and decision-making that affect their ability to cope with shocks and stressors today and adapt to changing conditions over the long term.

Programs that focus on local climate action and that create partnerships between governments, communities, and civil society can identify socially inclusive solutions tailored to local needs and priorities. Entry points for supporting locally led climate action vary with a country's national and local institutional readiness, previous engagements with local communities, and strength of local participatory processes for development. Local climate action programs reinforce systems and capacities for climate action by engaging with different levels of government; empowering communities to share local knowledge, assess their climate risks, and prioritize actions for resilience under a range of climate scenarios; and increasing the transparency and accountability to local stakeholders of processes for financing, designing, and delivering programs.

Mahallas have the potential to support and advance local climate action. Uzbekistan has over 9,000 mahallas, the lowest tier of territorial organization. Within the framework of the National Development Strategy 2022–2026, the government is expanding the role of mahallas in local service delivery, poverty reduction programs, and citizen engagement in program decision-making and oversight. Recent reforms have broadened the human resource base in mahallas, increased resource allocations for mahalla-level basic infrastructure investments, and introduced measures to enable mahallas to raise revenues and execute local development projects. Because mahalla leaders serve as the interface between higher tiers of government and individual citizens and civil society, training and capacity building on climate change can make these leaders more effective

[3] In a survey of over 4,000 households in five regions of Uzbekistan, less than half of respondents had heard of climate change (Uzbekistan Rural Infrastructure Development Project 2021 Survey).

in raising awareness of climate change impacts and adaptation strategies, informing local government planning and investments, and targeting resources to the poor and vulnerable in their communities.

This report presents the recommendations for the next stage of reforms through the climate change lens. The government is pursuing a comprehensive reform program including challenging structural reforms in the business enabling environment, the energy, water, and agriculture sectors, as well as many other sectors across the economy, and is implementing measures to strengthen the institutional framework for managing key climate change issues. The CCDR proposes a set of urgent actions to advance decarbonization and adaptation to climate change in Uzbekistan in the short term. The following actions include key policy and investment priorities to address the most critical challenges for unlocking a green transition in Uzbekistan. Over the medium term, deeper policy reforms and investment will need support across sectors that are most critical to advancing decarbonization and climate adaptation objectives.

Priority area	Recommended action in the short term
Climate action and climate commitments across sectors for a green transition	
Climate action	✔ Adopt more ambitious NDC targets and carbon-neutrality targets.
Green economy	✔ Develop a national green taxonomy and monitoring, reporting, and verification system.
Private sector development	✔ Continue and accelerate existing reform programs to improve business dynamism, enhance the investment environment, and strengthen the private sector's role in leading the green transition.
Subnational governance of climate action	✔ Increase the responsibilities of municipal government by empowering subnational governments, including mahallas and regional Uzhydromet offices, to support appropriate local climate policy design and implementation.
Energy policy reforms and investment to promote energy efficiency and clean energy	
Energy pricing	✔ Complete energy sector subsidy reforms, accompanied by social protection measures for the vulnerable population.
Energy efficiency	✔ Accelerate the implementation of existing energy efficiency programs in buildings.
Clean energy and natural gas	✔ Continue the scale-up of competitive and private sector-driven renewable energy generation. Adhere to the commitment of no new coal development while limiting natural gas to domestic use, prioritizing power and industry sectors.
Natural gas	✔ Reduce losses and emissions through systematic measurement by the regulator and attract investors in proven technologies of venting and flaring reduction.
Water resources management, climate-smart agriculture and ecosystem services	
Water resources and irrigation management	✔ Increase the efficiency of water use in irrigation by promoting the adoption of water- and energy-efficient technologies, in combination with complementary measures and climate-aligned agriculture policies.
Climate-smart agriculture and land policy	✔ Strengthen incentives for investments in climate-smart agriculture by strengthening land tenure security and promoting land conservation investments and other investments in climate-smart agriculture through financial incentives.
Landscape restoration	✔ Prioritize investments in adaptation, forest, and landscape restoration based on the potential for adoption of climate-smart technologies, the speed of investment recovery, and socioeconomic factors.

Priority area	Recommended action in the short term
Green urban development	✔ Adopt compact development and systematic green development, while applying biodiversity planning, green master plans, urban mobility plans, and efficient delivery of public transport.
Foundational skills and social protection for climate resilience	
Foundational skills	✔ Develop foundational skills and upskill workers to better integrate them into a green economy through upgrading formal education curricula.
Social protection	✔ Make the social protection system more adaptive to enable crisis preparedness, faster crisis response, and greater resilience among people.

Chapter 1

Climate and development

The abandoned ships in the deserted Aral Sea near the city of Muynak in Karakalpakstan, Uzbekistan.
Photo by the World Bank

1.1. An ambitious reform path amid the challenge of climate change

Uzbekistan has embarked on an ambitious reform path that aims to catapult it to upper-middle-income status early in the next decade. President Shavkat Mirziyoyev, who assumed office in 2016, embarked on an ambitious reform agenda to rapidly develop the economy and raise living standards by doubling incomes by 2030. Over the last seven years, the President has overseen major reforms aimed at moving away from a state-controlled economy to private sector-led markets and modern and inclusive social and environmental policies that may reshape the economy to achieve these goals.

This Country Climate and Development Report (CCDR) comes at a juncture when Uzbekistan needs to show results for the transformation path it has chosen. Uzbekistan, with 36 million people, is already Central Asia's most populous country and is expected to grow to more than 50 million people by 2050. A young and fast-growing population in need of jobs and a heavy but diminishing reliance on natural resource extraction have been motivating factors for the transformative new development model envisaged under the new reform agenda. Seven years into the transformation, policy frameworks are improving, but much remains to be done. Growth has been high, and poverty has fallen sharply, but job creation has been weak, putting the sustainability of gains at risk. As in many transition economies, after a first wave of landmark reforms, Uzbekistan now must complete a tougher phase of reforms to fully enable tangible change for people, a task made more difficult by the challenges of climate change.

Climate change impacts loom large for Uzbekistan, and the trajectory of its accelerated development path depends on how well it navigates this challenge. Uzbekistan is a small contributor—just 0.3 percent—to global CO_2 emissions yet one of the most energy-intensive countries in the world. Without action to decarbonize growth, achieving rapid economic growth will increasingly undermine global climate change mitigation efforts. Uzbekistan is already facing the destructive effects of a changed climate. The ecological disaster of the drying Aral Sea—once the fourth-largest lake in the world—creates pressing development challenges in large parts of the country. Droughts, extreme heat, rainfall volatility, and dust storms are having increasingly severe impacts on people and the economy. Air pollution is a growing environmental and health challenge. The annual costs of the damage to health from ambient $PM_{2.5}$[4] pollution, disproportionately borne by women, children, and vulnerable groups, have reached 6.5 percent of Uzbekistan's gross domestic product (GDP).[5]

Climate change and the green transition are intertwined processes representing Uzbekistan's biggest challenges. The formidable challenge of climate change requires not only the right policies but the right policy complementarities. At least some of the policies that aim to address climate change can also lead economies to a green transition. As firms and households comply with new regulations and change their economic behavior,[6] the resulting green economy may reinforce climate action goals, such as emission reduction.

Continued economic reforms and rapid growth offer the prospect of creating new, green markets and scaling up investment, which can be marshalled to build greater resilience to climate change. The costs incurred by the public sector, people, and firms in building resilience to climate change and transitioning to a low-carbon economy will be more easily absorbed in a fast-growing economy. Green markets are also the key to unlock faster growth if Uzbekistan can calibrate its policy frameworks to competitively engage. The frontier technologies of fast-growing green markets can support rapid growth in domestic productivity and exports. Analysis indicates that there is more than US$2 billion annually in potential exports for Uzbekistan to serve current green value chains, not counting future growth.[7]

Moving to a lower-carbon economy requires investment in a new set of endowments—capital, skills, and institutions. Studies have emphasized that the surest way to sustained growth is through investments in the

[4] Fine particulate matter of 2.5 microns or less in width.

[5] World Bank 2022a.

[6] Regulations can take the form of caps on emissions, elimination of certain pollutants from production processes, and others, and incentives can take the form of financing for firms' technological change or households energy consumption patterns, such as adoption of solar panels.

[7] Mulabdic 2023.

quality of policies, institutions, and human capital, along with physical assets.[8] These lessons are especially apt for Uzbekistan and its potential green transition. Improving the country's capabilities to engage in competitive, higher value-added activities at home and abroad will be what sees Uzbekistan move beyond its natural resource and geographic limits.

Investment in climate change adaptation will have multiple benefits and high payoffs. Climate policy and investment can bring associated benefits. For instance, reducing transport sector emissions has both decarbonization benefits and health benefits from air quality improvement, while investing in livestock breeds that emit less methane results in animal herds that are more resilient to drought and more productive. The investments in adaptation that Uzbekistan takes could yield triple dividends through avoided losses (first dividend), induced economic and development benefits (second dividend), and additional social and environmental benefits (third dividend). Importantly, the second and third dividends are realized regardless of whether the climate risk materializes. Thus, action on climate adaptation is in Uzbekistan's own best interest.[9]

A green transition, both globally and domestically, brings risks as it does opportunities. Winners and losers in the green transition will be determined to a great extent by their ability to adapt and adopt early. As Uzbekistan keeps expanding its economic reach, its greatest opportunities will naturally lie in green markets, some of the fastest growing in the world. As other countries follow a decarbonizing path, they are likely to limit imports of high-carbon goods, which will lead to a decline in competitiveness for countries like Uzbekistan whose economies are highly emissions intensive. Uzbekistan is also facing peak production of domestic gas, posing a significant risk for its economy and energy independence. A green transition could represent an important opportunity for mitigating such risk. On the domestic level, risks extend to workers and households that may be caught out during a green transition. As the economy transforms, labor market demand will evolve, as some jobs sunset and others require new skillsets. Decarbonization and carbon-pricing policies will alter relative prices as emission-intensive goods become more expensive. In the short term, households may face adverse price shocks. Policy frameworks need to be in place through the transition to help people and firms and support the vulnerable.

While Uzbekistan has demonstrated a commitment to climate change action, identifying more ambitious targets would be an important signal of intent and would be in line with the Paris Agreement. Uzbekistan's revised Nationally Determined Contributions (NDCs), submitted in October 2021, target reducing CO_2 emissions per unit of GDP by 35 percent below 2010 levels by 2030. But there are no targets for methane and nitrous oxide, which account for nearly half of greenhouse gas (GHG) emissions, and CO_2 emissions are likely to continue to rise as economic growth outpaces the targeted reduction in emission intensity. These factors, combined with the fact that Uzbekistan does not yet have a formal economy-wide net zero target, means the country is not yet sending a clear signal about where it is headed in a green transition.

1.2. How big is the challenge?

With rising temperatures, Uzbekistan's vulnerability to both climate-related shocks and chronic impacts, such as changes in river flow and precipitation patterns and ecosystems health, will increase. Uzbekistan's landscape is dominated by large desert plains, including desert areas in the far west that formed as the Aral Sea dried up. With its arid climate, the country already experiences considerable variation in temperature and precipitation[10] and is expected to be severely stressed by further temperature rises. Average temperatures, having risen 2.9°C from 1950 to 2020, are expected to rise by another 1.21°C–1.94°C over the century. In a pessimistic climate scenario, the most extreme temperature rises are expected in the northwestern Aral Sea region and in southeastern provinces—which is especially concerning as this is likely to trigger mudslides, glacier melt, and worsening drinking water scarcity. Changes in rainfall are more uncertain, but the higher expected frequency of heavy rainfall events would increase flood risks.

[8] Including Diversified Development (2014) and the Growth Commission Report (2008).

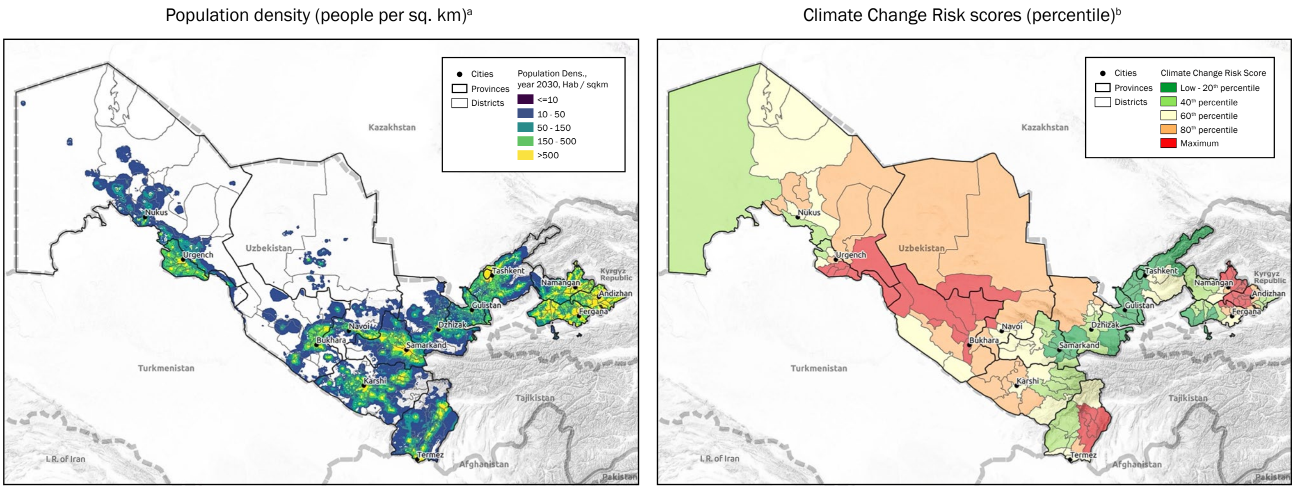
[9] World Resources Institute 2022.

[10] For instance, southeastern areas of Uzbekistan, including its largest cities of Tashkent and Samarkand, received nearly 10 times more rainfall (800–900 mm per year) than western areas (100 mm per year).

The high vulnerability to natural disasters calls for financial and fiscal systems that strengthen the resilience of people, firms, and assets. Economic losses from natural disasters in Uzbekistan are estimated at US$92 million (0.20 percent of GDP) a year.[11] Almost 15 percent of the country, with more than half of the population, is subject to high seismic risk. Landslides also present a high risk, with most of them triggered by snow melt, precipitation, and underground water. Preliminary estimates put the economic cost of flooding at US$236 million annually. With limited fiscal resources and capacities of businesses and households to recover, it is increasingly important to focus on financial protection to address potential disaster impacts.

With a large share of the rural poor engaged in agricultural work, poverty is highly associated with access to water, fertile land, and natural resources in Uzbekistan. Three of every five poor people in Uzbekistan lived in a rural area in 2022, and agriculture accounted for one in four jobs. In the same year, the regions of Karakalpakstan Republic, Khorezm, and Syrdarya topped the lists of areas with the highest poverty rates and elevated agricultural shares of employment. A large share of the population in both rural and urban areas will live in areas of very high climate risk—more than one-fifth of the projected population of Uzbekistan in 2030 (8 million). The highest population concentrations at risk reside in the Ferghana Valley, Khorezm, Bukhara, and Surkhandarya regions (Figure 1.1).

FIGURE 1.1. POPULATION DENSITY AND CLIMATE RISKS IN UZBEKISTAN, 2030



Source: World Bank. 2023. Landscape Restoration Opportunities for Climate Change Adaptation in Uzbekistan. Forthcoming.

a. Population projections based on climate risk mapping and mapping of potential beneficiaries of sustainable agricultural practices and as an indicator of pressure on natural resources in the calculation of the Population Risk Score for 2030 in chapter 4 of the source report.
b. The aggregate Climate Change Risk score is a multicriteria district risk score, unit-less. Higher values correspond to higher risk from potential climate change impacts. The score is the average of four indicators: anomalies in the standardized precipitation evapotranspiration index, maximum rainfall depth in one day, average annual rainfall depth, and anomalies in the growing season length.

People living in the downstream reaches of the Amu Darya basin and facing high water stress and land degradation are likely to experience higher pressure to migrate in the future as increasing droughts and water stress add to the other drivers of migration. Smaller pockets of irrigated croplands in southern Uzbekistan along the Amu Darya are also projected to be outmigration climate hotspots for the same reasons. Estimates of the magnitude of migration vary, but it is clear that a systematic approach is needed to support alternative livelihoods or facilitate outmigration to other regions.[12]

Women in Uzbekistan are especially vulnerable to economic exclusion and disproportionately rely on agriculture for income. Although men account for a larger absolute number of agricultural workers (box 1.1), agricultural work represents a larger share of employment among women, particularly in the cotton sector.

[11] World Bank 2020.

[12] World Bank 2021a.

BOX 1.1. COTTON HARVESTING IS A MAJOR SOURCE OF LIVELIHOODS FOR WOMEN IN RURAL AREAS, WHICH MAY BE THREATENED IN AREAS OF INCREASING WATER SCARCITY

Cotton, a dominant crop in the Karakalpakstan, Khorezm, and Bukhara regions, is highly sensitive to water availability. In these and other rural areas of Uzbekistan, many women rely primarily on informal and seasonal work in agriculture for their livelihoods. According to the International Labour Organization's Third Party Monitoring Report (2020), the cotton harvest season, for example, has offered one of the few opportunities for some women to earn cash income, despite poor working conditions and issues of full and fair payment: women represent 60 percent of pickers, 76 percent of them living in rural areas.[a] Female seasonal workers often encounter poor working conditions, such as long hours, inadequate safety measures, and insufficient access to basic amenities.[b] Increased water scarcity will eliminate scarce employment opportunities for women in areas where cotton production is no longer economically viable. Investment in supporting crop diversification in water scarcity hotspots, with attention to gender issues, is important for helping transition to other farming methods and other sectors.

[a] ILO 2020. [b] World Bank 2017.

At the national level, the country's food system, especially irrigated agriculture, will come under severe climate pressure. Uzbekistan's irrigation and drainage networks—affecting 95 percent of crop production—are the backbone of the country's agricultural and food systems. Irrigated agriculture accounts for more than 25 percent of GDP and employment and 90 percent of water use. Food production is thus especially vulnerable to water shortages, which are projected to increase in frequency and severity with climate change and rising economic and demographic pressures.

Stress on both surface water and groundwater resources will increase, and water will become an increasingly scarce commodity due to climate change, population pressures, and expected economic growth. Climate projections suggest that the flow of the Amu Darya will decrease by 5 percent and the Syr Darya by 15 percent by 2050, with an increase in frequency of low-water flow and drought years and with expected runoff losses of as much as 25–40 percent. Meanwhile, heat stress will increase the demand for water. Also, uncertainties related to the transboundary nature of water resources, including construction of the Koshteba Canal[13] in Afghanistan that will divert water from the Amu Darya, will exacerbate the water situation. In some catchments, water availability is projected to decrease by 30–40 percent by 2050, while irrigation water demand will rise by 25 percent. The total annual water shortage will increase to 7 billion cubic meters in 2030 and to 15 billion cubic meters in 2050. Crop and livestock production will decline, threatening food security countrywide, with potentially dire social impacts, including increased migration. The rural poor will be disproportionately affected. Avoiding these outcomes requires investments in climate-change adaptation measures and in building resilience to water scarcity. More than anything else, this means investing in irrigation modernization and water resources management.

Water shortages tax groundwater resources and lead to land degradation, creating a vicious cycle of lowered land productivity and further stress on water resources. Over 500,000 ha of land is already water-logged and degraded by salinization due to poor irrigation practices and inadequate drainage systems. In the absence of proper drainage, excessive irrigation leads to soil salinity and greatly reduces the productivity of land. To reduce salinity, farmers have to wash the soil by applying more water than is needed to grow crops. The result is a vicious cycle of land degradation and even more inefficient use of water resources. Modernizing irrigation and drainage infrastructure and improving water management practices could prevent further degradation.

Transboundary allocation issues and weak regional cooperation are also key constraints to improving water resources management. Water availability affects economic performance, social cohesion, and even political stability in the broader region, as water is a shared resource that is in high demand for food and energy

[13] According to some estimates, construction of the Koshteba canal in the upper catchment of the Amu Darya in Afghanistan will reduce flows of the river to Uzbekistan and Turkmenistan by 5 billion cubic meters. About 18 percent of the 285-kilometer canal was built recently. The canal will have a capacity of 650 cubic meters a second and will irrigate about 0.5 million hectares.

production, environmental safety, and livelihood security. Climate change is expected to amplify the seasonal and geographic variability in water resources, whose distribution is already highly uneven. Hydropower resources are concentrated in the Kyrgyz Republic and Tajikistan, while thermal energy resources are concentrated in Uzbekistan, Turkmenistan, and Kazakhstan. Energy–water links will play a critical role in Central Asia's economic development, poverty alleviation and shared prosperity, food security, and cooperative relations. However, transboundary water allocation and weak regional cooperation have been difficult barriers to overcome. At the core is a mismatch in the timing of water demands for energy and food production. Whereas the Kyrgyz Republic and Tajikistan need dams to release stored water during the winter to generate electricity, Kazakhstan, Turkmenistan, and Uzbekistan need the reservoirs to store this water until it is needed for agriculture in the summer growing season. Yet history and experience elsewhere have demonstrated that mutual benefits are to be gained from sharing and coordinating use of energy and water resources across borders.

Increased water scarcity risks creates disputes over access to water and productive land in affected areas and undermines social cohesion. A 2021 survey of rural communities participating in the Rural Infrastructure Development Project of the Government of Uzbekistan (GoU) found that, although community disputes are rare, those that arise most frequently relate to access to water (both irrigation and drinking water).[14] Thus mahalla leaders and representatives of state agencies responsible for irrigation services and drinking water delivery are likely to come under increasing pressure to provide services in line with community expectations and mediate increased competition for access to water that may occur among members of the same community, across communities, and between communities across borders.[15] Local disputes over access to water and land in vulnerable border areas such as the Ferghana Valley periodically escalate into large-scale or violent conflicts.

Some of the other most damaging effects of climate change are expected to be on agricultural and livestock productivity and on the health of people and animals. By 2050, rising temperatures may result in productivity losses across the economy of 2.0–3.5 percent. Productivity shocks are expected to be highest for agriculture, followed by industry and services. Significant climate-related losses to livestock productivity are anticipated, adding to food security challenges. By the 2040s, livestock production could decline by 8–13 percent. In the case of the health impacts of climate change, they are also anticipated to be very high. A rising incidence of water-borne and heat-related illnesses could result in a 0.6–1.2 percent increase in mortality by 2050.

Rapid urbanization and population growth exacerbate the risks and challenges associated with urban resilience and disaster management. Urban resilience is a critical issue in Uzbekistan as the country is exposed to multiple environmental and human-caused hazards, such as earthquakes, landslides, floods, droughts, and industrial accidents. Recognizing the importance of enhancing urban resilience, the government has strengthened disaster preparedness and response, improved infrastructure, and promoted sustainable urban development. Measures have included developing national policies and strategies on disaster risk reduction, establishing a national emergency management agency, and promoting community-based disaster risk reduction and climate change adaptation initiatives. However, much work remains to be done to enhance urban resilience, particularly by effectively implementing and enforcing policies and strategies, strengthening institutional capacity and coordination, and promoting public awareness and participation.

[14] In a survey of over 4,000 households in five regions of Uzbekistan, 9 percent of respondents indicated that serious disagreements occur in their village sometimes, often, or very often. Of this subset of respondents, nearly 50 percent reported that disputes occur over access to water.

[15] World Bank 2021b.

Chapter 2

Country climate commitments, policies, and capacities

The Charvak Reservoir, Tashkent region, Uzbekistan.
Photo by Eranicle / stock.adobe.com

2.1. Climate and adaptation commitments

Uzbekistan has made international commitments on climate change and has begun to tighten them. In 2018, Uzbekistan ratified the Paris Agreement and submitted an NDC to reduce GHGs per unit of GDP by 10 percent by 2030 from the 2010 baseline. At the United Nations Climate Change Conference (COP26) in 2021, Uzbekistan increased its commitment to 35 percent. With rapid GDP growth projected, Uzbekistan has scope to commit to even more ambitious GHG reductions. Its Long-Term Decarbonization Strategy, currently under preparation, may provide the basis for an updated NDC. In 2022, Uzbekistan took the Global Methane Pledge and committed to reduce methane emissions by 30 percent by 2030. Uzbekistan does not yet have sector- or GHG-specific emissions reduction targets, although it made significant commitments and showed progress in some sectors, such as the ambitious renewable energy program in the power sector.

Uzbekistan's NDC includes adaptation commitments. Some of the main NDC targets are to enhance the resilience of strategic infrastructure and ecosystems, protect biodiversity, and reduce the harmful impact of the degradation of the Aral Sea basin. Uzbekistan also plans to increase the efficiency of water use, promote crop diversification, introduce organic farming practices, encourage reforestation, and develop early warning systems for hydro-meteorological hazards.

Uzbekistan's plan to transition to a green economy includes important steps to reduce its carbon footprint. In December 2022, the government adopted a Program and a Plan of Action for Transitioning to a Green Economy and Ensuring Green Growth until 2030 (Presidential Decree No. PP-436 of December 2, 2022), which includes measures addressing environmental and economic challenges to achieve green, resilient, and inclusive development. The plan sets key strategic directions and measurable targets, including for crop diversification, water-use efficiency, sustainable land and pasture management, leveraging of public-private financing for sustainable irrigation and a green economy, energy security, low-carbon development, disaster and urban risk management, support for green jobs, and encouragement of innovation for decarbonization and climate resilience.

2.2. The institutional and regulatory framework for climate change is a work in progress

Without a unified law on the response to climate change, the governance framework on climate change impacts consists of a patchwork of presidential decrees, government resolutions, and sectoral strategies. Around 30 laws and 100 decrees related to climate change have been passed through presidential approval or government ministries and Oliy Majlis (Senate and Legislative Chamber). A national climate change strategy is being drafted, as is a National Adaptation Plan to complement the NDC.

Targets and measures to meet climate-related requirements are being incorporated into medium-term sector strategies for water, energy, agriculture, and the environment but are still needed for other sectors. Requirements take the form of GHG limits (power generation, industrial and residential energy use, transport, and land use); energy efficiency goals for industry; and increased water-use efficiency gains, renewable energy capacity, forest cover, and waste service coverage. Enforcement mechanisms still need to be defined.

Multiple ministries are engaged in activities related to the green transition and climate change (box 2.1).[16] The Strategy for Transition to a Green Economy assigns responsibility for strategic guidance and decision-making on the green transition to an interagency council consisting of heads of ministries and agencies and led by the Minister of Economy and Finance.

[16] The climate change institutional arrangements described in this section reflect the status before the ministerial consolidation.

The newly created Ministry of Ecology, Environmental Protection, and Climate Change has key climate change-related functions. Under the management of the Cabinet of Ministers, Uzhydromet has been responsible for developing the national climate change strategy and is the designated national coordinator for the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. In accordance with Presidential decrees issued in May 2023, the Ministry of Natural Resources was transformed into the Ministry of Ecology, Environmental Protection and Climate Change with expanded functions. The Ministry now includes Uzhydromet, the Forestry Agency and the Tourism Agency. The Central Asian University for Environmental Studies and Climate Change was created under the Ministry of Ecology, as well as the National Center for Green Transformation and Adaptation to Climate Change, responsible for fulfilling the obligations adopted under the Paris Agreement.

The Ministry of Economy and Finance (MEF) holds important implementation, coordination, and regulatory roles related to climate. The ministry is responsible for coordinating activities to promote a green economy and implement green growth principles, including reducing GHG emissions, coordinating implementation of activities under Article 6 of the Paris Agreement, and regulating and coordinating Uzbekistan's national and international implementation and management of GHG trade. Over August 2021–February 2022, Ministry of Economy in partnership with Central Asia Regional Economic Cooperation Program (CAREC) and the World Bank convened a set of 11 policy dialogues on green growth and climate change which helped engage over 700 stakeholders and policy makers, built the momentum toward implementation of green transition, and discussed relevant policy recommendations for each sector.[17] The ministry also develops financial mechanisms to support the green transition and monitors the use of funds in climate projects and programs.

BOX 2.1. MINISTERIAL RESPONSIBILITIES RELATED TO THE GREEN TRANSITION AND CLIMATE CHANGE

- Uzhydromet coordinates ministerial input and drafts the national climate change strategy and Nationally Determined Contributions (NDCs), UNFCCC biennial reporting, and climate change data management.
- The Ministry of Investment, Industry, and Trade is responsible for interacting with the Green Climate Fund The and attracting investments for implementing the NDC.
- The MEF is responsible for implementing the Strategy for Transition to a Green Economy and UNFCCC Clean Development Mechanism projects.
- The Ministry of Ecology, Environmental Protection and Climate Change is responsible for state policy in the field of nature conservation, use and restoration of natural resources, waste management, and climate change; maintaining state environmental control for nature protection, including atmospheric air, land, subsoil, water, forests, protected natural areas, protection of flora and fauna, waste management; forests; monitoring climate change and environmental pollution; reducing harmful emissions, reducing the negative impact of human activities on nature.
- The Ministry of Energy, together with the MEF, coordinates the development and implementation of the National Low-Carbon Development Strategy (Long-Term Strategy). The Intersectoral Energy Saving Fund has been established under the Ministry of Energy.
- The Ministry of Agriculture promotes climate-resistant and water-saving technologies and measures to reduce GHG emissions in agriculture.
- The Ministry of Transport leads the gradual transition of public transport to electric traction and measures to expand the production and use of more energy-efficient vehicles.
- The Ministry of Construction, Housing, and Communal Services devises innovative energy-efficient and energy-saving solutions in building construction.
- The Statistics Agency Under the President of the Republic of Uzbekistan provides state agencies with statistical information necessary to prepare and implement the NDC and coordinates implementation of the National Sustainable Development Goals.

[17] https://www.worldbank.org/en/events/2021/09/21/uzbekistan-policy-dialogues-green-growth-and-climate-change
Uzbekistan has adopted Presidential Decree No. PP-436 02.12.2022 "On measures aimed at increasing the effectiveness of reforms with the goal of transition of the Republic of Uzbekistan to a "green" economy until 2030." Raina et al (2022).

Both national and subnational policies are crucial for sustained and just climate change adaptation, mitigation, and green transition. While top-down approaches are necessary for the green transition, its successful implementation requires policies at other levels of government to be aligned with and ready to support complementary climate action and the human development policies (see example of the Netherlands in box 2.2).

BOX 2.2. INTERAGENCY COOPERATION ON THE CLIMATE CHANGE AGENDA IN THE NETHERLANDS

Under the Climate Act that sets emission targets in the Netherlands, the government is required to facilitate implementation of a climate plan, which defines the measures needed to achieve the targets in the Climate Act. The executive and the House of Representatives decide on the policies to be implemented. In addition, a national Climate Agreement with participating industries specifies what they will do to help achieve the climate goals. The Minister of Economic Affairs and Climate Policy coordinates and monitors implementation of the Climate Agreement. Sectoral implementation committees, with representatives of private sector and nongovernmental organizations, have been set up under the direction of sectoral ministers to develop activities under five thematic platforms for each industry to connect labor market demand and human capital development.

Source: National Climate Agreement, the Netherlands (2019).

Subnational governance mechanisms can be progressively strengthened and supported. Subnational governments (khokimiyats and the regional departments of Uzhydromet) prepare and implement territorial hydrometeorological programs, including measures to adapt to climate change, and develop social infrastructure. However, they are not directly involved in formulating national climate objectives. Implementing climate policy requires cross-sectoral approaches across different (urban, rural, and peri-urban) territorial areas. Meeting climate action priorities will mean that plans and resourcing are spatially aligned, with provisions to allow territorial administration mechanisms to effectively contribute.

The governance system in Uzbekistan is highly centralized. Municipal governments have limited capacities and budgets for local economic development programs. The allocation of land and access to existing infrastructure networks are their main tools. Despite some recent reforms, local governments still lack the authority to plan for revenue generation and spending obligations in the medium and long run, to manage them independently, or to make large capital investments. A starting point for more territorially responsive climate action would be to better define the roles, responsibilities, and accountabilities of subnational administrations across the tiers of territorial administration and align them with the requisite fiscal and administrative capabilities. Municipalities are playing an increasingly important role in promoting local climate actions in urban areas through urban planning, regulation, and incentives within their remit (box 2.3).

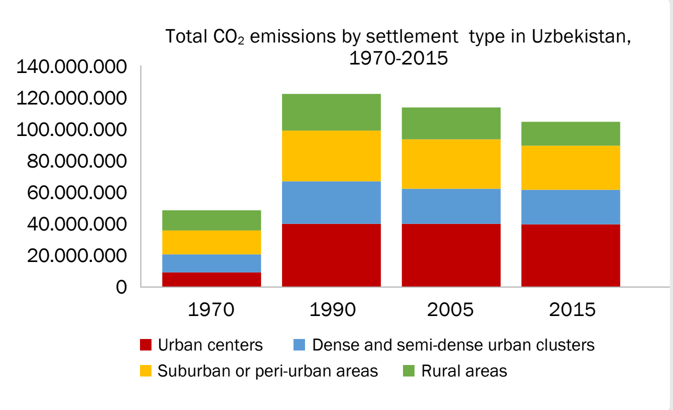
BOX 2.3. CLIMATE ACTIONS WITHIN THE AUTHORITY OF MUNICIPALITIES

Urban centers account for 37 percent of national carbon emissions (see box figure). Urban emissions will rise along with urbanization rates unless mitigation actions are taken. Emissions in cities could be reduced by almost 90 percent by 2050 with technically feasible, widely available measures.[a] While urban decarbonization will depend on national policies (such as electrification, industrial policies, and power sector regulations), cities can also take their own mitigation measures by supporting urban planning that favors compact, transit-oriented urban growth; investing in multimodal infrastructure, including public transit, walking, bicycling, and electric vehicles (EVs); enacting regulations and providing incentives for greater energy efficiency of buildings and industries; and improving solid waste management.

Urban climate mitigation actions have substantial local benefits. Emission reduction in cities also makes them more livable. Switching to clean energy and EVs reduces local air pollution. Reducing dependence on private vehicles also cuts travel costs for individuals and traffic congestion and its associated cost to the economy while promoting the positive health impacts of walking and bicycling. Compact urban form also reduces the cost of municipal infrastructure and service delivery, preserves natural ecosystems and biodiversity, and strengthens food security. Improving building energy efficiency reduces household energy costs. Finally, improving waste management would support climate change goals. Municipal solid waste management is responsible for a large and rapidly growing share of methane, a powerful driver of climate change. Upgrading the waste management system will be essential to curb GHG emissions and make the sector more resilient to climate impacts.

Note: [a]. Coalition for Urban Transitions 2019.

BOX FIGURE 2.3. TOTAL CO_2 EMISSIONS BY SETTLEMENT TYPE IN UZBEKISTAN, 1970–2015



Source: Crippa et al. 2021.

Mahallas, the lowest tier of territorial organization in Uzbekistan, have the potential to strongly influence local climate action. There are over 9,000 mahallas in Uzbekistan, and the government plans to strengthen their role in local service delivery, poverty reduction, and citizen engagement. Recent reforms have strengthened the human resource base in mahallas, increased resources for mahalla-level basic infrastructure, and introduced measures to enable mahallas to raise revenues and execute local development projects. Although the Law on Self-Government Bodies of Citizens, which defines the mandate of mahallas, indicates that mahallas can create commissions on ecology and environmental protection, but there is limited evidence that such commissions function in practice. As a result, public awareness in rural communities about the causes and consequences of climate change is low. Government capacity building for mahalla specialists on climate change could help them become more effective in raising awareness in the community.[18] Government capacity building for mahalla specialists on climate change could help them become more effective in raising awareness in the community.

[18] In a survey of over 4,000 households in five regions of Uzbekistan, less than half of surveyed citizens had heard of climate change (Uzbekistan Rural Infrastructure Development Project 2021 Survey).

Chapter 3

Policies and investments to advance decarbonization

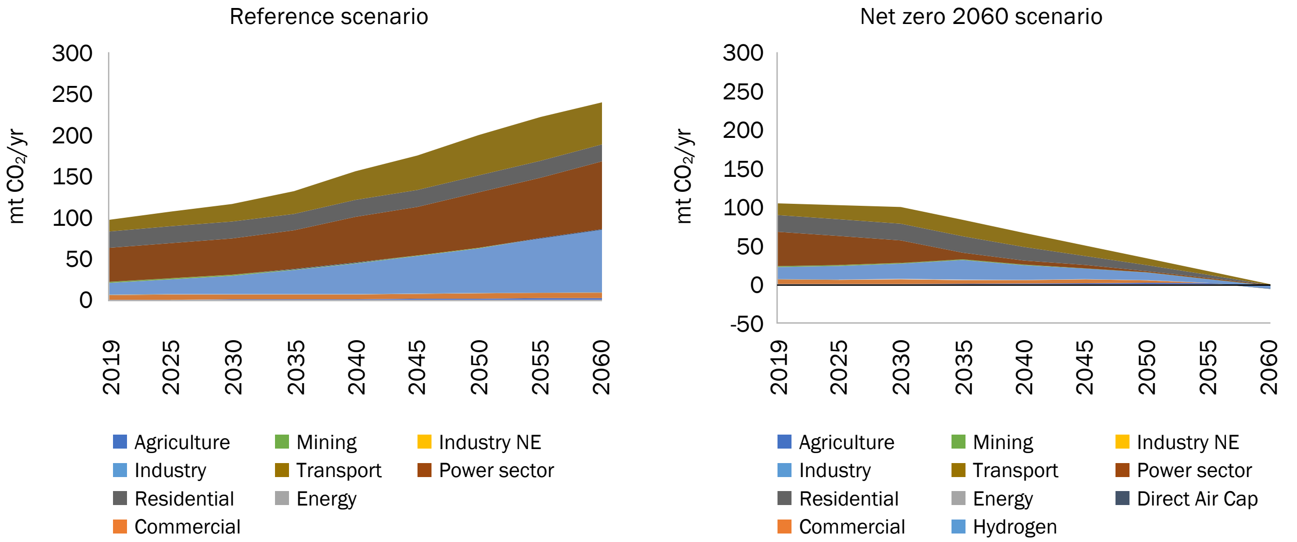
A solar power plant.
Photo by Agnormark / stock.adobe.com

3.1. Decarbonization of the energy system is an opportunity to strengthen energy security

The energy sector,[19] which accounted for 74 percent of GHG emissions in Uzbekistan in 2019, and agriculture, which accounted for 19 percent, are the most important sectors in decarbonizing the economy. Thus, they are the main focus of this chapter. Of the energy sector emissions, around 80 percent are from the burning of fossil fuels (combustion) and 20 percent from fugitive emissions.[20] The bulk of non-energy sector emissions emanate from agriculture (19 percent), waste management (4 percent), and industrial processes (3 percent), which in total account for the remaining 26 percent of GHG emission (2019). The energy sector, or energy system, encompasses the entire value chain from the extraction of energy resources through transformation (power, hydrogen, and so on) to main end users, including buildings, industry, agriculture, and transport.

This chapter examines a least-cost pathway for decarbonizing Uzbekistan's energy sector by 2060 (net zero emissions by 2060, NZ2060) compared with a reference scenario based on existing policies and trends (Figure 3.1). Based on modeling undertaken for this CCDR,[21] both scenarios assume cost-reflective pricing, which implies removing energy subsidies, and both pathways are aligned with Uzbekistan's 2030 NDC targets.

FIGURE 3.1. GHG EMISSIONS IN THE REFERENCE SCENARIO AND THE NZ2060 SCENARIO, 2019–2060



Source: World Bank analysis.

Under the reference scenario, current policies result in much higher dependency on imported energy resources and a doubling of emissions by 2060, indicating that more action is needed to promote the country energy security while mitigating rising emissions. With GDP (and energy demand) expected to rise quickly, Uzbekistan meets its 2030 NDC target as emissions rise more slowly and emission intensity declines. Nevertheless, the country will become highly dependent on imported energy resources, due to limited natural gas availability, with energy imports accounting for 66 percent of supply by 2060, renewables for just 21 percent, and domestic fossil fuel extraction and production for 13 percent. This will also produce a large increase in total emissions in the reference scenario, putting decarbonization out of reach. In this scenario, growth in energy demand is met largely through fossil fuels, while improved emission efficiency is due to the cost-driven uptake of

[19] The energy sector, or energy system, encompasses the entire value chain from the extraction of energy resources through their transformation (power, hydrogen) and use by end users, including buildings, industry, agriculture, and transport.

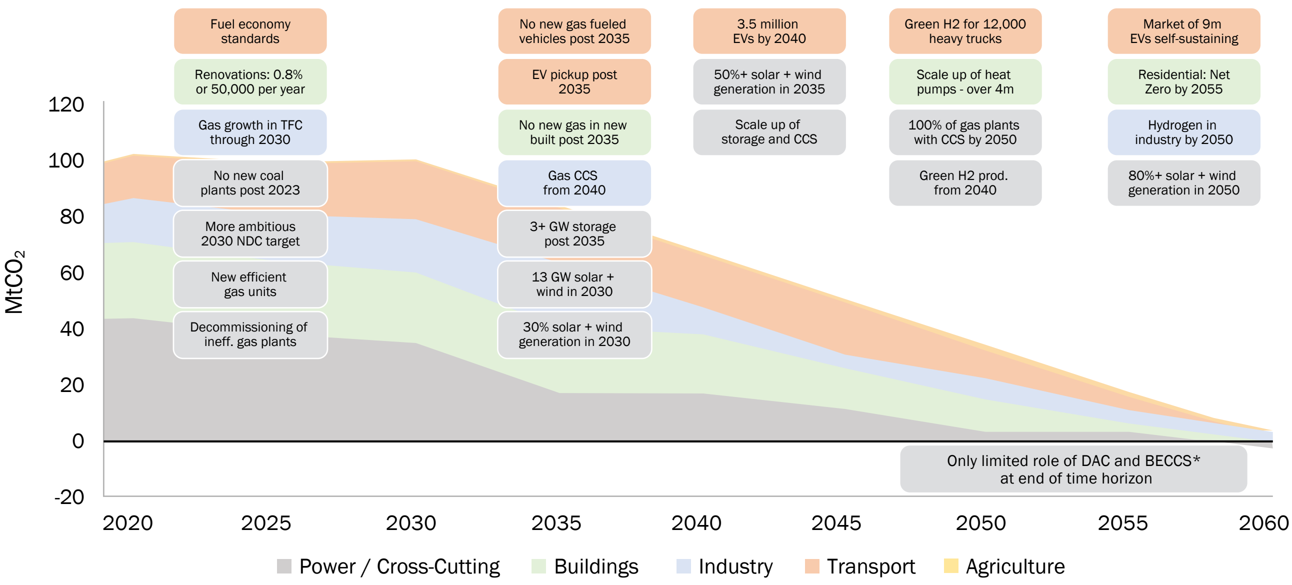
[20] Almost all fugitive emissions in Uzbekistan are related to natural gas leaks, mainly from corroded pipelines and outdated equipment, especially valves (IEA 2022a; see box 3.1).

[21] Various sensitivity analyses were carried out using KINESYS+, a TIMES based energy system modelling framework, and further details can be found in the accompanying Energy System Decarbonization technical paper (available upon request).

renewable energy, a shift from natural gas in the power sector and heating, improvements in energy efficiency, and a small cost-driven uptake of electric vehicles (EVs).

The NZ2060 scenario reflects a feasible least-cost path for the energy sector to achieve peak emissions before 2030 and decarbonization by 2060 while strengthening the country's energy independence. In the NZ2060 scenario, energy security improves, with net energy imports limited to 8 percent by 2060 as most energy is produced domestically. Domestic renewables provide 70 percent of domestic energy supply by 2060 and over 85 percent of supply when combined with hydrogen and domestic extraction and production. Decarbonization follows the steps described in Figure 3.2, including greater deployment of renewables, higher energy efficiency, and use of low-carbon technologies, among others. The power sector drives most of the emission reductions in the first two decades and then reaches almost full decarbonization by 2050, except for small residual emissions from natural gas with carbon capture and storage (CCS). Commercial buildings reach net zero before 2050, followed by residential buildings in 2055. Industry and transport decarbonize last, by 2060. Fossil fuels account for 19 percent of final consumption, which is mainly natural gas with CCS. The NZ2060 scenario would also allow for more ambitious NDC targets for 2030. Energy trade is still significant and an integral part of the country energy security.

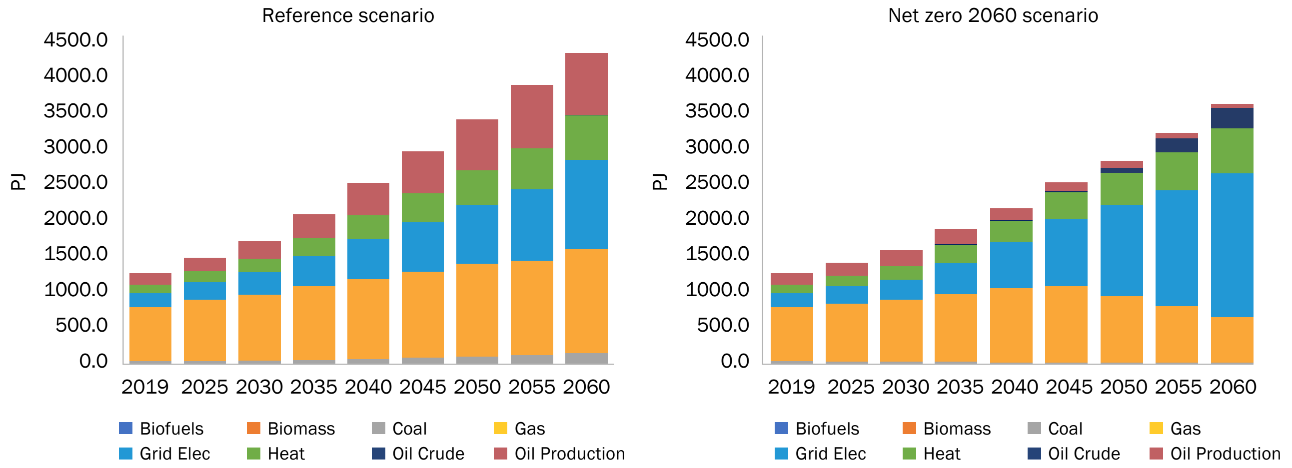
FIGURE 3.2. A POSSIBLE DECARBONIZATION PATHWAY TO A NET ZERO EMISSIONS ENERGY SYSTEM IN UZBEKISTAN, 2019–2060



3.2. How to strengthen energy security and transition away from a natural gas economy

Transition to a decarbonized economy supports Uzbekistan's path to energy security through energy efficiency gains and domestic renewables that are cost-effective and that secure economic growth. Projections show high annual rates of growth for Uzbekistan's economy (more than 4 percent) and population (1.5 percent), generating strong demand for energy and electricity. In the reference scenario, energy demand grows more than 200 percent and electricity demand more than 400 percent by 2060. In the NZ2060 scenario, energy efficiency gains and a switch to more efficient technologies moderate energy demand growth to 160 percent. The size of the power sector more than doubles by 2060 compared to the reference scenario as the net zero system relies on electrification and green hydrogen. In general, technologies available to reach net zero are more limited in Uzbekistan than in some other countries due to limits on natural gas and bioenergy availability for blue hydrogen production, transport, and residential heating. Figure 3.3 presents the total final consumption by fuel in the reference scenario and NZ2060 scenario.

FIGURE 3.3. ENERGY DEMAND GROWTH SLOWS IN THE NZ2060 SCENARIO COMPARED WITH THE REFERENCE SCENARIO: TOTAL FINAL ENERGY CONSUMPTION BY FUEL

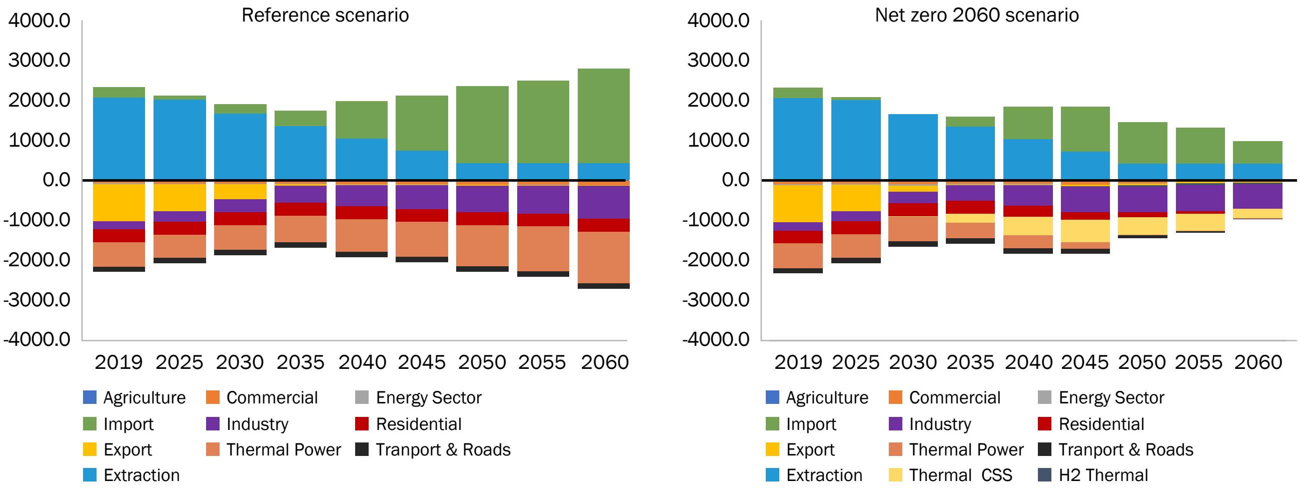


Source: World Bank analysis.

With natural gas running out, the energy system in Uzbekistan is at a crossroad. Uzbekistan's gas-dependent economy is gradually running out of domestic gas, with the gap between domestic production and peak gas demand increasing every year. Annual gas production is expected to peak in 2023, at around 57 billion cubic meters. Based on current reserves, gas production is expected to then decline sharply to 10 billion cubic meters by 2050. Historically, Uzbekistan has been a net exporter of natural gas, but it has begun to import increasingly more natural gas during the winter. As part of its strategy for the sector, the government is now planning to ban natural gas exports by 2025.

Rationing natural gas use can reduce its consumption by 40 percent by 2060 relative to 2019. Limited gas availability in Uzbekistan requires a significant shift away from gas across all sectors—for example, moving to more efficient vehicles, switching to EVs, and decarbonizing heating (supported by heat pumps and district heating). In the NZ2060 scenario, no new gas connections are permitted for heating in new residential buildings after 2035. In transport, no new compressed natural gas (CNG)-fueled vehicles are allowed after 2035. Natural gas is prioritized for the power and industry sectors, while its use is reduced for heating and transport. Natural gas is not available for blue hydrogen production. Figure 3.4 presents the natural gas balance for domestic production, imports, and uses in the two scenarios.

FIGURE 3.4. NATURAL GAS CONSUMPTION DECLINES BY 40 PERCENT IN NZ2060 SCENARIO COMPARED WITH THE REFERENCE SCENARIOS: NATURAL GAS DOMESTIC PRODUCTION, IMPORTS, AND USES, 2019–2060



Source: World Bank analysis.

Renewable energy and especially solar and wind power investments are expected to advance in both scenarios. The power sector accounted for 42 percent of energy sector emissions in 2019 and is expected to see the largest sectorial growth. With electrification, the power sector's share in total energy consumption increases from 16 percent in 2019 to 55 percent in 2060, in the NZ2060 scenario. Among renewables, solar and wind have the largest potential (39 GW in 2035 in NZ2060), starting to account for a majority of power generation after 2035 in the NZ2060, while accounting for 30 percent by 2035 in reference scenario. Hydropower reaches 3.4 GW by 2035 in the NZ2060 scenario. Other renewables could also play a role in the power sector as well as in heat production: geothermal and biomass have a theoretical potential of 1 GW and 15–17 GW, respectively, according to IEA (2022a). By 2050, power exports peak at 9 percent of generation and imports at 4 percent in the reference scenario, while exports peak at 9 percent in the NZ2060 scenario, helping to balance solar and wind generation and enabling the use of hydropower and thermal generation from neighboring countries.

Moving from a gas-dominated power system to a solar- and wind-dominated power system comes with significant integration challenges. Power system flexibility in Uzbekistan is relatively high already due to flexible gas and hydropower plants. Additionally, new sources of flexibility will need to come in after year 2030, including storage, cross-border trade, and the flexible dispatch of green hydrogen production. Battery storage needs reach 3 GW by 2035 in the NZ2060 scenario.

Under both scenarios, the government needs to promote more efficient use of natural gas in the power sector. More efficient gas use requires upgrading the design of gas infrastructure and equipment—from the well to the power switch—to minimize losses and inefficiencies throughout the supply chain. The decommissioning of simple cycle power plants and their replacement with combined-cycle gas turbine (CCGT) alone would increase the efficiency of gas use by 50 to 60 percent. In the NZ2060 scenario, most new gas-fired power generation is equipped with CCS from 2035 onwards. Gas with CCS continues to play a balancing role in the power system throughout the 2060 timeframe, alongside hydropower generation and storage. The key uncertainties of the CCS technology include capture rates (from 80–95 percent), the carbon transit routes (from the main domestic sources to the storage locations), and high uncertainty of associated costs and efficiencies.[22] Under both scenarios, Uzbekistan should prioritize reducing fugitive emissions (including methane venting and flaring) and technical losses of electricity (Box 3.1).

BOX 3.1. REDUCING ENERGY-RELATED METHANE EMISSIONS IN UZBEKISTAN'S GAS SECTOR

Rapid and sustained reductions in methane emissions are key to limiting near-term global warming and improving air quality. Based on the International Energy Agency (IEA) 2023 global methane tracker, methane is responsible for around 30 percent of the rise in global temperatures since the industrial revolution. The global warming power of methane is 84 to 87 times larger than that of carbon dioxide. The energy sector accounts for nearly 40 percent of methane emissions from human activity and has higher abatement potential than agriculture.

Both energy-related methane emissions and natural gas losses have been declining in Uzbekistan, but they are still very high compared to other countries. In May 2022, Uzbekistan became one of the 150 signatory countries of the Global Methane Pledge (GMP) and agreed to take voluntary actions to contribute to a collective effort to reduce global methane emissions by 30 percent by 2030 (compared to 2020). However, challenges with implementation are substantial and were made even more difficult by a high degree of uncertainty, as outlined below. Detailed measurement campaigns and studies are needed to identify strategies, road maps, and investment needs to reduce energy-related methane emissions and gas losses in Uzbekistan.

[22] To achieve decarbonization, further innovation in CCS technology is required to boost carbon capture efficiency from 90 percent to 95 percent and reach cost levels of $25/ton of CO_2 captured. CO_2 transportation and injection costs currently vary from $10 to $100/ton internationally, subject to transport distance and the geophysical characteristics of aquifers.

Box 3.1.

Energy-related methane emissions account for about 25 percent of total GHG emissions in Uzbekistan. Within energy-related methane emissions, fugitive[23] methane emissions account for 36 percent, while venting[24] contributes 54 percent and incomplete flaring[25] contributes 5 percent, according to IEA estimates. Incomplete flaring additionally contributes to CO_2 emissions via the combustion of 0.4 to 0.5 billion cubic meters of gas, adding approximately 1 million tons of CO_2 emissions annually in Uzbekistan.[26]

Investments of US$220 million could abate 150 million tons of CO_2 equivalent according to the geospatial analysis of methane emissions in Central Asia by the International Finance Corporation (IFC). For the implementation, Uzbekistan should also develop the capacity to monitor methane emissions and constructively engage with polluters. At the current price for carbon in Europe, such an abatement would be worth EUR 150 billion.[27]

Natural gas losses arise from the difference between the volume of gas entering the transmission and distribution system and the volume sold to end users. Fugitive methane emissions along the gas transmission and distribution system (due to leaks, for example) count toward technical losses, whereas venting, flaring, and fugitive emissions during upstream and non-gas-related operations are not included in losses because these volumes never enter the gas grid. In addition, commercial losses include measurement inconsistencies due to pressure and temperature differences at the place of entry and consumption, metering issues, and gas theft, among other issues. IEA statistics put natural gas losses at only 2.4 percent of total consumption, but the IEA's in-depth review of Uzbekistan's energy sector notes that "official information on Uzbekistan's gas distribution system losses is restricted and is not publicly available," so the reported statistics are not reliable.

Low-carbon (blue) hydrogen production is constrained by limited natural gas, but the NZ2060 scenario sees the development of green hydrogen after 2040. Hydrogen in this scenario represents 2 percent of energy use in 2050, rising to 8 percent by 2060. Hydrogen use does not become cost-effective before 2060 in the power sector, but it becomes cost-effective sooner in freight transport for heavy trucks; district heating; industrial fuel for cement, steel, and chemicals production; feedstock for ammonia production; and direct air capture operations. Hydrogen becomes cost-effective in district heating because alternative clean technologies like gas with CCS and biogas/biomass with CCS cannot reduce emissions to zero. Uzbekistan may be able to trade green hydrogen with neighboring countries and China through gas pipeline infrastructure updated to hydrogen, but access to other hydrogen markets is limited by high transport costs. The expected cost-effectiveness of electrolyzers, which are used to produce green hydrogen from electricity, supports the business case for green hydrogen production in Uzbekistan from both the supply- and demand-side perspective; hydrogen production in Uzbekistan could rely on domestic solar and wind power and benefit from the domestic demand for hydrogen.

In the NZ2060 scenario, energy efficiency measures and technology advances reduce end-use energy consumption by 16 percent by 2060. Among other benefits, energy efficiency gains provide an important buffer against energy bill increases resulting from upcoming tariff reforms, notably for consumers in residential buildings. Figure 3.5 shows total final consumption by sector in the reference and NZ2060 scenarios.

[23] Fugitive emissions refer to the unintended releases of methane into the atmosphere during the production, transmission and distribution of natural gas and other hydrocarbons (e.g., from faulty seals or leaking valves).

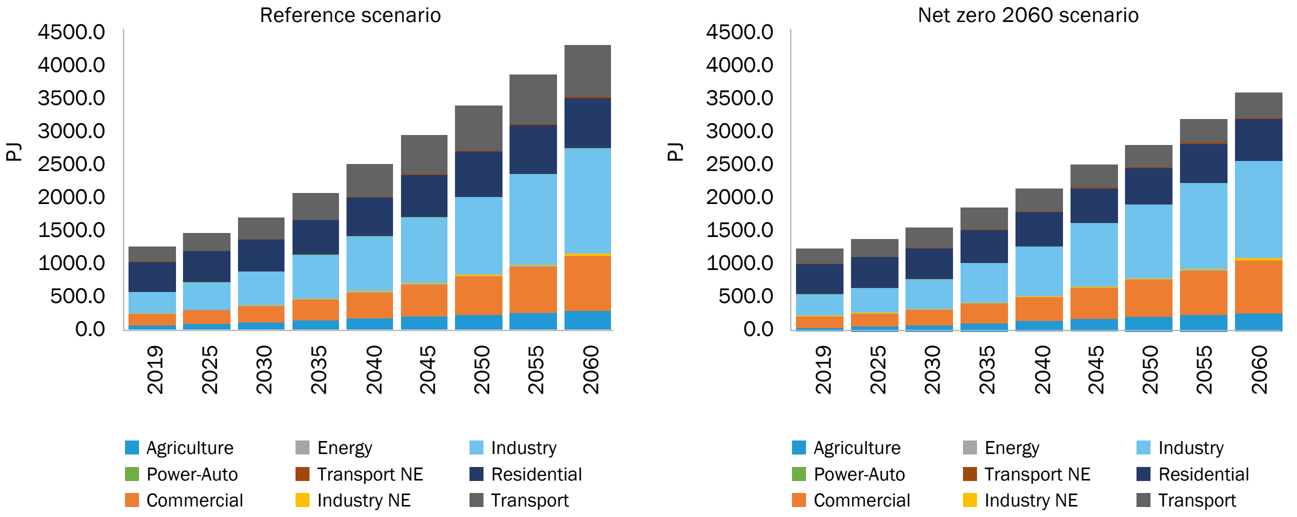
[24] Venting means the intentional release of methane into the atmosphere, predominantly during the upstream production process (e.g., for safety reasons) and – to a lesser extent – from the midstream infrastructure (e.g., to facilitate pipeline inspections).

[25] Incomplete flaring contributes to energy-related methane emissions when a portion of the methane intended to be burned is not combusted, and it thus enters the atmosphere in the form of methane rather than as CO_2 and water.

[26] Calculated based on World Bank Gas Flaring Data for Uzbekistan, using default assumptions for methane content (80%), flaring efficiency (98%), and global warming potential (100-year timeframe).

[27] According to the forthcoming IFC Methane study in Kazakhstan and Uzbekistan (2023)

FIGURE 3.5. END-USE ENERGY CONSUMPTION DROPS BY 16 PERCENT IN THE NZ2060 SCENARIO COMPARED WITH THE REFERENCE SCENARIO: TOTAL FINAL CONSUMPTION BY SECTOR, 2019–2060



Source: World Bank analysis.

Industry decarbonizes late, shifting to low-carbon technologies, including electrification, natural gas with CCS, and green hydrogen. In the NZ2060 scenario, emissions in industry climb gradually to 34 percent of end-use sector emissions by 2035 and remain above 30 percent until 2050, after which the adoption of green hydrogen and gas with CCS technologies results in a sharp decline to zero by 2060. Industry continues to emit a small amount of carbon by 2060, mitigated by direct air capture. In contrast, in the reference scenario, fossil fuels continue to dominate in industry. To realize the full impact of the low-carbon technologies, the NZ2060 scenario sees widespread adoption of energy management systems (such as ISO 50001), supported by tax breaks and other incentives that boost industrial efficiency, in combination with deployment of more efficient motors, pumps, drives, and other key technologies. From 2030 to 2040, an increase in the use of automation and artificial intelligence applications in the NZ2060 scenario reduces industrial energy and emissions intensity. Emission limits and minimum energy performance standards for key industrial technologies are additional tools to limit energy demand growth while cutting emissions in the NZ2060 scenario.

Population and GDP growth have caused a steep rise in private vehicle ownerships and truck movements in Uzbekistan's transport sector, while the railways and public transport have not kept up with the connectivity needs. Passenger-km has grown by 75 percent in only 12 years (2010–2022),[28] freight activity has grown by 25 percent in the same period,[28] and the total vehicle fleet has grown by 44 percent in the last 5 years. As the current motorization rate (around 100 vehicles per 1,000 inhabitants) is still well below international comparators, the vehicle fleet in the country is expected to increase further. As this would ultimately increase the energy needs for the transport sector, attention should be given to reducing reliance on CNG to fuel the national fleet, considering the limited availability of natural gas in the country, and a gap between domestic production and peak demand widening each year.

Increasing motorization associated with an old fleet and lack of attractive public transport are leading to increase in congestion and air pollution, particularly in Tashkent. Tashkent City accounts for one-fifth of the total passenger car flow in Uzbekistan, two-thirds of passenger car flow in the Tashkent region, and almost 17 percent of vehicles registered nationally. Rapid growth in the registration of vehicles has driven congestion and local particulate emission increases. Yandex data highlight the seasonal nature of congestion in Tashkent, with traffic jams being at their worst in winter months. These are expected to worsen without preemptive action from

[28] Statistics Agency Under the President of the Republic of Uzbekistan. 2023. Passenger transportation and passenger turnover by transport type. https://stat.uz/en/official-statistics/services

Tashkent City Hall. Congestion significantly raises transport's contribution to local particulate emissions through the idling of engines, fuel-inefficient driving patterns, and the need to drive extended distances to secure parking space.

Rail has a major role in freight transport in Uzbekistan but has been steadily losing freight modal share to an increasingly competitive trucking sector, especially on domestic traffic. While rail still holds the majority of the freight transport market with 55 percent of freight activity in 2022 (ton-km) against 45 percent for roads,[29] this has been showing a steady reduction compared to the 71 percent share sustained in 2010.[30] The limitations on last-mile connectivity make rail domestic traffic more exposed to the growing competition from roads, while for international transport, the rail sector has managed to increase the transported volumes, leveraging its higher competitiveness over longer distances. The rail sector shall not only consolidate and increase its relevance for international freight transport (including transit, where rail holds a large majority share[31]) but also improve the operational efficiency of the sector to limit the loss in the modal share for domestic transport.

Uzbekistan, a doubly landlocked country, faces high transport costs that restrict its productivity, but it can integrate more deeply into regional and global value chains by improving logistics services. In the recently released 2023 international Logistics Performance Index, Uzbekistan's overall ranking was 88 out of 160 countries.[32] Further improvements to railway efficiency, enhanced cross-border operations, and strategically located logistics centers can lower transport costs and increase competitiveness in foreign markets,[33] especially in sectors where Uzbekistan's comparative advantage is not being fully exploited due to transport costs barriers. In addition to lowering logistics costs and increasing efficiency, this can help consolidating the rail competitiveness over long hauling distances (for certain commodities) against a more carbon-intensive trucking sector.

As natural gas availability shrinks toward 2060, the transport sector shifts to a reliance on oil and electricity in the reference scenario and to electricity and hydrogen in the NZ2060 scenario. The transport sector accounted for 25 percent of end-use sector emissions in 2019 and is expected to account for 32 percent by 2060 in the reference scenario. Along with industry, the transport sector is the last to decarbonize in the NZ2060 scenario. Electrification of transport in the NZ2060 scenario is accompanied by energy efficiency gains of close to 50 percent arising from dramatically increased vehicle power conversion efficiency compared with internal combustion engines. The key drivers of transport sector decarbonization in the NZ2060 scenario include rising fuel efficiency standards and their enforcement, electrification of passenger road and rail transport, a shift to hydrogen for freight, a shift from individual to public transport, and urban design for walkable cities. In 2019, the transport consumption mix consisted mainly of natural gas (54 percent) and oil (44 percent). In the NZ2060 scenario, gas use drops to 42 percent by 2035, 20 percent by 2050, and 2 percent by 2060 (Figure 3.6). Grid electricity rises from 2 percent to 25 percent of consumption by 2040 and 82 percent by 2060. Hydrogen accounts for 5 percent of transport consumption in 2045, climbing to 16 percent by 2060. Biofuels play an insignificant role in both scenarios because of lack of land and water for biofuel production in Uzbekistan.

In freight road transport, light duty trucks decarbonize by going largely electric in the NZ2060 scenario, while heavy duty trucks decarbonize through electrification and hydrogen. In the NZ2060 scenario, light duty trucks go electric, reaching 250,000 electric light duty trucks by 2040 and over 1.2 million by 2060. Hydrogen fuel plays a role in freight transport for heavy duty trucks in the NZ2060 scenario, fueling a fleet of 12,000 vehicles in 2045 and growing to 61,000 by 2060, in the final push toward decarbonizing road transport. Hydrogen accounts for 5 percent of transport consumption in 2045, climbing to 16 percent by 2060. Biofuels play an insignificant role in both scenarios because of inadequate land and water for biofuel production in Uzbekistan.

[29] Considering only the rail-road split, i.e., excluding pipeline transport.

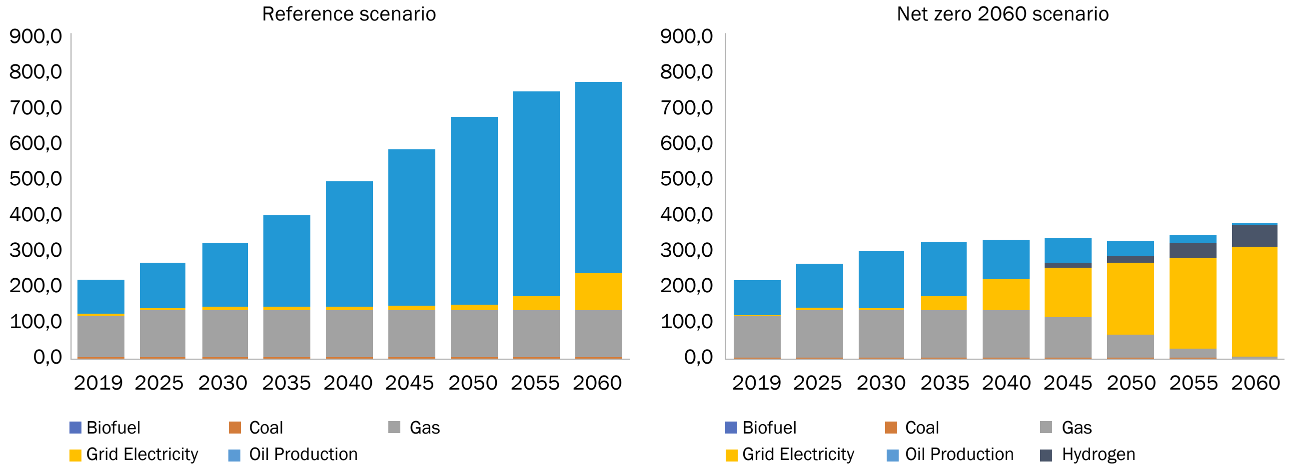
[30] Statistics Agency Under the President of the Republic of Uzbekistan. 2023. Freight transportation and freight turnover by transport type. https://stat.uz/en/official-statistics/services.

[31] Statistics Agency Under the President of the Republic of Uzbekistan. 2023. Socio-economic situation of the Republic of Uzbekistan. https://stat.uz/en/quarterly-reports/39036-2023-eng-2.

[32] World Bank. 2023. Connecting to Compete 2023: Trade Logistics in an Uncertain Global Economy. The Logistics Performance Index and Its Indicators.

[33] World Bank. 2020. Uzbekistan: Building Blocks for Integrated Transport and Logistics Development.

FIGURE 3.6. OVERALL FUEL USE DECLINES IN THE TRANSPORT SECTOR, AND THE FINAL CONSUMPTION MIX SHIFTS GREEN IN THE NET ZERO SCENARIO COMPARED WITH THE REFERENCE SCENARIO: TRANSPORT'S TOTAL FINAL CONSUMPTION BY FUEL, 2019–2060



Source: World Bank analysis, preliminary results.

EVs begin to feature in the NZ2060 scenario from 2030 to 2040, with 3.5 million EVs projected on Uzbekistan's roads by 2040. By 2060, EVs reach a little over 9 million in the NZ2060 scenario, making up almost the entire vehicle fleet. Well-designed public transport systems included in the NZ2060 scenario help Uzbekistan reach higher levels of motorization. Combined with other policies to decarbonize the transport sector, this can forestall the purchase of more than 3 million new passenger vehicles by 2060 in the NZ2060 scenario compared with the reference scenario and reduce electricity demand for transport. In the NZ2060 scenario, the number of electric buses reaches 60,000 in 2040 and 210,000 in 2060, while all rail lines are electrified. In addition, urban planning and awareness campaigns in the NZ2060 scenario support modal shifts to public transport, walking, and cycling, while remote and hybrid work patterns further reduce transport demand and emissions pressures. Achieving transport sector decarbonization and electrification in line with the NZ2060 scenario will require a strong focus on EVs and related charging infrastructure in the near and medium terms and advanced (automation) e-mobility solutions and green hydrogen for freight in the longer term.

The mining sector is expanding quickly but sustaining its competitiveness will require reducing emissions and pursuing new climate-smart mining opportunities related to green manufacturing and low-carbon growth. Uzbekistan ranks among the top 30 countries in the world in terms of energy and mineral reserves, including natural gas (proven reserves for 18 years), oil (reserves for 35 years), gold, copper, uranium, and coal (reserves for over 200 years). Gold represents about 25 percent of the country's exports. Furthermore, Uzbekistan has regionally significant CO_2 storage potential. A key question for the next decade is how these natural resources can best be utilized and maximized for economic growth.

3.3. Costs of the energy transition and investment needs

Significant investments are needed to replace aging energy infrastructure (US$262 billion in the reference scenario), and even more for mitigation, decarbonization (US$341 billion) (table 3.1). Total investment needs without decarbonization are estimated to amount to 2.9 percent of GDP per year or 3.8 percent of GDP per year to reach decarbonization by 2060. These investments encompass all technologies involved in the energy system value chain including the power and hydrogen sectors, as well end-use sectors: buildings, industry, and transport (machinery, appliances, conventional and EVs, boilers and heat pumps, building energy efficiency upgrades, and so on). Such investments will spur economic opportunities in the country and will require a conducive environment, as well as a mix of public and private funds, with foreign direct investment (FDI) playing an important role. For the most energy and end-use sectors, the share of private sector investments is expected be higher than 60 percent, with a high degree of uncertainty as public sector spending can vary depending on targeted government support programs.

TABLE 3.1. INVESTMENT NEEDS BY SECTOR, AND SHARE OF PRIVATE SECTOR INVESTMENTS

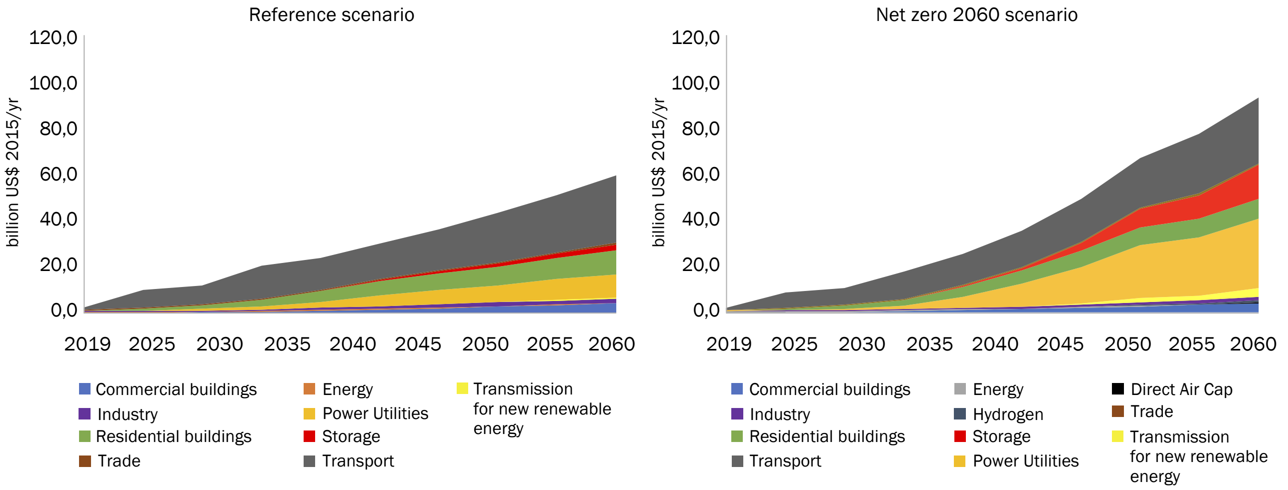
Scenario	Sector	Total discounted investment needs 2023–2030	Total discounted investment needs 2031–2060 (US$, billions)	Estimated share of private sector (%)	Total discounted investment needs 2023–2060 (% of GDP per year)
Reference scenario	Residential and commercial buildings	8.8	46.8	80–95	3.0
	Power sector	7.3	34.2	60–75	1.6
	Industry	2.7	6.8	90–100	0.5
	Transport sector (including vehicles)	46.4	109.5	90–95	8.4
NZ2060 scenario	Residential and commercial buildings	8.9	49.2	80–95	3.1
	Power sector and hydrogen	7.5	98.4	60–75	4.0
	Industry	2.5	6.3	90–100	0.5
	Transport sector (including vehicles)	46.2	122.1	90–95	9.0

Source: World Bank analysis.
Note: Estimated share of private sector is based on international and country specific sub-sector trends (historic and projected).

Power, storage, and transmission investments are significantly higher in the NZ2060 scenario, reflecting the needs of a much larger and more complex power sector. In both scenarios, most investment goes into transport (including cost associated with vehicle purchases), followed by commercial and residential buildings (including the cost of building energy efficiency upgrades), the power sector, storage, and cross-border infrastructure (Figure 3.7). In the NZ2060 scenario, transport and power sector investments rise, and storage investments skyrocket to US$16 billion (undiscounted) in 2060. Annualized total investments in the NZ2060 scenario reach US$20 billion (undiscounted) in 2030 and US$106 billion (undiscounted) in 2060.[34] These investments encompass all technologies involved in the energy system value chain (machinery, appliances, EVs, heat pumps, building envelops related to energy efficiency investments, and so on). Mobilizing that level of investment will require a mix of public and private funds, and FDI will be important. The private sector will have a large role in funding investments in the transport sector, in buildings, in industry, and in the power sector. For instance, firms and households will purchase EVs, electrolyzers, heat pumps, and building envelopes, and the government can facilitate and accelerate the transition by introducing incentives (including grants) for scaling up the adoption of new building envelops, EVs, and heat pumps. Government funding, state enterprises, and international financial institute financing are expected to play a larger role in transport infrastructure and in transmission and distribution.

[34] Annualization means that investments are spread out over the lifetime of the asset.

FIGURE 3.7. ANNUAL INVESTMENT NEEDS (UNDISCOUNTED) IN THE REFERENCE SCENARIO AND THE NZ2060 SCENARIO, BY SECTOR, UNDISCOUNTED VALUES, 2019–2060



Source: World Bank analysis.

Note: Transmission investments include only the transmission necessary to connect new renewable energy. The analysis excludes the update and extension of electricity and gas transmission and distribution networks that are expected in both scenarios.

Decarbonization will bring substantial benefits across the infrastructure sector compared to the reference scenario. The CCDR has estimated such benefits at over US$178 billion over 2023 to 2060 (including about US$112 billion of avoided economic cost of pollution; accidents and damage in the residential, power, industry and transport sectors; and US$66 billion of avoided fossil fuel imports). Table 3.2 summarizes the results of the analysis.

TABLE 3.2. DECARBONIZATION'S INVESTMENT NEEDS AND ECONOMIC BENEFITS

Sector		Present Value 2023–2030 (US$, billions)	Present Value 2031–2060 (US$, billions)
Decarbonization's additional investment needs in comparison with the Reference scenario *(Reference case investments minus NZ2060 investments)*	Residential and commercial buildings	−0.1	−2.8
	Power, heat, and hydrogen sectors	−0.3	−63.4
	Industry	0.2	0.3
	Transport sector (including vehicles)	0.2	−13.1
Decarbonization's benefits - avoided economic cost of pollution, accidents, and damage per sector in comparison with the Reference scenario	Residential	4.1	
	Power	22.0	
	Industry	11.6	
	Transport including air pollution, reduced traffic accidents, and reduced road damage	74.4	
Decarbonization's benefit - avoided fossil fuel imports		66.6	

3.4. Enabling environment for the transition of the energy value chain

As Uzbekistan decarbonizes its economy and energy sector, enabling measures will be critical to successful transition. While some key enabling measures across fuels and sectors have already been mentioned, this section examines select measures in more detail for end-use sectors (buildings, industry, and transport) and the power sector and identifies necessary governance reforms.

Policy leadership, in the form of strategic direction and concrete milestones, is the foundation for a suite of enabling measures for a transition to net zero emissions. The GoU has already made substantial progress (see chapter 2), but it could go further in adopting a net zero target for the power sector by 2050. Current targets could also be consolidated into an overarching net zero action plan.

Energy sector reforms to improve governance and spur competition are a critical enabling component for achieving net zero. The government has already initiated reforms to move toward a market-based model for energy sector management and operation. It has established a new agency for public-private partnerships and has unbundled vertically integrated utilities. Still needed are regulations for a wholesale energy market, establishment of an independent energy regulator, and commercialization of the National Electric Grid of Uzbekistan (NEGU).

Reducing the country's dependency on natural gas will require implementation of a series of short to medium term actions, which will help mitigate winter shortages. The emergency response protocol currently under development by the government prepares the country for the possible upcoming winter crises and also supports the long-term decarbonization effort by preparing the gas and electricity system stakeholders (including relevant agencies, ministries, and system operators) for the higher variability of supply, in terms of both gas availability and variability of solar and wind generation while also tapping into new demand side flexibility opportunities.

Additional measures, such as ensuring that transmission system operators and distribution system operators are incentivized/remunerated to support distributed renewable energy sources can help level the playing field in the sector while moving toward a fully functioning energy market that is ready for net zero. In addition to tariff and subsidy reforms, the government can use temporary tax breaks to incentivize industries to deploy energy-saving technologies. Getting Uzbekistan's industries ready for net zero will also require review of building codes, and targeted incentives to increase the uptake of CCS and green hydrogen, particularly during 2050–2060.

Accelerating the scaling up of renewable energy will play an essential role in the power sector, but more broadly technologies and fuels will need concentrated attention across the energy system to enable decarbonization. Declining domestic gas production can result in more electrification and together with a ban on new coal power development can drive the system toward lower emission in the short term. In the medium- and long-term, increased domestic gas storage would drive further efficiency in the use of gas resources. Setting a specific target for battery energy storage system by 2030/2035 would be appropriate, particularly if accompanied by a requirement for all gas power stations to adopt CCS. There are also possibilities to use geothermal resources for district heating and cooling, especially in the Fergana Valley (Namangan region: potential of 42,600 tons[35] of coal equivalent [tce]) and the Bukhara region (81,200 tce).

Targeted incentives will also be crucial in the transport sector, particularly for shifting from internal combustion engines to EVs. In the short term to 2030, consumers will need incentives to adopt EVs and retrofit older vehicles, as appropriate. Making the EV market self-sustaining by 2060 will also require substantial incentives during 2030–2050. Incentives for using green hydrogen in freight will be an important part of this policy mix. In agriculture, technology-specific incentives can offset some of the projected emission increases by enabling farmers to procure on-site renewable energy sources, pumps, irrigation technologies, and other equipment at reduced costs.

[35] According to IFC analysis by BeicipFranlab, Scaling Geothermal – Phase 1, Analytical Report, April 2023

Standards, notably for fuel economy, are fundamental in the transport sector. In addition to standards, targets for electrification of road and rail transport are important for sending the right market signal to manufacturers, investors, and consumers on the transition to EVs.

In the buildings sector, minimum energy performance standards for all types of energy-using equipment can deliver significant efficiency gains while supporting energy security objectives. Standards are particularly effective if accompanied by annual building renovation/retrofit targets, robust codes for new buildings, and targeted phase-outs of fossil fuel technologies. Minimum performance standards can also improve energy and carbon efficiency in industry.

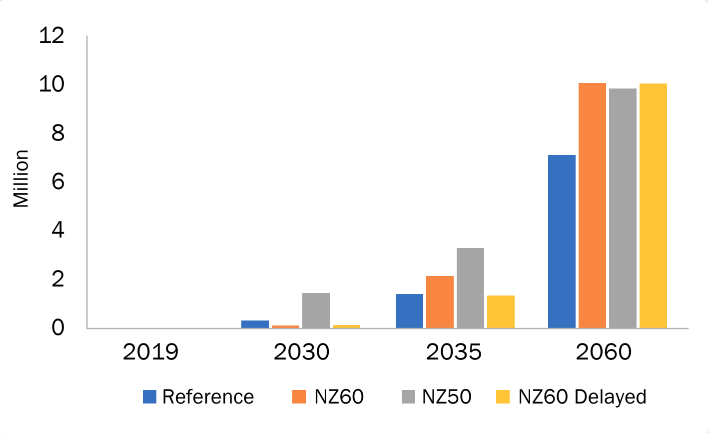
The buildings sector is a particular focus of financing and investments, with urgent action required to avoid locking in high-carbon and energy intensities in the built environment. Implementing policies and regulations for low-carbon housing and enforcing minimum energy performance standards in building codes would enable scaling up construction of low-carbon housing and settlements. In addition to dedicated funding to support building retrofits, investments in Uzbekistan's district heating systems could make it easier to shift from the heavy reliance on gas, especially in residential buildings. Bulk procurement of efficient technologies could be rolled out in the near term to improve efficiency and reduce emissions in buildings and industry. At a later stage, green hydrogen and CCS could receive dedicated investments to support late-stage decarbonization in industry, as outlined in the modeling for this report.

A range of technologies would need to be deployed across building types to drive down emissions and avoid locking in inefficient systems. In residential buildings up to 2030, key technologies to focus on are district heating, insulation, LEDs, heat pumps (see box 3.2), smart meters, and on-site solar. In commercial and public buildings, controls, automation, and analytics are readily available and affordable. Medium- and longer-term focus areas include EV charging and renewable energy technologies, particularly in new construction. Residential buildings could also be enabled with such technologies. Energy consumers can become 'prosumers' by becoming energy producers with generators of on-site renewables and aggregators of providing demand response and storage services.

BOX 3.2. THE HEAT PUMP OPPORTUNITY

Heat pumps are a critical and mature decarbonization technology whose uptake is expected to pick up in Uzbekistan and globally. In all scenarios in Uzbekistan, heat pumps reach over 6 million units serving 6 million dwellings by 2060. The uptake of heat pumps is much steeper in a green growth pathway, reaching around 2 million in 2030 and over 3 million in 2035. With the shift to heat pumps in the NZ2060 scenario, 82 percent of residential heat output is provided by heat pumps in 2060 as opposed to 59 percent in the reference scenario. These scenarios assume a ban on new gas/coal boiler buildings from 2035 onward. This policy is already being deployed in several EU countries, including France and Germany, and in the United Kingdom, effective from 2023 to 2025.

BOX FIGURE 3.2. ESTIMATED NUMBER OF HEAT PUMPS IN THE RESIDENTIAL SECTOR, 2019–2060



Source: KINESYS-based World Bank Energy System Model.

Pumping water for irrigation consumes 15–20 percent of the electricity used in Uzbekistan, which is equivalent to more than 3 million tons of CO_2 emissions every year or about 2–3 percent of the country's total emissions. Water-use inefficiencies directly contribute to the high carbon footprint of irrigation services, as more energy is spent to channel water through the system to compensate for high water losses. Conveyance losses are large because of aging irrigation infrastructure, with some systems reporting water-loss rates of as much as 60 percent.

The Ministry of Water Resources plans to reduce energy consumption at 1,687 state-owned pumped-irrigation systems from 8.2 billion kilowatt hours (kWh) to 6 billion kWh in 2030. This will require major investments in upgrading equipment and modernizing[36] irrigation systems to improve water-use efficiency and energy efficiency. This will entail establishing a real-time automated monitoring and control system for electricity consumption at pumping stations and developing alternative energy sources. In addition to the 5,000 pumps operated by the 1,687 state-owned pumping stations, there are 9.4 million pumping units on farms or managed by special service organizations (former water user associations). These stand to benefit from conversions to solar pumping and the shift to gravity-fed irrigation where feasible.

3.5. Decarbonizing agriculture through climate-smart livestock is also vital

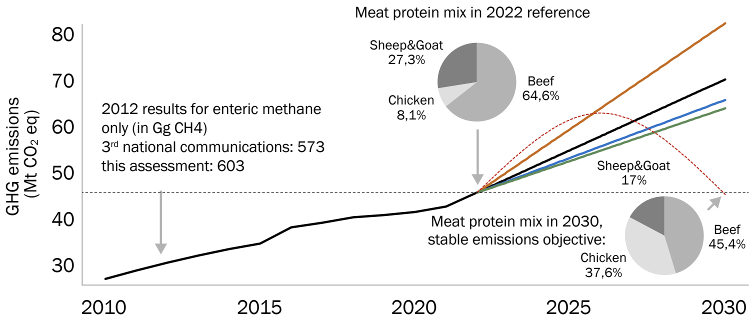
Controlling GHG emissions in agriculture, particularly in the livestock sector, is essential to meet mitigation targets. The livestock sector is a fast-growing emitter in Uzbekistan. From 1990 to 2017, livestock emissions grew by over 160 percent and accounted for two-thirds of total agricultural emissions (57.8 percent from enteric methane plus 9.2 percent from manure management). Detailed assessments caried out for this report using local data and applying the Intergovernmental Panel on Climate Change Tier2 method estimated the livestock sector's GHG emissions at 45.7 million tons CO_2 equivalent.[37] Ruminant species are the major source of emissions, with cattle accounting for 81.4 percent of emissions and sheep for 16.7 percent. Most of the livestock (85–95 percent of animals) is owned by dehkan farms, which are therefore the source of most emissions in the livestock sector.

Scenario modeling to estimate livestock GHG emissions by 2030 considered GHG mitigation practices, including genetic improvement, health improvement, control of herd growth, and replacement of some ruminant production by poultry. Under the business-as-usual scenario, livestock production growth is achieved mostly through increased herd expansion, which drives GHG emissions in 2030 up 54 percent over the 2022 reference year. In a productivity scenario, one-third of dehkan farms grow and achieve large productivity gains supported by genetic improvement, herd management, and animal health programs. Relative to the business-as-usual scenario, the productivity scenario produces more animal protein (25.7 percent more) and reduces emission intensity slightly (6.6 percent lower) but raises absolute emissions (17.4 percent). To achieve similar protein production as in the business-as-usual scenario (4.1 percent gain) and reduce absolute emissions (6.2 percent lower), the productivity and herd control scenario combines productivity gains with control of herd growth (20 percent fewer ruminants than in business as usual). Additional mitigation effects could be achieved in the productivity, herd control, and protein shift scenario by increasing poultry production (by 30 percent) and replacing part of current ruminant consumption (moving from about 8 percent to 25 percent of the meat protein consumed). Figure 3.8 summarizes the results for each scenario.

[36] The Food and Agriculture Organization of the United Nations defines irrigation modernization as "technical and managerial upgrading (as opposed to mere rehabilitation such as canal lining and switching to alternative irrigation technology) of irrigation schemes with the objective to improve resources utilization (labor, water, economics, environmental) and water service for farmers" (FAO 2018, p. 59).

[37] This Figure includes both direct (enteric fermentation and manure management) and indirect emissions (mostly related to feed production and energy consumption) from ruminants and chicken.

FIGURE 3.8. RESULTS OF MODELLED SCENARIOS TO DECARBONIZE UZBEKISTAN'S LIVESTOCK SECTOR, 2010–2030



	Protein production		GHG emissions	
	Total	*Per* capita	Total	Emission Intensity
	Gg	g/capita/day	Mt CO_2-eq	kg CO_2-eq/kg prot.
Reference	575.2	44.4	45.7	79.4
	In % difference compared to Reference			
BAU	58.9	37.1	53.9	-3.1
Productivity	99.8	72.4	80.7	-9.6
Productivity & herd control	65.4	42.8	44.3	-12.8
Productivity, herd control & protein shift	68.6	45.6	40.2	-16.8
Stable emissions objective	31.9	13.9	-0.9	-24.9

Source: World Bank analysis.
Note: The 'Stable emissions objective' scenario does not consider year-to-year changes; the curve is based on an interpolation of 2022, 2026, and 2030 data points.

Stabilizing livestock GHG emissions could be possible while maintaining per capita protein production but would require significant reductions in ruminant population and changes in meat consumption patterns. An additional scenario was explored with the objective of stabilizing livestock sector's emissions in 2030 compared to the 2022 reference year while slightly increasing the domestic production of animal proteins (44.4 g per capita per day in 2022 according to this assessment) to maintain the current meat protein consumption level (46.0 g per capita per day in 2022 according to Food and Agriculture Organization Corporate Statistical Database [FAOSTAT]), without relying on imports. In this 'Emission stabilization' scenario, the same types of interventions as in the 'Productivity, herd control, and protein shift' scenarios were considered but with a higher adoption rate, impact, and pace. Productivity gains and levelling of the ruminant herd growth were assumed to be progressively implemented by 2026. Between 2026 and 2030, the ruminant herd is further controlled to reduce not only its growth rate but its actual size. Because of the important productivity gains and growth of poultry production, the production of meat protein reaches 50.5 g per capita per day in 2026, a value higher than the 2022 protein consumption but lower than a 2030 (56.2 g per capita per day) estimate obtained from linear project of the 2010–2022 trend. This exploratory scenario indicates that stabilizing emissions by 2030 while growing the domestic production to sustain the current level of per capita meat protein consumption could be technically feasible but would require a significant transformation of the sector, downsizing the ruminant population by 23 percent between 2022 and 2030 and increasing the share of poultry meat consumption from about 8 percent of meat intake in 2022 to one-third by 2030.

Productivity gains are within reach if the government accelerates efforts to increase livestock productivity through animal health, management, and breeding programs. Translating efficiency gains into significant climate benefits requires additional measures to control growth of the livestock sector. This could include introducing improvements in genetics and herd management and focusing on herd replacement rather than expansion. For example, livestock production could be reoriented toward species with lower emissions, such as poultry, and public support for higher pedigree animal imports could be conditioned on the culling of low pedigree animals. In the "emission stabilization" scenario, the economic and equity effects of reducing the ruminant herd by about a quarter should be closely assessed and monitored. Getting people to eat chicken instead of beef, for example, would require behavioral change. Communication campaigns could be rolled out to promote chicken dishes, highlighting chicken's nutritional value and emphasizing food safety measures (such as improvements in the cold chain and avoidance of antibiotics and hormones in poultry food). In addition to a reduction of GHG emission, such dietary change is likely to result in healthier diets given the relatively lower content in saturated fatty acid of chicken meat.

The mitigation approaches modeled in this initial work are conservative. An important mitigation pathway that was not considered in this assessment is the improvement of animal feed, due to the water scarcity constraint on fodder production. Other options to improve feed quality may exist, however, and should be investigated. Similarly, grassland restoration for soil carbon sequestration, although also limited by declining rainfall and rising temperatures, could create mitigation-adaptation synergies that were not considered because of a lack of information.

Chapter 4

Policies and investments to promote adaptation to climate change, boost climate resilience in water resources, agriculture and forest landscapes and reduce degradation

Women working in a greenhouse in Uzbekistan.
Photo by the World Bank

This chapter analyzes the impact of climate change on water, agriculture and pastures, and forests; estimates the investments needed for adaptation; and prioritizes opportunities for adaptation to reverse land degradation. The investment cost to restore degraded land in opportunity hotspots is lower than the cost of inaction (economic losses from land degradation). Further analysis reveals that the benefits of climate adaptation measures are far greater than often assumed, expressed through a "triple dividend" of high induced economic development benefits, additional environmental benefits, and the benefits of protection against losses from natural hazards. The impact of climate change on the natural capital of Uzbekistan affects the potential for economic growth and the livelihoods of a large share of the vulnerable population.

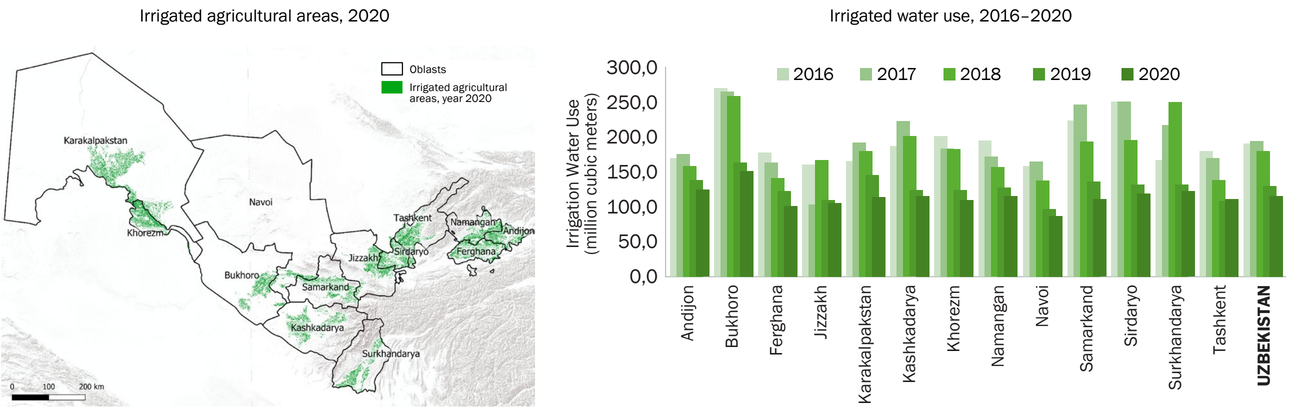
4.1 Improving water management practices to reduce water stress and scarcity

Already limited water resources are projected to decline in Uzbekistan. By 2050, water resources are projected to decline in Syr Darya (by 5 percent) and Amu Darya (by 15 percent) as the glaciers feeding the two rivers recede, even in the 2°C warming scenario. Forecasts project that a 2°C increase would shrink glacier cover by half and a 4°C increase would shrink it by more than three-quarters. For some catchments, estimates project an even steeper decline of 30–40 percent in water availability by 2050.

At the same time, water demand for competing uses within and outside Uzbekistan will increase with economic development, adding to water resource stress. Water demand for irrigation could increase by 5 percent by 2030 and by 7–10 percent by 2050 under median projections, and by as much as 25 percent by the 2040s during summer months under a high-emissions scenario.[38] Water shortages will rise to 7 billion cubic meters a year by 2030 and 15 billion cubic meters by 2050. In the near term, climate change is also projected to shift the intra-year timing of peak flows from summer to spring and increase inter-year volatility in water availability.

Uzbekistan's irrigation and drainage system is the backbone of the country's agriculture and food production. Nearly all (95 percent) crop production is dependent on the country's extensive irrigation and drainage network, which is the largest in Central Asia. Irrigated agriculture contributes more than 25 percent to GDP and employment and accounts for 90 percent of water use in the country (Figure 4.1).

FIGURE 4.1. DISTRIBUTION OF IRRIGATED AGRICULTURAL AREAS AND IRRIGATED WATER USE, BY OBLAST



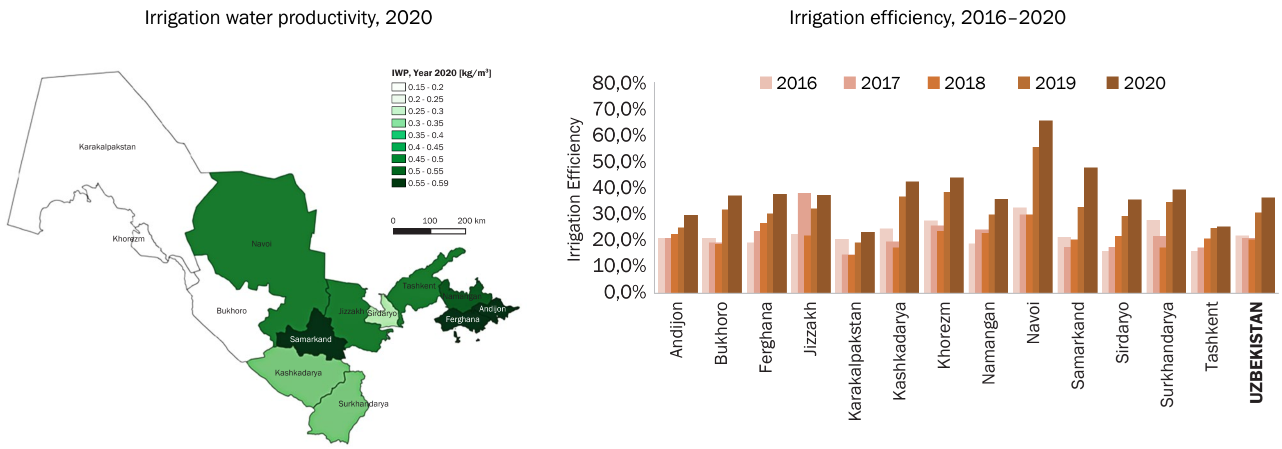
Source: World Bank analysis based on remote sensing data.

Agriculture's extreme reliance on irrigation exposes the economy to risks of large losses from droughts and water shortages, calling for increased water-use efficiency in irrigation. By 2050, agricultural yields are projected to shrink by 10 percent without extensive interventions to improve water-use efficiency or to

[38] USAID 2018.

increase by up to 62 percent with measures to modernize irrigation infrastructure and adopt more efficient water management practices. The productivity of irrigation water varies across the country (Figure 4.2), but current irrigation efficiency is low, at about 40 percent. Although 4.3 million hectares of land are equipped for irrigation, only 2.6 million hectares were irrigated in 2019. Multiple factors may prevent the use of irrigation and drainage infrastructure, including infrastructure damage, electricity shortages, and salinization of soils, which can lead to the abandonment of agricultural lands), and lack of water availability due to competing uses (such as for urban and industrial centers). Uzbekistan's investment in irrigation and drainage is lower than in neighboring countries; for example, Kazakhstan's average CAPEX over 2015–2019 was four times greater than Uzbekistan's.

FIGURE 4.2. IRRIGATION WATER PRODUCTIVITY BY OBLAST, 2020



Source: World Bank analysis of irrigation performance based on remote sensing.

Adapting to climate-related water risks will require large investments to modernize irrigation and drainage. Aging irrigation and drainage infrastructure puts stress on both surface water and groundwater resources, as well as on land resources. Poor water management and inadequate drainage are major contributors to land degradation, lowering yields and land productivity. Half of Uzbekistan's area equipped for irrigation suffers from soil salinization resulting from human and natural causes, well above Asian averages. More than 500,000 ha of land is already water-logged and salinized due to poor irrigation practices and inadequate drainage systems. In a moderate spending scenario with the objectives of avoiding further deterioration of irrigation and drainage infrastructure and promoting modernization, total investment needs are projected at about US$6 billion through 2030.[39] An additional US$1.5 billion in on-farm investments would be needed for improved water management practices to increase water-use efficiency, bringing baseline investment costs to US$7.5 billion. An estimated additional US$1.2 billion would be needed to improve water-use efficiency to adapt to climate impacts,[40] bringing the total capital costs of full modernization of the irrigation system through 2030 to US$8.7 billion.

Improvements in water management practices and monitoring systems will also be crucial for dealing with water shortage risks. Improved management practices include monitoring the water footprint of crops such as wheat and cotton across regions to promote production with optimal water efficiency. Increasing the productivity of water will require water metering and deployment of water-efficient technologies such as drip irrigation. Digitalization and water accounting systems at all scales will allow for monitoring water use and receiving dynamic feedback for adaptation of irrigation and drainage systems.

[39] Based on an estimated unit cost of US$1,400 per ha and an area equipped for irrigation of 4.3 million ha. Identification of the area equipped for irrigation comes from Uzbekistan's Water Sector Development Concept 2020–2030, while unit cost per hectare comes from Izvorski et al. (2019).

[40] Adaptation cost, based on estimated additional water-use efficiency investments required in developing countries under high-impact climate change scenario, come from Rosegrant et al. (2017, table K-2). The additional annual investment of US$170 million needed for adaptation is 0.25 percent of 2021 Uzbek GDP and aligns with the upper range of investment estimates proposed by Rozenberg and Fay (2019).

Dams and reservoir storage are important for increasing resilience to droughts and floods. Uzbekistan has 55 reservoirs, with a total volume of about 20.0 billion cubic meters, that need investments to address dam safety and sedimentation. Optimizing cascades and the operation of existing and future hydropower reservoirs can help secure energy production and water for irrigation while protecting against flooding. Furthermore, the region around the Aral Sea basin has immense potential for development of water storage and hydropower infrastructure, which would benefit all countries in the region through increased energy production and better control of seasonal water availability. However, transboundary allocation issues and poor regional cooperation have made it challenging to coordinate the planning and operations of such infrastructure, while the unplanned and regionally uncoordinated development of infrastructure in upstream regions amplifies the risks of water shortages for downstream regions.

4.2 Realizing the 'triple dividend' through adaptation investments in the water and agriculture sectors and landscape and forest management

Climate impacts could reverse the progress in poverty reduction and worsen food insecurity as changes in the seasonal distribution of temperature and precipitation increase uncertainty for agricultural production. Agricultural productivity is expected to fall as temperatures rise and large swaths of land shift from cold arid and cold steppe to hot arid and hot steppe status and as water availability for irrigation declines. Rural populations are likely to be the worst affected because of their high dependence on agriculture, lower ability to adapt, and high share of income spent on food (50 percent on average).

Investments, policies, and technologies in water management and use in agriculture and in land restoration are climate-smart options for Uzbekistan that can deliver the triple dividend of avoided losses (first dividend), induced economic and development benefits (second dividend), and additional social and environmental benefits (third dividend). Adopting climate-smart agriculture requires a clear road map and an integrated process for aligning agricultural policies with climate change impacts and identifying and prioritizing needed investments.

Investment must increase to realize a triple dividend. A growing array of practices show that it is possible to simultaneously deliver higher agricultural productivity, greater climate resilience, and lower emissions.[41] Efforts have often focused on these aspects independently. However, a focus on increasing synergies for multiple outcomes advances food security even in the pessimistic climate change scenarios, while enabling agriculture to become part of the solution for tackling climate change. The triple dividend of resilience approach accounts for and quantifies the full economic, environmental, and social benefits of climate change adaptation actions, grouping them along the three dividends.[42] The second and third dividends are especially important since they accrue regardless of whether projected negative climate outcomes materialize.

Climate adaptation measures have strong economic and development benefits in Uzbekistan, making the investments worthwhile even without considering climate risks. A triple-dividend-of-resilience analysis of water resources, agriculture, and land restoration out to 2040 reveals a high net present value of adaptation investments of more than US$9 billion (a benefit-cost ratio or BCR of 2.6). The analysis includes the benefits of avoided losses from negative impacts on crop yields revealed in the computable general equilibrium (CGE) model (first dividend), projected increases in crop production and water savings (second dividend), and GHG emissions reductions due to energy savings in the water sector (third dividend) with a value based on the World Bank's shadow cost of carbon. Further benefits, while assumed to be large, were not included in the analysis due to data gaps.[43]

[41] Important among these are silvopastoral livestock systems, agroforestry, intercropping, diversification of production systems toward less water- and emission-intensive crops, improved pasture management, better fertilizer use, minimum tillage, alternative wetting and drying of rice, biogas production from agricultural waste products/livestock manure, less food loss and waste, and greater irrigation and drainage efficiency, including lowering GHG emissions by reducing energy consumption of pumping station.

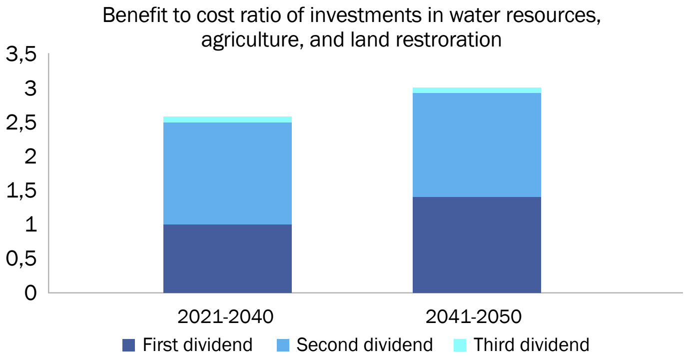
[42] Heubaum et al. 2022.

[43] A sectoral triple dividend analysis can raise awareness of the full benefits of adaptation, improve impact evaluation, and support investment decision-making. Also important, it can enable better distinguishing between public and private benefits as a basis for designing blended finance approaches. To facilitate such analysis, the quantified benefits included in Figure 4.4 focus on water resources, agriculture, and land restoration. Similar assessments can be undertaken for other sectors, for example road transport, but require data to be available on costs and benefits across all three dividends

High second and third dividend benefits drive a forceful economic and financial case for investment. Avoided-loss benefits only about break even with the cost of adaptation interventions over the period to 2040 (Figure 4.3), while large induced economic benefits exceed costs by roughly 50 percent (a BCR of 1.5). In the later period (2041–2050), avoided-loss benefits grow significantly due to greater climate impacts on crop yields. This increase in avoided-loss benefits raises the overall BCR for the 10-year period to 3, meaning that the benefits of adaptation interventions over this period are three times greater than the costs, at a net present value of roughly US$10.4 billion.

Continuing to reform agricultural policies and avoiding policy reversals are preconditions for adopting climate-smart agriculture practices at scale. Major progress has been achieved since 2018 in reforming wheat and cotton production, which account for 70 percent of irrigated planted area, 70 percent of irrigation water, and 80 percent of public expenditure on agriculture. Notably, wheat and flour prices have been liberalized, production targets eliminated, and the share of wheat sold by farmers through state procurement mechanisms greatly reduced. In cotton production, forced labor and child labor have been eliminated, enabling Uzbekistan to sell cotton yarn freely on high-value markets; production targets have been eliminated; and the share of cotton sold through the state procurement system has been reduced. Increasing farmers' income from wheat and cotton production is a precondition for broader adoption of climate-smart agriculture practices, which require heavy investments by farmers (such as planting orchards and purchasing high-quality seeds and water-efficient equipment). In livestock production, transitioning to climate-smart farming requires more and better-quality feedstock. Major next steps on the policy reform agenda are improvements in land tenure security and elimination of the crop placement system, which prevents farmers from making planting decisions based on market opportunity.

FIGURE 4.3. CLIMATE ADAPTATION INVESTMENTS IN UZBEKISTAN HAVE A HIGH TRIPLE DIVIDEND, 2021–2040 AND 2041–2050



Source: World Bank analysis.
Note: First dividend is avoided losses from climate change (negative impacts on crop yields drawn from the CGE model), second dividend is induced economic and development benefits (increases in crop production and water saving benefits), and third dividend is environmental benefits (GHG emission reductions).

Adapting agriculture to adverse climate impacts will also require greater investment in public goods, including agricultural knowledge and innovation. The government has been redirecting some public expenditures in line with its agriculture strategy. Since 2019, it has allocated more investments to support farmers through better access to finance and matching investment grants and to general support services such as agricultural knowledge and innovation systems, which have demonstrated an ability to generate good economic returns worldwide. While the composition of Uzbekistan's public spending on agriculture is improving, it needs to shift even more from farm support that stimulates production and input use to support that facilitates on-farm investments and increases general support services. Enhancing national capacity in rural advisory, agricultural extension, input, and credit service delivery systems will encourage and incentivize the private sector to provide these services and to manufacture needed equipment.

At the same time, investments in restoring degraded lands and forests are essential to climate change adaptation and mitigation (box 4.1). Measures to restore lands involve stabilizing soils and mitigating sand and dust storms in the cold desert area and the Aral Sea area, including afforestation of exposed dry seabed and upstream areas of the Aral Sea, protecting river banks and water flow; restoring tugai forests along the main rivers, establishing and restoring shelterbelts to protect agricultural soils, reducing erosion and preventing further land degradation, and conserving and sustainably developing the country's unique mountain forests.

BOX 4.1. CLIMATE ADAPTATION THROUGH RESTORATION OF DEGRADED LANDS AND FORESTS

Geographic and climate factors limit Uzbekistan's forest coverage. Its estimated 3.9 million ha of forested land covers just 8.7 percent of the country's land area. The largest forest areas (estimated at more than 3 million hectares) are in cold desert areas and consist mainly of saxaul forests, which have the characteristics of woodlands rather than forests. Submontane and mountain forests account for more than 300,000 ha of total forested area and include broadleaf trees (for example, pistachio and walnuts) and juniper trees (locally known as archa). In addition, there are around 95,000 ha of riparian forests (tugai forests) distributed in patches along the larger river belts of the country. Although limited in land cover, forests in Uzbekistan are important for preventing desertification and supporting healthy landscapes.

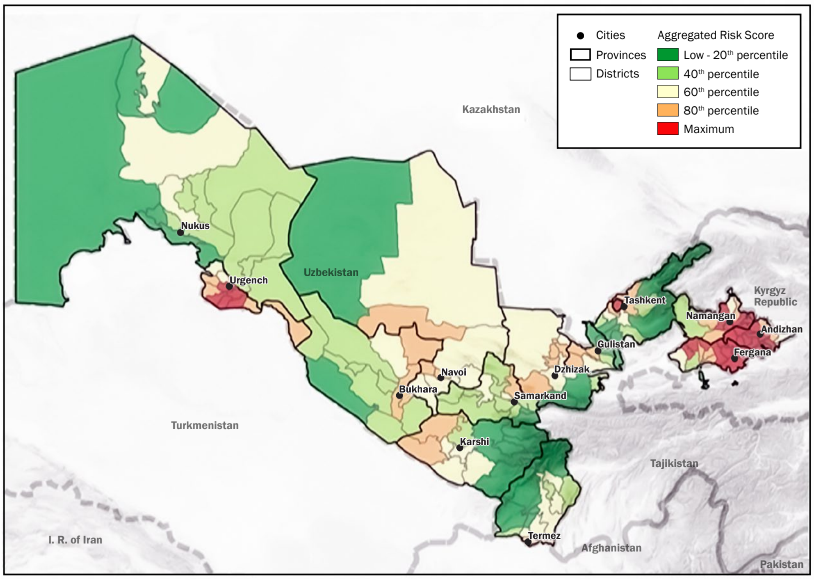
Large areas of forest and woodlands suffer from degradation. Overgrazing, which can make tree regeneration next to impossible, is a major cause of forest degradation. Local forest enterprises under the State Committee on Forestry (leskhozes) generate much of their revenue from grazing leases. Unsustainable agricultural practices, poor management of irrigation, and the degradation of shelterbelts and riparian strips also contribute to land degradation.

Forests sequester carbon and increase the resilience and reduce the vulnerability of people and ecosystems to the effects of climate change while also likely to being harmed by climate change. Even small changes in temperature and precipitation could greatly affect future forest growth and survival in Uzbekistan.

4.3 Reducing climate change and land degradation risks through integrated landscape restoration

Over the last 20 years, productivity has declined continuously on one-third of agricultural land. Given the extent of land degradation in Uzbekistan and the large scope for investments that benefit productivity and climate adaptation, resilience, and mitigation, this report has identified areas with the highest economic, social, and environmental benefits from investments to slow or reverse land degradation. The rate of land degradation and its causes vary widely by province. Fergana Valley, the Gulistan–Dzhizak corridor and north of Nukus, north Namangan, and around Tashkent are hotspots of degradation of agricultural land (Figure 4.4). However, the most severely affected natural ecosystem, as measured by total area, is the desert shrublands in the steppes north of Navoli in Navoiy Province and west of Aydar Lake in the center of the country.

FIGURE 4.4. LAND DEGRADATION HOTSPOTS: COMPOSITE MAP OF RISK FROM CLIMATE CHANGE, LAND DEGRADATION, AND POPULATION PRESSURES, BY DISTRICT IN UZBEKISTAN BY 2041–2050



Source: World Bank analysis.

The rates of land degradation and its probable causes vary widely[44] In the intensive cropland hotspots (Fergana Valley, Gulistan–Dzhizak corridor), a combination of water stress, soil degradation, and salinization seem to be

[44] A land degradation hotspot is defined as a land parcel where vegetation gross primary productivity has been declining in the last 20 years based on remote-sensing data. A land parcel is considered to be in a degradation trend when its annual rate of decline is greater than 1 standard deviation from country average measurements and in severe degradation when the rate of decline is greater than 2 standard deviations from the country average

the main causes of land degradation. In agricultural areas surrounding densely inhabited areas, land use change due to urban sprawl (around Tashkent, Namangan, and Fergana) seems to be driving waning productivity. And in western areas, water scarcity, desertification, and dust storms are likely responsible for the declining productivity of croplands, natural desert shrublands, and riparian flooded vegetation.

Degradation of natural capital, especially water resources, agricultural land, and forests, is exacerbated by the chronic impacts of climate change and natural hazards. Some 30 percent (13.7 million ha) of the country's land is severely degraded. Half of this is natural pasturelands, while 40 percent is land that is not used for agriculture, pasture, or forest. A map of land degradation hotspots displays the composite risk from climate change, land degradation, landslides (and their impact on infrastructure), and population growth, with red areas indicating the greatest risk (Figure 4.4). Negative impacts are estimated to be greatest, along with population increases, in agricultural areas of the Fergana Valley and around Samarkand, Karshi, and Tashkent.

The cost of inaction on severely degraded land is estimated at 4.6 percent of GDP. The cost includes the loss of agriculture productivity, increased soil erosion, reduced water availability, and loss of carbon sequestration and ecosystem services.

In contrast to land degradation hotspots, adaptation opportunity hotspots are areas where integrated adaptive and climate-smart technologies can have the greatest positive impact on both agricultural productivity and ecosystem services. These areas also have the greatest potential to alter trends in land degradation.[45] Key technologies can be used in an integrated way to maximize their benefits for crop production, pastures, forestlands, water, landslide/flood management, and carbon sequestration (Figure 4.5). Integrated adaptation technologies include measures to control erosion and reduce soil loss and sediment export; improve water regulation (slow quick flow and surface runoff to reduce flood risk and nutrient leaching) and quality in reservoirs/dams; and stabilize slopes to reduce landslides. Results from erosion control, water regulation, landslide models (showing the impact on agriculture productivity), and carbon sequestration were converted into a composite adaptation opportunity score for each district (Figure 4.6). Blue shades indicate areas with higher potential for landscape restoration at the farm level to maximize ecosystem services and increase agriculture and water productivity.

FIGURE 4.5. TECHNOLOGIES RECOMMENDED FOR INTEGRATED LANDSCAPE RESTORATION IN ADAPTATION OPPORTUNITY HOTSPOTS

Estimating cost and benefits of the sustainable technologies (ICARDA)

- Cost of Inaction in DEGRADATION hot spots (the ecosystem services that are lost and their monetary values)
- Benefits of Action in OPPORTUNITY areas and Costing of adaptation policy
- Cost/benefit analysis of adaptation policy

Crop production

1. Conservation practices
2. Crop diversification, rotation, agroforestry
3. High - yield, water efficient, heat/ drought /salt/cold tolerant, disease resistant varieties
4. Planting wheat on standing cotton

Grazing lands

1. Rotational grazing and season al resting
2. Participatory: establish pastures on poor crop lands or alternate components of rotations for drought prone areas such as alfalfa and sainfoin

Forest lands

1. Reforestation using appropriate tree/shrub species
2. Protection and management of vegetation
3. Agroforestry

Farm level water management

1. Irrigated fams: Mechanized Raised Beds; Drip Irrigation; Sprinkler irrigation; weather-based irrigation scheduling; laser-assisted land leveling; communal structures
2. Rainfed farms: Water harvesting

Floods and landslides prevention

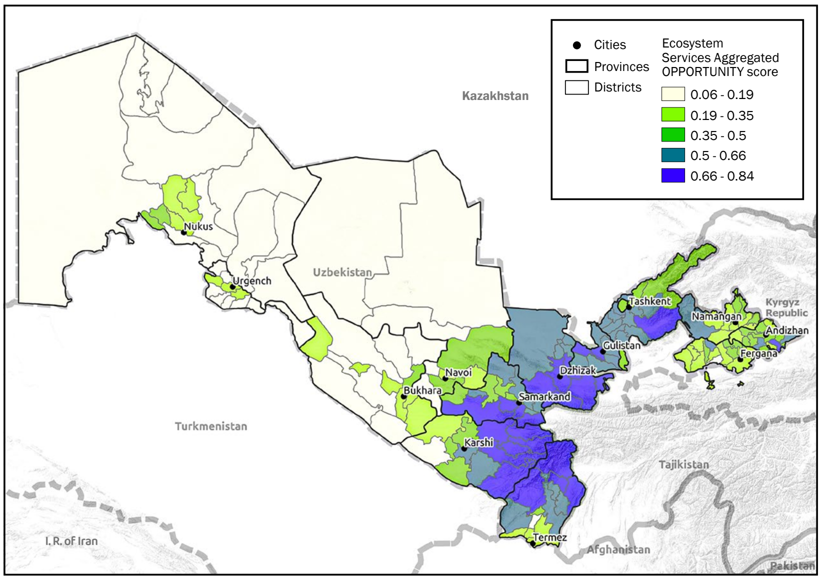
1. In the plains / steppe: Levee - setbacks, reconnecting floodplains / floodway
2. In the hills: Reforestation, landscaping, terracing, bioengineering (headwater watershed management
3. Small river channels: Series of check dams, riverbank stabilization with gabions or anchored vegetation

Source: World Bank analysis.

[45] Adaptation potential to enhance ecosystem services was estimated using the InVEST Sediment Delivery Ratio and Seasonal Water Yield models, and a landslide/slope stability model.

While investing in adaptation and integrated landscape restoration benefits the entire country, the highest opportunity areas are in the east. These are predominantly in Tashkent, Surkhandarya, Kashkadarya, Samarkand, Jizzakh, and Syrdarya. In the southwest, smaller but still significant potential is identified in highly degraded Khorazm, Qaraqalpaqstan, and Bukhara.

FIGURE 4.6. ADAPTATION OPPORTUNITY HOTSPOTS IN UZBEKISTAN: COMPOSITE SCORE (BY 2041–2050)



Source: World Bank analysis.
Note: Composite map shows areas where integrated adaptive and climate-smart technologies can have the greatest positive impact on ecosystem services and agricultural productivity.

Integrated landscape restoration and adaptation actions also preserve the carbon stock above and below ground. Using the trend in gross primary production as an indicator in estimating carbon stock reveals that implementing integrated landscape restoration technologies would stop or reverse losses in carbon stock (the sum of all above and below ground carbon). The carbon stock in biomass in Uzbekistan was estimated at about 95.4 million tons of carbon in 2020. By 2030, the expected carbon stock in the business-as-usual scenario is estimated at 92.8 million tons of carbon. By 2030, carbon sequestration in the hotspots of opportunity (1.6 million hectares) rises from 40 percent in the business-as-usual scenario to 100 percent in the integrated landscape restoration scenario (to 4.7–6.7 million tons of carbon). Under business as usual, the loss of economic benefits from reductions in agricultural productivity, forest productivity, and water availability total an estimated US$2.8 billion.

The national adaptation opportunity hotspots (an area of 1.6 million ha, which is 3 percent of total land area and 10 percent of agricultural land) are prioritized for interventions based on the potential for adoption of the technologies, the speed of investment recovery, and socioeconomic factors. An immediate optimization of ecosystem services is constrained to avoid the unrealistic assumption of an unlimited adaptation budget. Opportunities are identified in areas (1.6 million hectares) where the targeted, limited budget for investments in sustainable technologies can make a greater difference. With a limited budget, deciding on measures becomes an optimization of resources problem.

With implementation of integrated adaptation technologies over the 10-year horizon, crop production increases by about US$4.6 billion, production on natural pastures rises US$0.1 billion, and 1.8 billion cubic meters of water are saved annually.[46] Accounting for the full benefits of adaptation investments across croplands, water, forests, and associated sectors reveals a high triple dividend, with strong BCRs underpinned by commonly unquantified economic benefits. By integrating traditionally excluded benefits, the triple dividend of resilience approach can help both the public and private sector address information market failures and catalyze the required level of investment.

Large, induced development benefits (the second dividend) are particularly important for attracting private sector investment, while building resilience through nature-based solutions can also generate high third dividend benefits. Shifting the debate toward a broader adaptation framework informed by a triple dividend of resilience approach can help make the case for scaling up investments in adaptation and resilience.

[46] These benefits are estimated conservatively taking into account additional monetizable benefits in agriculture and forestry.

Investment needs for the national adaptation opportunity hotspots (1.6 million ha) are estimated at about US$489–US$560 million over 10 years (US$305–US$350 per ha), which is 0.7–0.8 percent of GDP in 2021. The cost of action in the adaptation opportunity hotspots is some three to four times lower than the cost of inaction. The largest shares of the investment are for technologies for croplands (48 percent) and the water sector (45 percent), followed by natural pastures (4 percent) and forests (3 percent). Benefits follow the same pattern.

Forest landscape management presents opportunities for sustainable development and for climate adaptation and mitigation as well, despite multiple challenges. Increasing forest area requires a holistic approach to soil degradation that includes improved livestock husbandry, better soil management, and agricultural practices. Landscape restoration practices that maximize ecosystem services through increased soil retention and reduced soil erosion are closely linked to increased vegetation cover in croplands and pastures. Reforestation, afforestation, and sustainable forest management are a pillar for resilience building, enhancing both climate change mitigation through carbon sequestration and adaptation through sustainable restoration of degraded landscapes. Leskhozes (local forest enterprises under the State Committee on Forestry) are central to transforming forests into an economically vibrant sector that helps address climate change, so augmenting their capacity and skills should be an important part of the response to land degradation. Equally important is to encourage community participation through the mahallas and create favorable conditions for private sector involvement.

To inform optimal investment decisions, an urgently needed next step is to invest in improving data availability and the capacity to model biophysical systems. Development of sophisticated but transparent modeling and monitoring tools would allow for better targeted infrastructure planning and development. This is especially pertinent where there is a need to generate consensus and coordination with neighboring countries on shared resources that require modeling at a regional scale. A critical example is water resources, whose transboundary nature is a defining feature of the broader region in which Uzbekistan is situated. A calamitous example is the decline of the Aral Sea, which can be viewed as a tragedy of the commons, rooted in the inadequate availability of transparent information on water resources and their competing uses. Current hydrological models of the region contain large uncertainties, often leading to inaction or even suboptimal investment decisions. The availability of new technologies, such as vastly improved computation capacity and remote sensing capabilities, and the increasing salience of climate challenges, create a strong impetus for developing improved hydrological and meteorological modeling systems that can account for the changing stock of and competing demands for natural resources such as water in the face of climate, demographic, and economic pressures.

Chapter 5

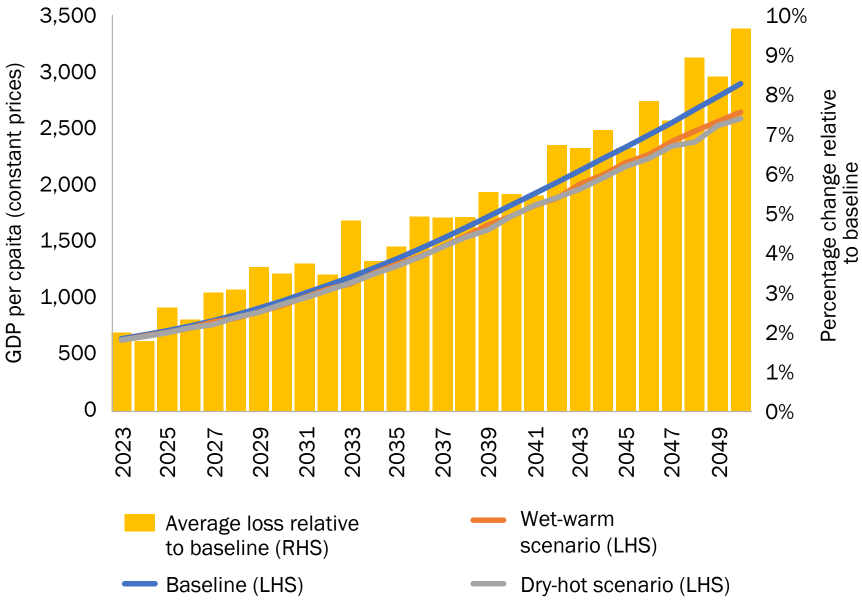
Economic implications of an economywide policy of green transition

The view of Tashkent city, Uzbekistan.
Photo by the World Bank

5.1 Modeling the economy-wide transition

Without action on climate, Uzbekistan cannot achieve its development vision. Uzbekistan is on a rapid growth path but one that does not lower emission intensity. The realities of climate change are increasingly likely to undercut the country's ambitious economic goals for two main reasons. First, the rapid population and economic growth projected for Uzbekistan will place unreasonable strains on key resources and ecosystems. Thus, this trajectory is likely to be unattainable unless growth is made more sustainable. And second, unless action is taken on adaptation, climate change will cause serious harm to Uzbekistan, whose geography, ecology, and unsustainable economic structures mean that climate change damages will be severe. Macroeconomic modeling reveals that climate change impacts are likely to lead to greater economic volatility and lower growth, with the economy 10 percent smaller by 2050 than it would have been without climate damages (Figure 5.1). The results are similar whether climate change leads to a 'wet-warm' or 'dry-hot' pattern.[47]

FIGURE 5.1. GDP WITH AND WITHOUT THE EXPECTED EFFECTS OF CLIMATE CHANGE, 2023–2050



Source: World Bank analysis.
Note: See box 5.1 for an explanation of the scenarios.

Economic modeling illustrates the macroeconomic path of possible decarbonization. Net zero transition brings economic benefits in terms of improved productivity and market opportunities. Reduced emissions are also associated with health benefits of reduced localized air pollution, which is monetarized and included in the macroeconomic estimates. But during the transition period, the high investment needs and a relatively rapid transition from energy intensive to low carbon leads to a temporary drop on the efficiency of carbon-intensive factors of product and a crowding-out effect on other investment, particularly in the peak investment period between 2034 and 2040. The economic effects of net zero transition broadly offset each other, which the economy about the same size it would have been without decarbonization, but with annual growth higher going forward. The withdrawal of energy subsidies, a critical prerequisite for decarbonization and already government policy, leads to a temporary loss of growth in the first few years, but is also associated with more air pollution reduction benefits (Figure 5.2). Modeling assumes that the government implements countercyclical policies to reduce adjustment costs by increasing social transfers, reducing labor taxes, and raising public investment in energy efficiency programs by 2.5 percent of GDP over the four years.

[47] Scenarios in which the outcomes are the most 'dry' and 'hot' and scenarios in three which the outcomes are the most 'wet' and 'warm' (less hot; see box 5.1).

BOX 5.1. MODELING THE MACROECONOMIC IMPLICATIONS OF CLIMATE CHANGE

A new, environmentally informed CGE model was developed for this CCDR to assess the macroeconomic implications of climate change. The Mitigation, Adaptation and New Technologies Applied General Equilibrium (MANAGE) model, a recursive dynamic single-country CGE model developed at the World Bank, is the first fully specified CGE model based on complete input-output tables known to have been produced for Uzbekistan. Based on core data for 2017 to 2019, the CGE model results presented in the chapter draw from several different scenarios. A first set of scenarios quantifies the impacts that climate change is expected to have on Uzbekistan, while a second set looks at Uzbekistan's green transition. The two sets of scenarios are summarized below.

Modeling climate change damages

Analysis of possible climate damages using the CGE model is based on two scenarios, wet-warm and dry-hot, relative to an artificial baseline of no-climate impacts. There are 14 underlying scenarios that reflect different possible paths of climate variables. The two composite scenarios average three scenarios that present the most 'dry' and 'hot' outcomes and three that present the most 'wet' and 'warm' (less hot) scenarios. In each, there are six major channels through which climate change affects the economy: heat stress on labor productivity, human health, damages to roads and bridges, losses on livestock, losses in irrigated and unirrigated crop yields, and losses in hydropower generation. These shocks affect labor productivity, labor supply, capital supply, and the production of agriculture and hydropower in the CGE model. The model has an endogenous adaptation mechanism through which the factors of production adjust to the climate shocks. Any additional adaptation investment can reduce the magnitude of the climate shocks.

Modeling a green transition

Analysis of the economic implications of policy action to support a green transition is based on two scenarios and a baseline. The baseline assumes that Uzbekistan continues to implement its current economic reform program but does not take strong measures to decarbonize. Under baseline assumptions, the returns to ongoing reform programs intended to make domestic markets more competitive, open access to external markets, and develop education, finance, and labor markets are expected to yield rapid GDP growth and rising productivity. Growth peaks at 7 percent around 2030, before gradually declining to 4 percent a year by 2060. However, in this baseline, the country does not address its huge energy subsidies, nor does it implement the recommendations for decarbonization contained in this report. As a consequence, emission intensity remains high.

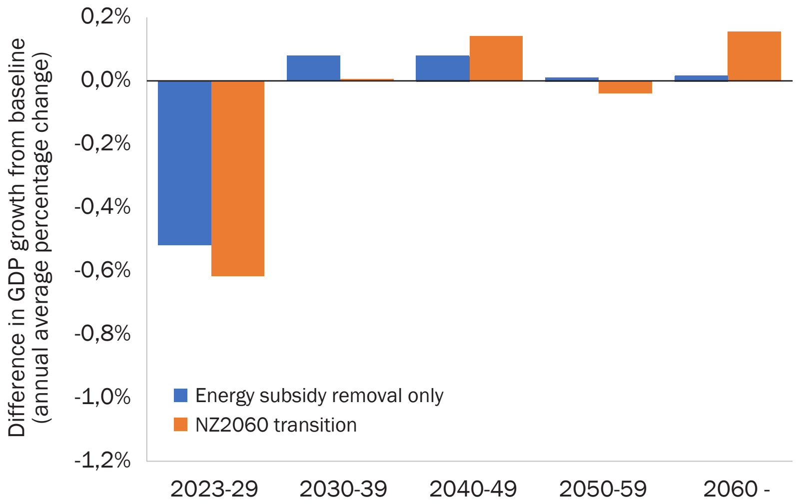
The first scenario, called the reference scenario, is aligned with the same scenario for the energy sector presented in chapter 3. An important policy change in this scenario is that energy subsidies are withdrawn, but no further action is taken to support decarbonization. In the second scenario, NZ2060, a full range of policies are taken to support decarbonization. These policies are reflected in the CGE model in a stylized way as a carbon tax, fiscal policies to soften its impact on households, and energy efficiency investments. Energy sector decarbonization is aligned with results presented in chapter 3.

The structural change associated with decarbonization will create more jobs in high value-added sectors, but workers must have the skills to fill these jobs. Decarbonization is expected to accelerate the relative decline of agriculture and growth in manufacturing, with services maintaining its share in the economy. Certain subsectors, such as renewable energy, will see massive job growth, while higher value-added service sectors such as insurance and information and communication technologies as well as other service sectors such as hospitality are expected to create more jobs in the NZ2060 scenario than in the baseline. The energy sector is expected to see a net increase in jobs. These include new jobs in construction, installation, and operation and maintenance of new, greener technologies and take into account a loss of jobs in declining technologies. A major challenge is to ensure that workers have the right skills to fill the new jobs.

Compensatory policies are important to ease the impact of changes with adverse impacts on the vulnerable and share the benefits widely. Targeted transfers and generalized tax reductions can ease the impact of the price increases that result from these policies. The price increases that are needed to make the energy sector viable in the absence of subsidies and incentivize investments in green sectors will also increase consumer prices, both directly as higher energy prices and indirectly through the increased costs of energy embedded in other products.

The poorest households will be most exposed to these price increases because they pay proportionately more of their limited budget for essentials such as energy and transport (figures 5.3 and 5.4). However, fiscal savings are sufficient to finance compensatory programs to ensure that most of the population is no worse off than before, with the poorest significantly better off and only those in the richest decile slightly worse off in a energy subsidy reform only scenario.[48] These scenarios assume that 40 percent of the increased fiscal resources are used for targeted transfers to the bottom four deciles of the income distribution, 30 percent to income tax reductions, and 30 percent to higher public investment.

FIGURE 5.2. REMOVING ENERGY SUBSIDIES TRIGGERS A MAJOR STRUCTURAL CHANGE THAT COMES WITH A SHORT-TERM COST BUT BOOSTS GROWTH OVER THE LONGER TERM, BASELINE AND POLICY SCENARIOS, 2022–2060



Source: World Bank analysis.
Note: Impacts include the monetized benefit of reduced air pollution.

FIGURE 5.3. DISTRIBUTIONAL IMPLICATIONS OF SUBSIDY REFORM POLICY PACKAGE

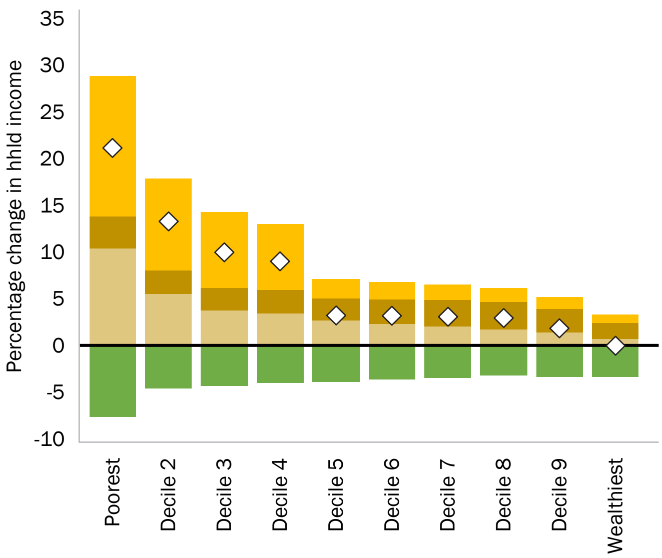
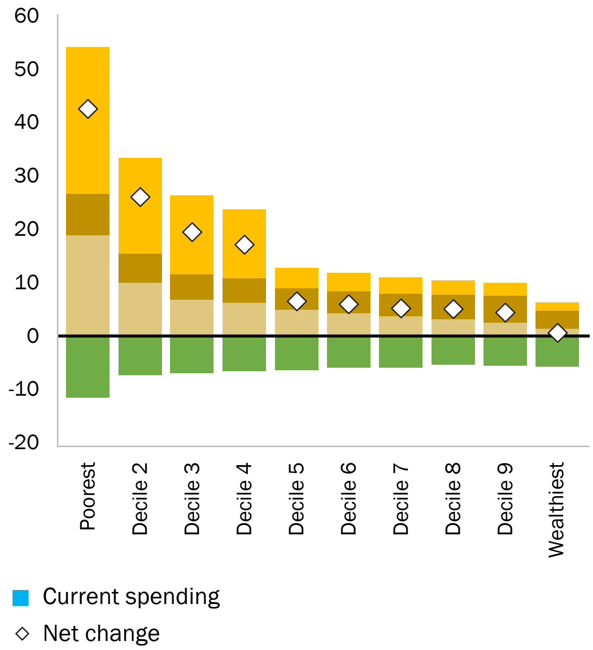


FIGURE 5.4. DISTRIBUTIONAL IMPLICATIONS OF SUBSIDY REFORM PLUS CARBON TAX REFORM PACKAGE



Source: World Bank analysis using the Climate Policy Assessment Tool (CPAT) model.
Note: Policy simulations based on latest available household data. The subsidy reform policies allocate 30 percent of energy subsidy savings to targeted transfers to the bottom four deciles of the income distribution, 30 percent to income tax reductions, and 40 percent to higher public investment. The model assumes a social protection leakage rate of 25 percent.

Source: World Bank analysis using the CPAT model.
Note: Policy simulations based on latest available household data. This policy mix allocates 30 percent of energy subsidy savings to targeted transfers to the bottom four deciles of the income distribution, 30 percent to income tax reductions, and 40 percent to higher public investment and add a carbon tax. The model assumes a social protection leakage rate of 25 percent.

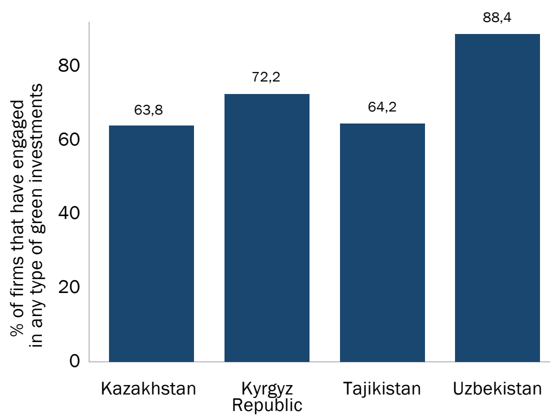
[48] Raising the revenue recycling to general labor tax reductions can lead to all deciles being better off, but it results in lower benefits to the poorest and less public investment, so it not presented as the lead option here.

5.2 Creating the environment for a green private sector

The private sector is pivotal for achieving Uzbekistan's development objectives, and so too for a successful green transition. The rationale behind the bold economic reforms now well under way in Uzbekistan is that a strong, independent, and vibrant private sector will better serve the people and create jobs than the largely state-planned model did. The authorities have a critical role in setting the course for achieving these objectives, and the same is true for the green transition. It will be crucial to accelerate movement along the reform path on which the country has already embarked to enable needed private investment and support productive green growth. This section discusses key policy areas of focus toward this goal.

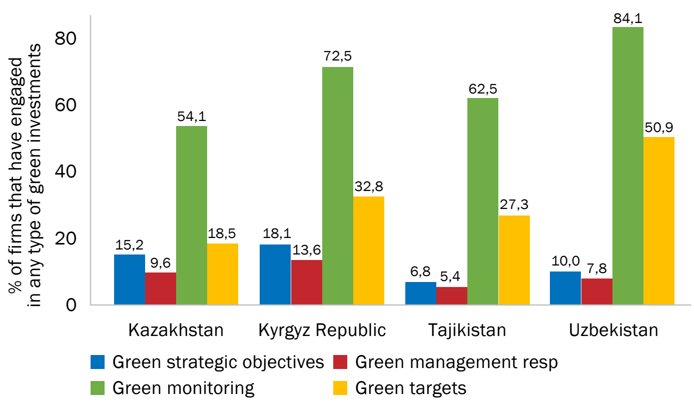
Businesses are more active in green sectors of the economy in Uzbekistan than in other economies in the region. There is evidence that businesses are at the forefront of green investments and practices even though climate change is a recent public policy issue in Uzbekistan. By 2019, nearly 90 percent of firms in Uzbekistan were already making some form of green investments (Figure 5.5), while 80 percent of firms monitored green results and half had green targets (Figure 5.6). The business community shows greater attention to climate in Uzbekistan than in three neighboring countries. However, in business planning and setting of strategic objectives, only 10 percent of firms factor in green issues and only 8 percent have a clearly assigned management role for green issues.

FIGURE 5.5. SHARE OF FIRMS THAT ENGAGED IN ANY GREEN INVESTMENTS IN THE PAST THREE YEARS, 2019



Source: Iootty et al. 2022.
Note: Share of private firms in manufacturing and services based on 2019 Enterprise Survey.

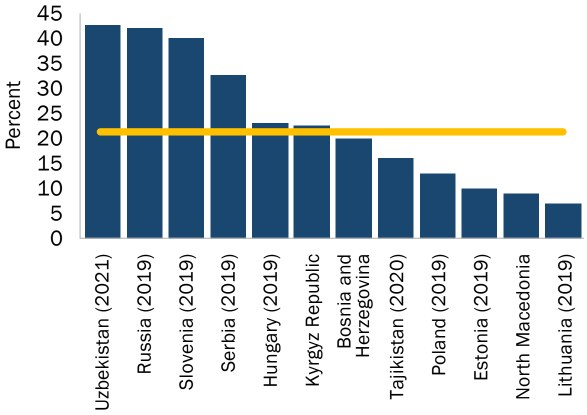
FIGURE 5.6. SHARE OF FIRMS ENGAGING IN GREEN MANAGERIAL PRACTICES, 2019



Source: Iootty et al. 2022.
Note: Share of private firms in manufacturing and services based on 2019 Enterprise Survey.

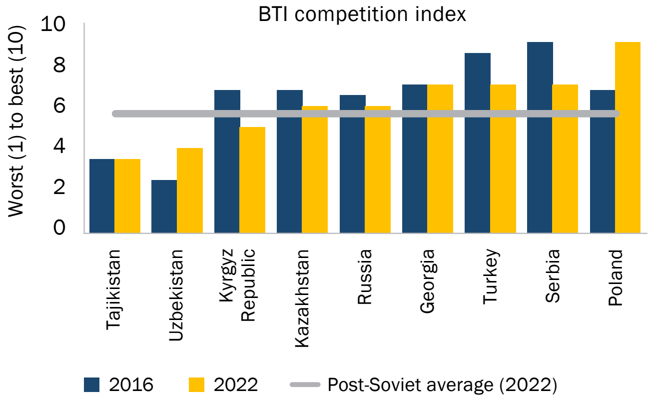
Holding the course on Uzbekistan's reforms to make the economy more open and competitive is a prerequisite for a successful, private sector-led, green transition. Underdeveloped market institutions and an excessive state presence in the economy must be addressed to enable the private sector to grow and respond to new, green opportunities. Perceptions about market competition have become more positive in Uzbekistan since 2016, but much remains to be done. Uzbekistan has the largest share of state enterprises in the economy among comparator countries (Figure 5.7) and an underdeveloped competition policy framework to ensure a level playing field (Figure 5.8). Nearly 80 percent of Uzbekistan's state enterprises operate in competitive sectors where the case for their presence is weak. Reforms are moving in the right direction, but the pace of change needs to accelerate. Until the private sector has the space to operate more freely, the economy will lack the dynamism needed to transform and adapt to a green economy.

FIGURE 5.7. STATE ENTERPRISE REVENUE IS HIGH AS A SHARE OF GDP, LATEST AVAILABLE



Source: World Bank Integrated State-Owned Enterprises Framework (iSOEF) reports (multiple), World Bank Business of the State, World Bank staff estimates.
Note: Orange line is average for all countries in the sample.

FIGURE 5.8. MARKET COMPETITION FRAMEWORKS ARE IMPROVING BUT ARE STILL WEAK, 2016 AND 2022

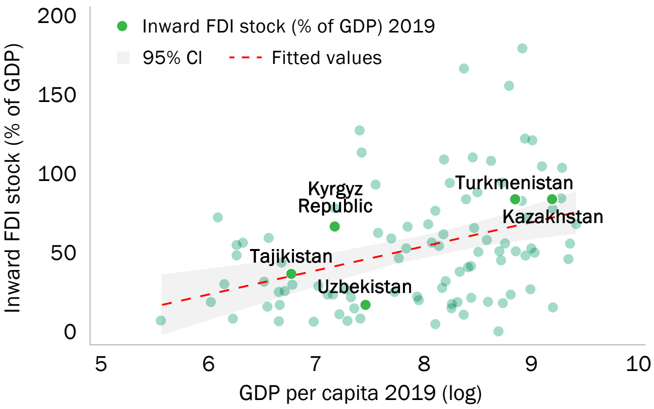


Source: Bertelsmann Stiftung Transformation Index (BTI).

The lack of reliable access to electricity is a top-cited concern of businesses. According to the latest Enterprise Survey, access to reliable electricity is the third most cited constraint (after tax rates and practices of the informal sector) by businesses in Uzbekistan. Frequent blackouts and power variation raise the cost of doing business and affect business activity. The transition to a modern, green energy system will make it easier for firms to do business in Uzbekistan. While the withdrawal of energy subsidies, along with improved sector governance, will help overhaul energy service delivery, this is likely to take time. Until then, businesses may face both higher costs and continuing weak service, which will call for careful management by electricity service providers.

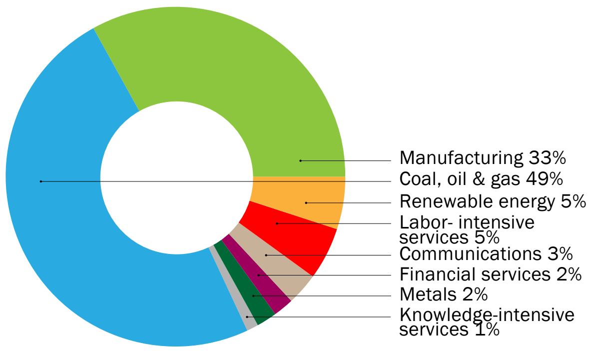
Increasing FDI is a priority to accelerate the development of low-carbon sectors. FDI in low-carbon sectors is a key priority as it brings both finance and technological know-how. To date, Uzbekistan has underperformed in attracting FDI overall, especially in green sectors. Uzbekistan's stock of FDI is far below regional averages and that of its neighbors (Figure 5.9). While increasing over the last five years, FDI inflows remain modest (at 2.4 percent of GDP in 2022) and are concentrated in mining and quarrying (Figure 5.10). Raising FDI levels depends on the reforms already described to roll back the state in, and strengthen, competitive markets. Especially important for FDI is to ensure transparent and stable regulations, strong property rights, a coherent government coordination framework, and stronger investor service delivery.[49]

FIGURE 5.9. UZBEKISTAN'S STOCK OF FOREIGN DIRECT INVESTMENT IS BELOW THAT OF COMPARATOR COUNTRIES, 2019



Source: World Bank 2022b.

FIGURE 5.10. HALF OF GREENFIELD FOREIGN DIRECT INVESTMENT HAS BEEN IN COAL, OIL, AND GAS, 2003–2019 AVERAGES

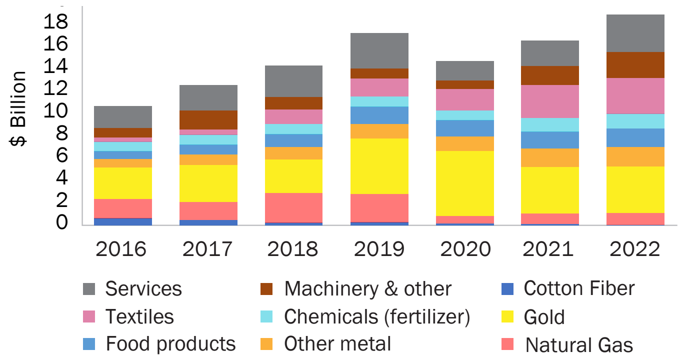


Source: World Bank estimates, FDI Markets, and Thomson Reuters database.

49 World Bank 2022b.

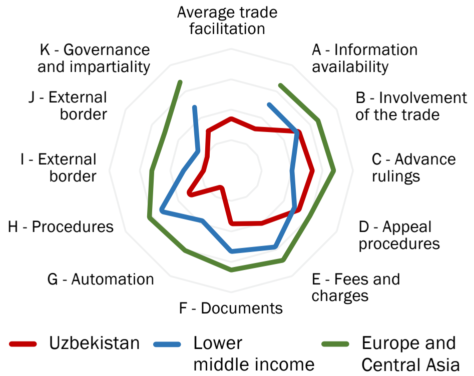
Accelerating trade integration would increase competition, efficiency, and productivity and enable firms to access external markets in a green transition. Since 2016, Uzbekistan has seen robust growth of relatively less carbon-intense exports. Historically high exports of cotton and natural gas have fallen to low levels, while textile and service exports have grown rapidly (Figure 5.11). Uzbekistan faces high trade costs, and their impact is compounded by poor logistics, delays, and uncertainties imposed by trade regulations (Figure 5.12). And despite large reductions in customs tariff rates, tariffs in Uzbekistan remain some of the highest in the region. Easing these constraints will help firms access large markets and drive growth and job creation.

FIGURE 5.11. EXPORT GROWTH IN LESS CARBON-INTENSE SECTORS HAS ACCELERATED, 2016–2022



Source: World Bank analysis based on national data sources.

FIGURE 5.12. UZBEKISTAN'S TRADE FACILITATION IS WEAK IN SEVERAL AREAS, 2022



Source: Organisation for Economic Cooperation and Development (OECD) Trade Facilitation Indicators.
Note: Percentile rank among all countries: 0 (lowest) to 100 (highest).

Uzbekistan has considerable potential for green exports. Global trade gravity modeling by the World Bank indicates that Uzbekistan has sizable green export potential of US$2 billion per year, equivalent to more than 10 percent of exports of goods and services now.[50] By export destination, Uzbekistan has the greatest potential to export green goods to the Europe and Central Asia region, but North American and East Asia Pacific also have considerable potential (Figure 5.13). By product, the highest green export potential lies in exports of machinery and electrical appliances used for green purposes (Figure 5.14).

FIGURE 5.13. EUROPE AND CENTRAL ASIA HAS THE HIGHEST GREEN EXPORT POTENTIAL VALUE, MISSING GREEN EXPORTS BY REGION, 2010–2020

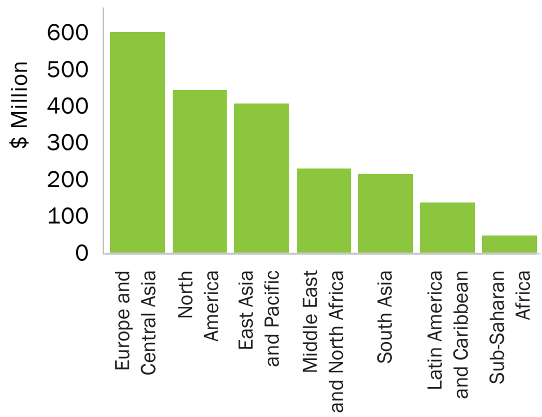
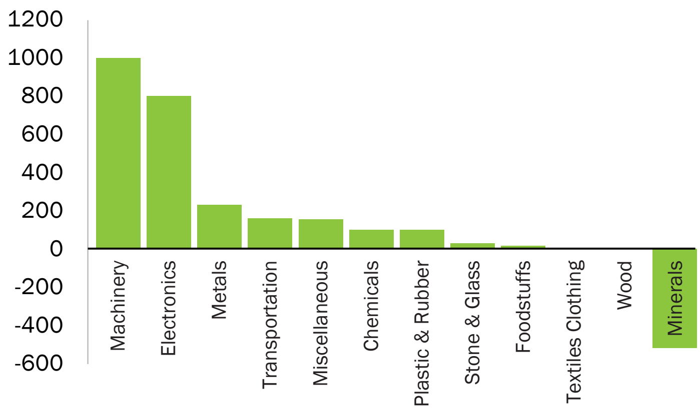


FIGURE 5.14. MACHINERY AND ELECTRONICS ACCOUNT FOR BY FAR THE LARGEST SHARE OF MISSING GREEN EXPORTS, BY PRODUCT, 2010–2020



Source: Mulabdic 2023.
Note: Missing exports is the gap between potential and actual exports. Categorization of 543 environmentally beneficial products that were identified by Penny Mealy & A. Teytelboym (2022), Economic complexity and the green economy, Research Policy, Volume 51, Issue 8, using existing OECD, WTO, and Asia-Pacific Economic Cooperation (APEC) lists.

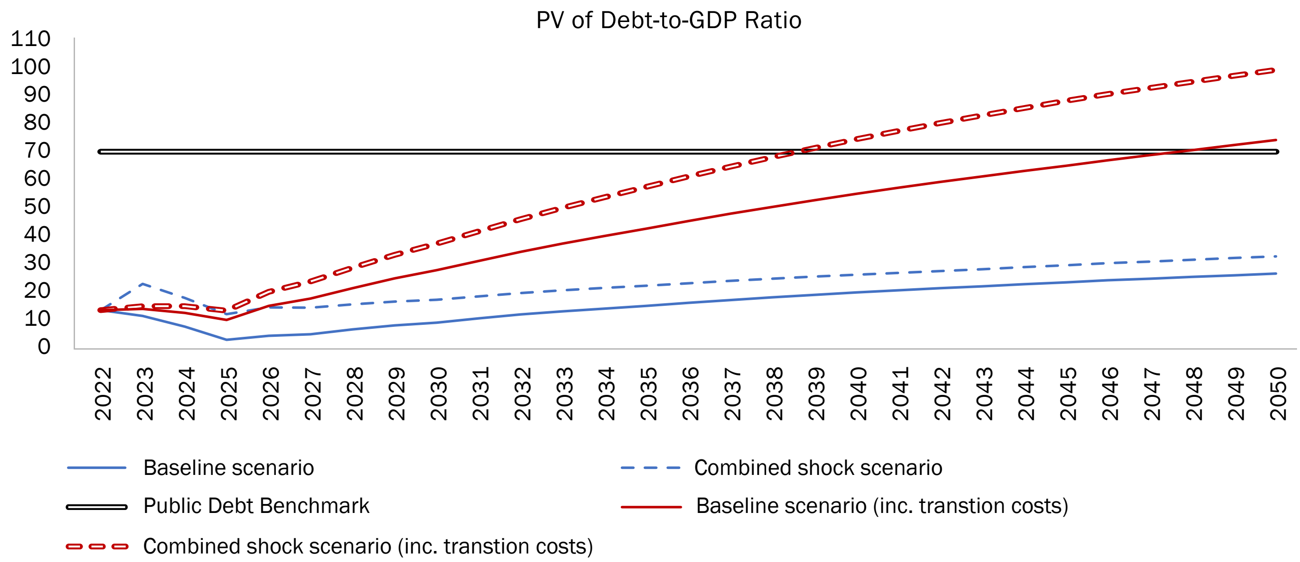
[50] This estimate is based on the results of a gravity model that compares actual trade with trade that would be predicted by countries' bilateral distance, bilateral trade policy frameworks, and other country characteristics. The estimate is indicative only. More detailed market feasibility analysis would be required for a more precise estimate.

5.3 Financing a green transition

Uzbekistan's fiscal position will quickly become unsustainable if the public sector must shoulder large green transition costs without creating fiscal space elsewhere. At 34 percent of GDP in 2022, Uzbekistan's public spending is already higher than that of most of its income-level peers. And while, in the past, revenues have been buttressed by natural resource receipts, these are declining. As a result, a sizable budget deficit has emerged, limiting the capacity of the public sector to take on major additional financing demands. Investment will require a mix of public and private financing. The temptation may be to rely more on public finances, which can be mobilized quickly and do not require the tough policy reforms needed to attract private investment. But scenario analysis indicates that this would move the budget onto an unsustainable path. Under a scenario where half of the investment costs of the green transition is financed by the budget, the public debt-to-GDP ratio could exceed the benchmark for sustainable levels before 2050 and could move much higher if there are adverse economic shocks over the period (Figure 5.15).[51]

The government needs to improve public expenditure management and Increase its efficiency to create fiscal space for financing some of the costs of the green transition. A strong consolidation strategy to move toward fiscal balance will be important to create space for the transition. Measures could include reducing inefficient spending, such as unproductive tax incentives and subsidies (energy subsidies in particular) and raising additional revenue. The investment needs of the decarbonization transition alone are substantial (see section 3.3).

FIGURE 5.15. PUBLIC DEBT RISES SHARPLY IF ONE-THIRD OF EXPECTED TRANSITION COSTS ARE MET BY THE PUBLIC BUDGET



Source: DSA Excel tool, World Bank staff estimates.
Note: The investment cost of the energy transition alone is estimated at around 5 percent of GDP annually (see section 3.1.3). In this scenario, the assumption is that half of this investment will be met by the public sector.

Adjusting prices by removing energy subsidies and introducing carbon pricing is a key ingredient for triggering the green transition. Removing energy subsidies and introducing carbon pricing, such as through a carbon tax, will generate fiscal space for green investment, spur private investment needed to reach net zero emissions, and create positive behavioral incentives for transition. Macroeconomic modelling suggests that these two policies combined can create as much as 5 percent of GDP worth of additional fiscal space over the transition period. These resources can be used to leverage private finance by providing smart subsidies for green investment, support accelerated transition in difficult sector such as residential energy efficiency, and finance essential low-carbon public goods, both physical infrastructure and the strengthening of education and labor

[51] This illustrative scenario is based on the application to Uzbekistan of a tool that the International Monetary Fund and the World Bank use to conduct debt sustainability analysis. It is a risk scenario and should not be interpreted as a central estimate.

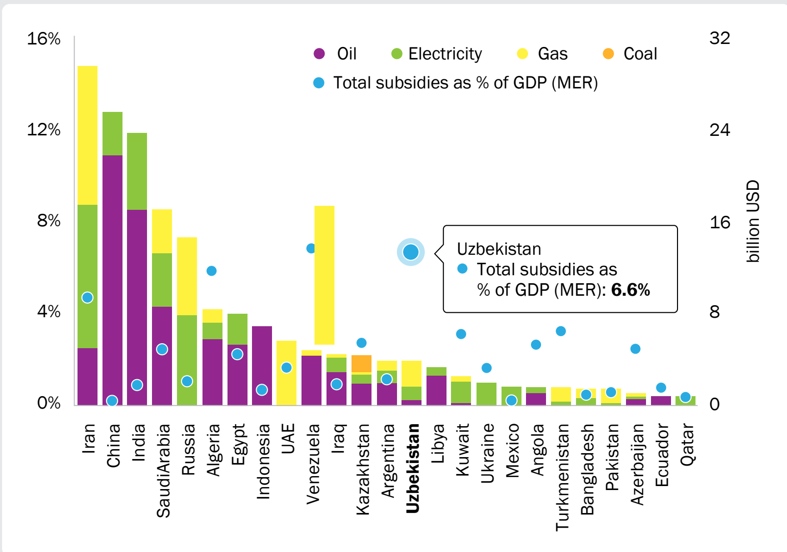
market frameworks to build human capital for the green transition. As shown in table 3.1, these policies will also enable higher share of private sector investments, further relieving the pressure on the public budget.

A successful decarbonization will require follow-through on the authorities' plans to phase out energy subsidies. Removing energy subsidies in the gas, electricity, and heating markets is an essential component of a green transition, supporting the efficiency and financial viability of the energy sector, reducing the sector burden on the public budget, and providing incentives for energy-efficient options. As described in box 5.2, energy subsidies in Uzbekistan are among the highest in the world. The current system of artificially low energy tariffs and high subsidies undermines investment and results in obsolete energy assets in need of modernization, an inadequate price signal for a green energy transition, and lack of incentives to save energy. To close the cost recovery price gap by the end of 2026, the government intends to introduce tariff adjustments over 2024–2026 and removing energy price subsidies is an indispensable part of the strategy. However, as this could lead to a rise in production costs and reduce firm-level competitiveness, targeted measures are needed that facilitate the green transition while minimizing the potential losses to competitiveness by altering the micro-level incentives for private firms to improve their green credentials. Measures could include strengthening green regulations, such as environmental standards and energy audits; implementing programs to improve firm; green management practices; and eventually conditioning credit concessions on the adoption of green technologies. These measures would improve firm incentives to adopt green-friendly solutions while increasing their ability to access more sophisticated export markets with stricter customer preferences.

BOX 5.2. ENERGY SUBSIDY REFORMS IN UZBEKISTAN

Uzbekistan is one of the top 25 countries in the world with the largest energy subsidies, which accounted for 6.6 percent of GDP in 2020. Electricity and natural gas prices are among the lowest in the world, with average electricity tariffs standing at around US¢4.5 per kWh, which is around 70 percent of its cost, placing the country among the top 10 countries with the cheapest prices out of 230 countries. Similarly, natural gas tariffs are among the lowest in the world, with the average tariff of around US¢72 per m^3 standing at about half of its prevailing cost and at 40 percent of its opportunity cost.

BOX 5.2.1. COUNTRIES WITH LARGEST ENERGY SUBSIDIES, 2020

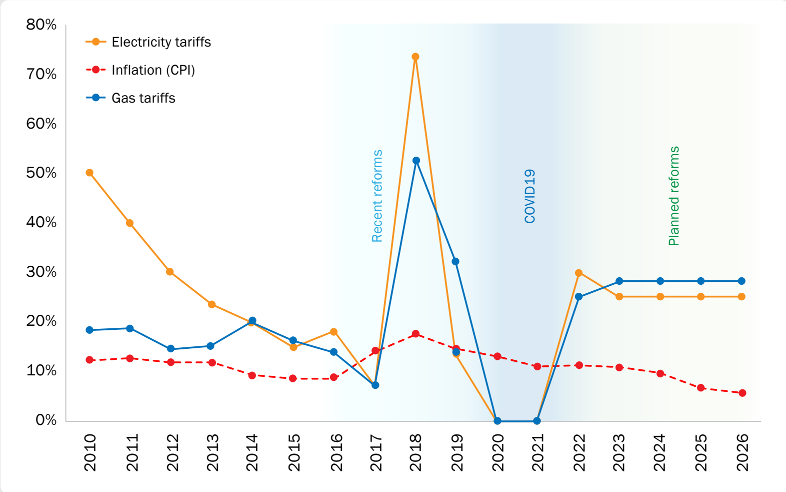


Source: IEA

The below-cost recovery tariffs have created continued disincentives to efficiently consume energy aside from being a drain on government finances. First, the low tariff resulting from subsidies creates a lack of incentive for households and businesses to conserve energy or invest in energy efficiency measures, thereby hindering efforts to optimize energy consumption. Moreover, these subsidies are limiting the GoU's fiscal capacity for other pressing priorities such as education and health, as the GoU has been allocating direct budget transfers of around US$1.0–1.5 billion annually toward the energy sector over recent years.

The GoU has committed to continue pursuing energy subsidy reforms with a target to reach cost recovery in both electricity and gas sectors by 2026. In April 2019, the GoU adopted a new electricity tariff setting methodology, defining a path for tariffs to be systematically adjusted in the future. Similarly, a new natural gas tariff methodology is being finalized by the GoU. The GoU also established a separate tariff commission under the Cabinet of Ministers to set out a path for tariffs to be adjusted towards full cost recovery levels. The GoU also implemented three tariff adjustments in 2018–2019 that collectively doubled the weighted-average tariff of electricity and gas. Although tariff reforms were paused in 2020–2021 due to the impacts of COVID-19, the GoU further adjusted electricity and gas tariffs for selected non-residential customers in May 2022. However, despite the recent tariff reforms, the current level of retail electricity and gas tariffs is not sufficient to recover the cost of supply. The box Figure here illustrates the historical tariff adjustment and planned tariff cost recovery trajectory.

BOX FIGURE 5.2.2. ENERGY TARIFFS HISTORICAL ADJUSTMENT AND COST RECOVERY TRAJECTORY, 2010-2026, % YOY

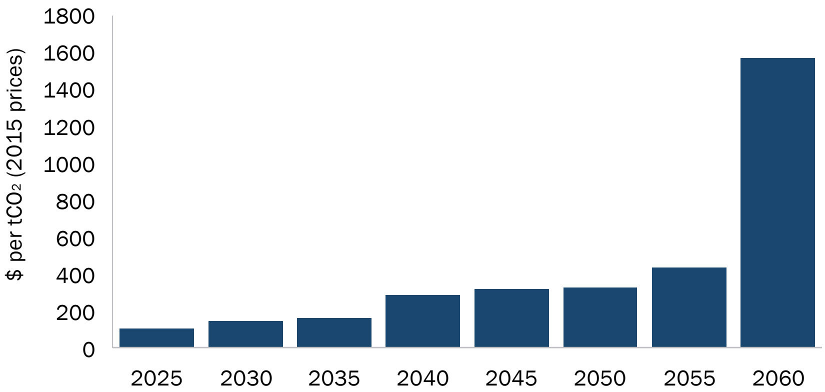


Source: WB team based on the GoU data.

The government has prioritized social protection measures and communication campaigns to accompany tariff reforms. The authorities reviewed several mitigation options to address negative impacts, including (a) phasing tariff increases to allow adaptation among users, (b) adjusting social transfer amounts and coverage to offset the budgetary impact of tariff increases, (c) adjusting the tariff design itself, and (d) potential lifeline tariffs. Phased tariff increases are standard in reform policies that may have particularly adverse effects on vulnerable groups rather than increasing tariffs to full-cost recovery levels in a single large step. This has been the principal approach to mitigate the impact of tariff reform the government has taken over the past decade. The approach allows consumers to prepare for increases, for instance, by adapting their energy use or more quickly retiring inefficient appliances. Under plausible assumptions of adaptive behavior on the part of energy consumers, a more gradual approach is expected to moderate welfare losses and the resulting increase in poverty.

The government could support the green transition with financing and market-based incentives using carbon pricing instruments. Carbon pricing uses regulatory instruments—such as a tax or tradable quota—to raise the cost of emission-creating activities. This makes lower-carbon alternatives more attractive, and as these alternatives scale up, their prices can fall below those of the original polluting activity, increasing their uptake, as is now happening with several renewable energy technologies worldwide. The NZ2060 scenario assumes that the energy system reaches net zero emissions in 2060, which could be achieved through a mix of incentives and regulatory measures, such as a carbon tax to trigger investment in decarbonization across the economy (Figure 5.16).

FIGURE 5.16. SHADOW CARBON PRICES IN THE NZ2060 SCENARIO, 2025–2060

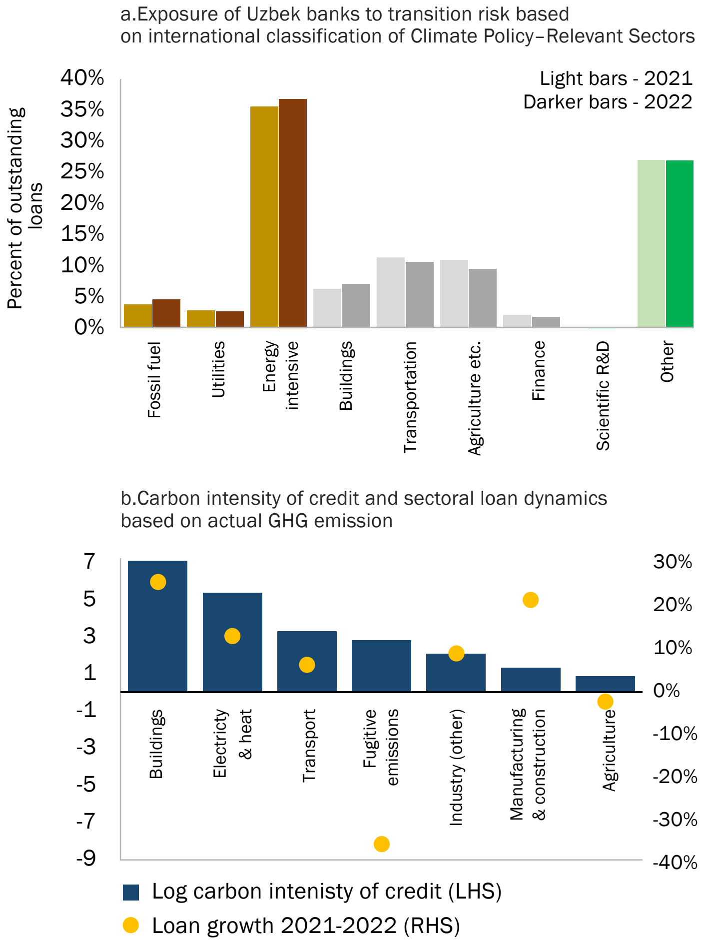


Source: World Bank estimates.
Note: The high 2060 shadow carbon price represents the difficulty of eliminating the last 1 percent of emissions in the energy cost, which comes at a very high cost of using direct air capture. Costs could be reduced by offsetting emissions in other sectors or by applying technologies that become available over the next decades.

5.4 Developing fiscal policies for resilience and green transition

In most countries, funding the transition to a less carbon-intensive economy relies heavily on the financial system. Financial institutions can accelerate the flow of funds into green economic activities and demand transparency through public disclosure requirements about green and brown investments. Funding a green transition hinges on the availability of a clear, transparent, and consistent definition of what qualifies as a green investment or activity and independent verification of green impacts. Uzbekistan could begin by developing a well-defined and clearly structured green taxonomy that focuses primarily on screening (labeling) investments and activities. Further measures would be needed to promote transparency and accountability for green impacts, such as requiring sustainable reporting standards or developing an independent impact verification industry to assure investors and financiers about positive green impacts and forestall greenwashing and green bubbles.

FIGURE 5.17. SOME 40–50 PERCENT OF BANK LENDING IN UZBEKISTAN MAY BE EXPOSED TO SIGNIFICANT TRANSITION RISK, AND THIS EXPOSURE APPEARS TO BE GROWING, 2021–2022



Source: World Bank analysis based on CBU data.
Note: Panel a reflects analysis of bank lending that rates the exposure of bank credit to economic sectors by transition risk. Panel b approximates carbon intensity using a ratio to GDP of total GHG emissions produced by each sector adjusted for credit for sectors for which data on GHG emission were available as of 2019 (https://ourworldindata.org/grapher/ghg-emissions-by-sector?time=1990..latest&country=~UZB).

For financial system stability, regulators need to ensure that the banking sector identifies and manages climate and transition risks. Support for green financing from the Central Bank of Uzbekistan (CBU), a supervisory authority that has traditionally limited its activities to ensuring price and financial stability, could be contentious since such activities are not explicitly within its mandate. But climate change is inextricably linked to these traditional goals. The CBU should focus on assessing and mitigating climate-related risks in the banking system and building bank resilience to residual risks that cannot be mitigated. The CBU could develop a regulatory framework that incorporates a climate risk strategy to ensure that banks pay close attention to climate-related and environmental risks and properly disclose their exposures to these risks. The CBU should regularly assess the banking system's exposure to these risks, develop green and sustainability dashboards, and regularly conduct and publish the results of related system-wide investigations.

Analysis reveals that 42 percent of bank lending in Uzbekistan was exposed to high-emission-prone sectors by the end of 2022, mainly through the financing of fossil fuels, utilities, and energy-intensive sectors. Credit to internationally defined[52] energy-intensive sectors dominates bank lending and was the fastest-growing share of bank financing during 2021–2022 (Figure 5.17a). Based on actual emissions in Uzbekistan, bank lending for

[52] The Climate Policy-Relevant Sectors methodology scores economic sectors based on their propensity to produce GHGs and rates their credit financing from high risk (1) to low risk (9).

buildings and electricity and heat was the most GHG intensive during 2021–2022 (Figure 5.17b), and highly carbon-intensive sectors accounted for the greatest increase in bank lending. This may suggest that banking system exposure to transition risk is rising unless the buildings and transport loans are for greening projects. Agriculture, the least GHG-intensive sector, appears to be starved for credit.[53]

Support for green finance should not rest on a lax regulatory framework. The CBU introduced temporary amendments in its capital adequacy regulation in March 2023 that excluded banks' investments in start-ups engaged in renewable energy from deductions in banks' regulatory capital and that risk-weighted at 0 percent their loans to such start-ups. Amendments to prudential requirements to promote credit to the green economy—such as lowering reserve requirements, capital buffers, or credit risk weights on assets—should be carefully thought out to avoid undermining the effectiveness of prudential instruments or creating unintended regulatory risks. Likewise, any direct intervention tools such as minimum green quotas or maximum limits on lending to brown sectors should be applied cautiously.

The public sector can incentivize private green finance. Once banks establish appropriate frameworks to incorporate environmental risks into credit decisions and their internal systems, the government may further incentivize green lending through financial support measures for green funding intermediated by banks and other financial institutions. Measures to stimulate green investment through green funds, for instance, could include direct investments (debt or equity), co-investments, or de-risking instruments such as credit and equity risk guarantees. Improvements in bank environmental, social, and governance frameworks can build on green taxonomy and impact verification systems to help the banking sector tap the sizable resources of international financial institutions for green finance.

The insurance sector could do a lot more to support robust climate risk management. The GoU shoulders much of the contingent liability arising from disaster damages. Despite the high exposure to climate risk, there is little involvement by the private insurance industry. The capacity of the government, businesses, and individuals to cope with the costs of climate-induced disasters is very limited. Although there are numerous insurance companies in Uzbekistan, penetration of disaster insurance is very low. For example, fewer than 10 percent of residential dwellings are insured against natural perils, fire, lighting, explosion, and aircraft damage risks. In 2022, the ratio of premiums to GDP was just 0.7 percent, compared with a global average of 7.0 percent and an average of 3.7 percent for Emerging Asia.

Uzbekistan should consider developing a national disaster risk financing strategy to cope with climate change-induced disasters. Uzbekistan does not have a comprehensive strategy for post-disaster financing. The government takes a mostly reactive approach to financing disaster response, recovery, and reconstruction, but reserve funds for this purpose are limited. Current funding available for disaster relief seems insufficient to cover even the recurrent losses from disasters and certainly not the capital costs. The damage caused by weather-related events is likely to increase with climate change. The government may wish to develop a disaster risk finance strategy, which could define government policy priorities and set out a cost-effective risk layering approach. Risk layering could include developing local private insurance markets or accessing global capital/reinsurance markets to increase private capital participation.

[53] Because data reporting for sectoral GHG emissions does not match data reporting for bank sectoral lending in Uzbekistan, better data alignment is needed to enable better monitoring of green lending and transition risk exposure. That is especially relevant for sectors such as energy and water, for which data are particularly difficult to compare.

Chapter 6

Climate change and people

Children playing on one of the streets of the city of Samarkand, Uzbekistan.
Photo by Khusen Rustamov / www.shutterstock.com

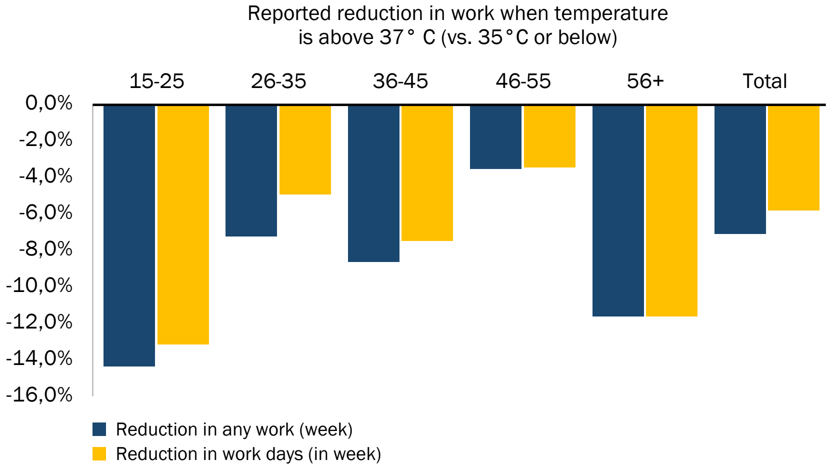
Climate will affect the people of Uzbekistan in multiple ways and by 2030, at least 8 million people will be residing in very high climate risk areas across the country. Changes in climate (for example, droughts, extreme heat, dust storms, and rainfall volatility), climate-induced disasters (for example, pollution, flooding, and mudslides) and climate mitigation and adaptation policies (for example, carbon taxes, energy price increase due to the removal of fossil fuel subsidies) could lead to losses in agricultural productivity; reductions in labor productivity caused by health hazards; and limited access to green skills, food insecurity, and shortages of safe drinking water. In addition, decarbonizing and transitioning to a green economy will affect people's lives and livelihoods, for example, through loss of employment/reduction in income due to economic volatility, as the labor market transitions from brown to green jobs. By 2030, at least 8 million people in rural and urban areas in Uzbekistan will be residing in very high climate risk rural and urban areas, including the Ferghana Valley, Khorezm, Bukhara, and Surkhandarya regions.

The distributional impacts of climate change and climate policies are uneven on the poor and other vulnerable groups. The costs of transition and the adverse climate impacts are disproportionally higher on the poor and disadvantaged communities as they tend to be less resilient to cope with natural shocks, land degradation, increased temperatures, price increases, and displacement. Agriculture will likely be the worst hit, and the rural poor are particularly at risk, especially the rural women, who represent 50 percent of cotton pickers in the country. Poverty levels among the rural population will also likely increase as rising temperatures will reduce livestock production by 8–13 percent by 2040. Other vulnerable groups include the elderly, women (especially those employed in agriculture), high-risk communities (especially near the Aral Sea and other climate-risk areas), and people with disabilities (because of social marginalization, lower skills, and inaccessible public infrastructure).[54]

People with disabilities are at greater risk from climate change impacts because they are largely excluded from social and political engagement. Challenges in accessing essential public services and infrastructure, such as medical exams, assistive devices, disability pensions, public transportation, and public facilities, will be greater in the aftermath of climate-induced disasters. The demand for social and medical assistance usually rises following a disaster, and the logistical challenges associated with accessing assistance multiply.

The impact of extreme temperatures due to climate change will reduce labor productivity and increase mortality risk. High temperatures affect the productivity, health, and safety of workers, particularly those in outdoor or physically demanding occupations. As temperatures rise, workers experience accelerated fatigue, dehydration, and other heat-related ailments, which reduce a person's ability to engage in strenuous activity. In Uzbekistan, extreme temperatures during the summer months lead to large reductions in the number of days of work. By 2040, heat stress could result in a labor supply shock ranging from around −0.07 to −0.13 percent of the labor force and job losses as high as 2.0–3.5 percent are possible over 2041–2050. Reported employment could

FIGURE 6.1. REDUCTIONS IN REPORTED EMPLOYMENT AMONG WORKERS IN UZBEKISTAN DURING PERIODS OF EXTREME HEAT, BY AGE RANGE, 2018–2023



Source: World Bank estimates using Listening to the Citizens of Uzbekistan survey data, 2018–2023.
Note: Figure depicts reductions in reported work during summer months when temperature is 37°C or higher (any reported work in preceding 7 days or number of days worked in previous 7 days) relative to a benchmark of no recorded high temperature (35°C or lower). Temperature is measured using remote sensing; reported work is based on monthly survey data.

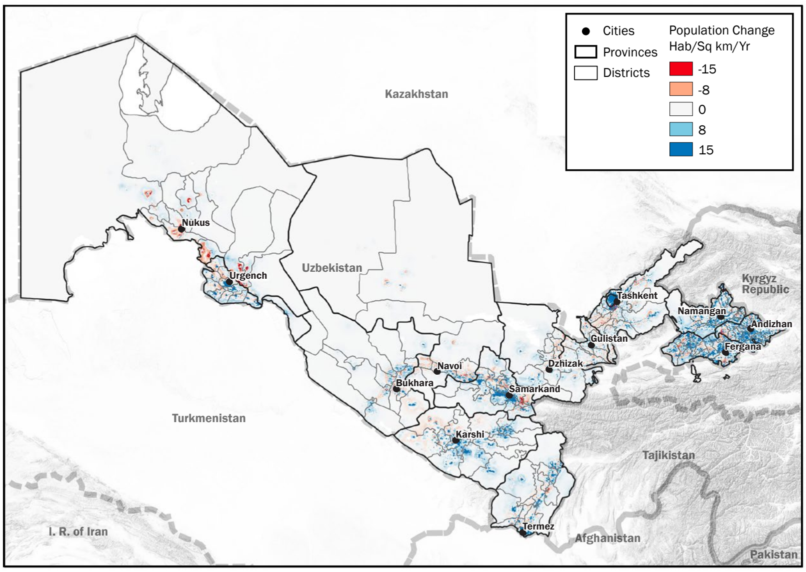
[54] Auerbach and Yusupov 2023.

decline by up to 7.1 percent during weeks with any number of days of extreme heat. Youth (ages 15–25) and older workers (56+) are particularly vulnerable and as much as twice as likely to reduce their days worked during periods of extreme heat (see Figure 6.1). Illness and excess mortality rates rise with the frequency of abnormal temperatures, especially among people with chronic lung or heart illnesses or other health conditions and the elderly. A review of temperature-related effects on mortality across 13 countries found that more than 7 percent of mortality was attributable to suboptimal temperatures.

By increasing the pressure to migrate in search of better livelihood opportunities, climate change could lead to higher rates of internal migration unless adaptation measures are adopted. The agricultural system is resource inefficient in Uzbekistan compared to comparator countries, with output per unit of water among the lowest in the world. As climate change threatens to reduce the availability of resources, especially water, maintaining or increasing agricultural output will require large efficiency improvements. The least productive agricultural areas may become uneconomical due to increased resource scarcity. As a result, domestic migration may become more pronounced in those hotspot areas. The regions most likely to be under the greatest stress, including west of Urgench, Karakalpakstan, and the area surrounding the Aral Sea (see map 6.1), may experience more rapid out-migration than otherwise similar parts of the country. Climate-induced in-migration opportunity hotspots are projected in more fertile areas of the Ferghana Valley and in the area around Tashkent by 2050, driven largely by greater water availability and crop productivity.[55]

The people of Uzbekistan will drive the country's green transition through their skill sets, knowledge, innovation, and behavior change. The NZ2060 scenario forecasts massive job growth in the renewable energy sector, manufacturing sector, higher value-added service sectors, such as insurance and information and communication technologies, and other service sectors such as hospitality. New jobs are also expected in construction, transport, and the installation and operation and maintenance of new, greener technologies, which will require workers with the right skills. A successful and sustainable green transition will therefore rest on having enough people with the skills to fill the new jobs and innovate and willing to change their behavior in ways needed to sustain the transition.

FIGURE 6.2. CHANGE IN POPULATION IN CITIES, PROVINCES, AND DISTRICTS OF UZBEKISTAN BY 2041–2050



Source: World Bank analysis. Forthcoming.

Integrating human development policies in education, social protection, health, and social cohesion within the GoU's policy instruments to support its Climate Change Action Plan and green growth will be crucial in bolstering resilience and helping people adapt to climate change and reduce carbon emissions (table 6.1). Such policies can play a vital role in strengthening the resilience of people against changing climate and climate shocks, mitigating the unintended negative consequences of climate actions on the most vulnerable, and ensuring that the gains of a greener economy are equally distributed and shared. The needs of vulnerable groups should be at the center of the climate change agenda, to ensure that the transition is people centered and inclusive. Policies should focus on adaptive labor market programs, knowledge and skills development, and awareness building to incentivize behavior change.

[55] Clement et al. 2021.

The rest of this chapter describes key pathways for strengthening people's resilience to climate change impacts—as well as other sources of welfare risks—through human development policies that enable a just transition. These pathways include the following:

- Developing an ASP system capable of rapid response when vulnerable population groups are heavily affected by various welfare risks, including climate-related risks.
- Building the skills to prepare people for a green transition, including through job training and other active labor market policies.
- Changing mindsets and behavior to raise awareness of climate change and thereby inform people about adaptation options and opportunities from decarbonization.
- Strengthening integrated information systems to better prepare Uzbekistan's institutions for targeted and timely response.
- Establishing cross-sector and inter-agency coordination mechanisms.
- In Uzbekistan's cultural context, local-level institutions can play a major role in identifying vulnerable populations and implementing solutions.

TABLE 6.1. A PEOPLE-CENTERED FRAMEWORK FOR CLIMATE CHANGE AND THE GREEN TRANSITION

<table>
<tr><th></th><th>Adapting to climate change</th><th>Mitigating climate change</th><th>Enabling the green transition</th><th>Integrating workers and societies into green economy</th><th>Abating unintended consequences of climate change</th></tr>
<tr><td>Human and social development</td><td>Resilient education systems (curricula, programs, institutions)
ASP systems
Responsiveness to shocks and inclusive health systems</td><td>Decarbonization of human development service delivery (education, social and health services provision)
Public works with mitigation focus
Targeted subsidies (energy, housing)</td><td>Education systems to support skills development, research, and innovation that enable green transition (curricula, programs, institutions)
Social protection and labor market reforms to support green jobs and changing nature of work</td><td>Inclusive education and health policies to support and broadly share the benefits of green transition
Safety nets and active labor market programs for just transition
Inclusive health systems to cope with emerging diseases</td><td>Inclusive education and health policies to support poor people's adaptation to the impacts of some reforms
Social protection and labor market reforms to protect the well-being of poor people in the face of reform impacts
Public works</td></tr>
<tr><td rowspan="3">Cross-cutting areas</td><td colspan="2">Adaptation of human development infrastructure (education and health facilities)
Decarbonization of human development infrastructure (education and health facilities, health waste management)</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Skills development across life cycle
Education, health care services, and skills development for climate adaptation
Education and skills and research and development (R&D) for green transition</td></tr>
<tr><td colspan="5">Behavior changes and increased awareness
Enabling behavior change through technological innovations and education</td></tr>
</table>

Source: World Bank compilation based on Rigolini, Jamele. 2021. Social Protection and Labor: A Key Enabler for Climate Change Adaptation and Mitigation. Social Protection and Jobs Discussion Paper; No.2108. World Bank, Washington, DC. and Sanchez-Reaza et al. 2023. Making the European Green Deal Work for People. World Bank, Washington DC.

6.1. Adjusting social protection programs to adapt rapidly to people's needs

Effective social protection climate-adaptation response requires stronger institutions and financing anchored in a solid policy framework for ASP. The newly created Agency for Social Protection is mandated to coordinate and oversee the full range of social protection measures.[56] The establishment of a dedicated agency for social protection sets the right momentum to develop a policy framework, which Uzbekistan currently lacks. A robust policy framework would define (a) the ASP policy objectives and links with the national social protection strategy; (b) specific social protection program adjustments to be made in the event of a disaster; (c) interagency disaster and emergency response arrangements across relevant state actors namely the Ministry of Employment and Poverty Reduction (MEPR), the Ministry of Emergency Services, Uzhydromet, and the Pension Fund, among others; (d) the financing sources and emergency budget procedures; and (e) monitoring and evaluation indicators, data collection sources, and frequency of reporting. The Agency for Social Protection is best positioned to develop such a policy framework for adaptive social protection, including the preparation of the necessary legislation and protocols for social protection programs scale up and down. New climate financing instruments could be deployed based on savings from the removal of energy subsidies and carbon taxes.

Investments are required in adaptive social protection delivery and information systems to strengthen crisis preparedness and enable timely and inclusive response to climate-induced disasters. The social protection system in Uzbekistan covers over 50 programs nationwide, reaching 55 percent of the population. Most social protection programs are designed to address traditional social risks, not emergencies. Predefined response mechanisms and operational procedures to activate the social response in a timely manner during and after climate-related shocks are not existent. Currently, the government responds to crises with ad hoc support, making one-off decisions to provide benefits and services after disasters or to adjust delivery processes (payment and benefit amount) following a disaster event. Operational processes to govern the implementation of social protection program adaptations to climate risks and shocks need to be developed and adopted.

The MEF has made substantial progress in the past five years to roll out an electronic and inter-operable social registry nationally. However, only one in four households in the poorest per capita income quintile is registered; hence, outreach and poverty targeting rules should be reformed to reduce exclusion errors. In addition, it takes time to verify eligibility which is based on the average per capita family income over the past 12 months. The 'adaptation' potential of the social protection delivery system could be better exploited by defining specific climate events and indicators triggering social protection responses.[57] For example, the social registry—now hosted in the new Social Protection Agency—should be upgraded to enable automatic enrolment procedures of vulnerable citizens in affected areas through their integration with other disaster risk management (DRM) information systems, such as the proposed 'seismic early warning system'. With adaptive delivery systems, social protection benefits such as cash transfers, minimum crop guarantees and vouchers to purchase seeds could be activated to respond to crop losses for example, and food transfers activated to address reduced access to food and displacement due to climate-related disasters.

Livelihood support and social insurance policies would need to be adapted to increase long-term resilience to climate change and address losses due to a changing climate. Strong social insurance programs for individuals, businesses, and the self-employed in high-risk areas will help protect against the loss of property and livelihoods. Farmers and people who experience the harshest negative impacts of climate change need to be assisted in moving to less affected areas through mobility and housing allowances, assistance in finding jobs, and access to public education, health, and social protection services. Where households are not able to relocate, climate-adaptation measures should be integrated into existing social protection programs (including public works, Low-Income Family Allowance (LIFA), and in-kind assistance for farmers to strengthen the resilience

[56] Decree of the President of the Republic of Uzbekistan dated 01.06.2023, No. 82. The seven remits of the agency are social protection, persons with disabilities, protection of minors, improving women's protection, working with families, young people, the elderly, and directing social security programs.

[57] If drought triggers are used, for example, as in the Kenyan Safety Hunger Net Program, the basic rain or vegetation indexes are applicable.

and ability of households and communities to cope with climate shocks. Action should be taken sooner rather than later to reduce vulnerability and limit future costs.

Finally, mitigating the unintended consequences of government climate actions is central to social protection policies and important to win support for climate policies and avoid social unrest.

6.2 Building the skills needed for a green transition

Skills development should be a cornerstone of adaptation and the green transition in Uzbekistan (see chapter 5). Many of the skills required to enable a green transition are foundational, helping people interpret new situations, adapt their thinking, collect information, and make decisions under uncertainty. For that reason, the quality of formal education is a critical contributor to green skills. The government is committed to upgrading formal education curricula. The curriculum at all levels of formal education and training should cover key sustainable development issues to build climate risk awareness and inspire behavioral and consumption change later in life. Learning outcomes need improvement too: recent studies find that learners are underperforming in language comprehension skills and in applying numeracy skills to problems.[58] Uzbekistan could benefit from having more people (than the current 33 percent) enter science, technology, engineering, and math (STEM) programs, which impart crucial skills for the green transition.[59] Finally, gender disparities in science subjects need to be addressed to maximize the country's human capital.

Human capital development is also essential to bolster technology adoption and the creation of local solutions through R&D. Higher education institutions need to offer programs that develop the skills needed to enable the adoption of new technologies and the creation of local solutions through R&D. Low capacity to adopt technologies and commercialize research can be explained by inadequate skills development in Uzbekistan.[60] Partnerships between industry, research institutions, and universities need to be encouraged to support advances related to climate change and green transition.

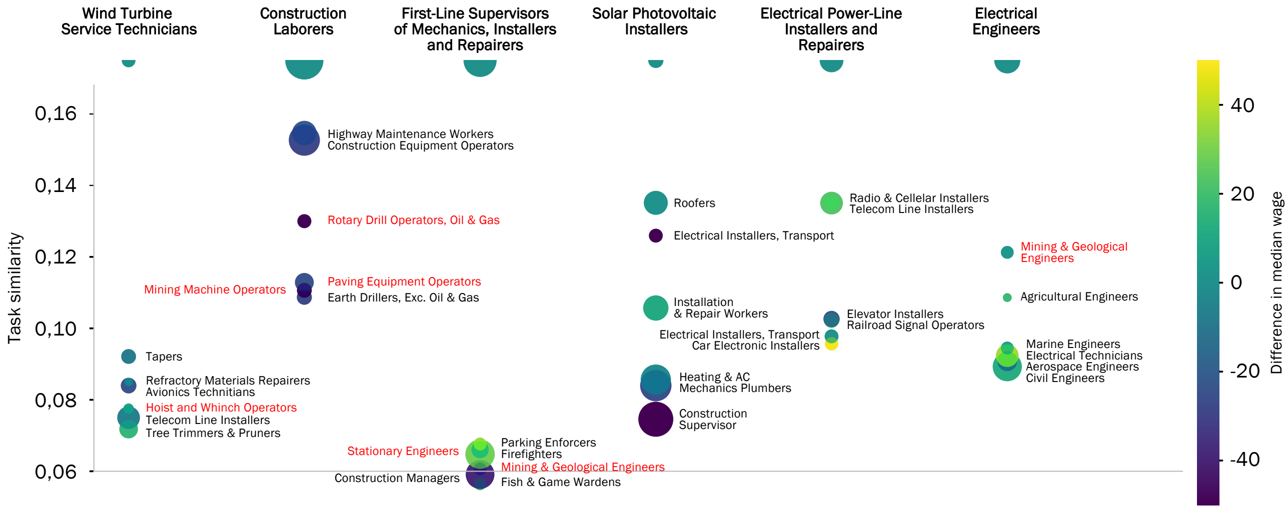
Upskilling may be all that is needed to fill some new jobs, while other jobs may require more education and training. A mapping of the similarity of tasks between new and legacy jobs indicates, for instance, that the fast-growing profession of solar photovoltaic panel installer is similar to the existing work of roofers and installation and repair workers, suggesting that these workers could be upskilled to fill the new jobs (Figure 6.3). In contrast, wind turbine operators need a new set of skills, and equipping a group of workers at scale with the necessary skills will require more time and policy support. Active labor market programs could provide targeted training based on assessments of skills of works. In general, growing occupations in a green transition tend to involve higher educational requirements than legacy jobs, and so education and well-targeted training programs will be critical. Policies to encourage skilled migration could also ease labor supply constraints.

[58] Uzbekistan has made remarkable progress in expanding access to preschool education from 28 percent in 2017 to almost 72 percent in 2023, but learning gaps remain in basic subjects at the primary school level. The average achievement scores of fourth graders on a nationally representative assessment were 50 percent in reading, 52 percent in math, and 59 percent in science (with some of the poorest students almost 4 years behind their richest peers). By age 18, an Uzbekistani student has achieved only 62 percent of educational potential (UNICEF 2019a).

[59] UNICEF 2019b.

[60] Elci 2020; Kurbanbaeva 2020.

FIGURE 6.3. TASK SIMILARITY FOR SELECTED GROWING OCCUPATIONS AND LEGACY OCCUPATIONS



Source: World Bank analysis.
Note: Bubble size indicates total employment per occupation in the United States. Colors indicate whether moving to the growing occupation would increase wages (yellow) or decrease them (purple). Occupations with a red label are shrinking in the net zero scenario. Some occupational titles have been shortened for readability.

Active labor market policies[61] should be reoriented to support workers vulnerable to the green transition and integrate them into the green economy. Some workers are more vulnerable than others to the green transition, in particular, those in brown jobs (polluting sectors) and those workers in jobs expected to undergo substantial change in task content.[62] Existing one-stop shops for employment services and professional training can play a key role in facilitating the transition of workers to greener jobs but are not well equipped to play this role. The authorities can prepare by developing a forward-looking assessment and regular monitor of skills and occupations in demand, in close coordination with the private sector, to inform the design of training curricula and to target active labor market policies. As part of this, employment support centers (ESCs) should establish stronger partnerships with employers creating green jobs to expand and re-orient the supply of internships, apprenticeships, and wage subsidies. Vocational training can also be adapted to respond to green skills demand.

6.3 Changing mindsets and behavior

Building public awareness of climate change is indispensable for a sustained green transition. Dissemination of information about climate change and the threats it poses to human well-being, households, and communities can be a catalyst for behavioral changes that are supportive of a green transition.[63] A survey of over 4,000 households in five regions of Uzbekistan found very low levels of public awareness of the causes and consequences of climate change (box 6.2)[64] Local self-governing bodies that intermediate between local (district) administrations and citizens, as well as teachers, the media, and other trusted authorities, can play a decisive role in raising awareness of climate change.

[61] Active labor market policies aim to assist job seekers to find employment, keep workers employed, increase their productivity and earnings, and improve the functioning of labor markets.

[62] Lack of data did not allow to quantify the incidence of workers in green and brown jobs.

[63] Allcott 2011; Banerjee et al. 2013; Conley and Udry 2010; Zilberman, Zhao, and Heiman 2012. For related literature on how information provision spurs political accountability, see Pande (2011) and Dunning et al. (2019).

[64] Uzbekistan Rural Infrastructure Development Project 2021 Survey.

BOX 6.2. PUBLIC AWARENESS OF CLIMATE CHANGE REMAINS LOW IN UZBEKISTAN

A 2021 survey of 4,000 households in Uzbekistan reveals the following:

- Less than half of the people surveyed were familiar with the meaning of climate change. On average, women, less-educated residents, and lower-income residents demonstrated less awareness.
- When residents were asked about the effects of climate change in their village, only 32 percent of respondents indicated that climate change has caused temperatures to become more irregular in their village.
- Close to 70 percent of respondents who experienced negative economic impacts of climate change and 45 percent of respondents who experienced a recent natural disaster reported having done nothing to cope or adapt.
- Socioeconomic status shapes adaptation strategies in a consistent pattern: the wealthiest respondents are far more likely to have taken actions to adapt than the poorest respondents.
- Over half of respondents either believe that there is nothing they can do or do not know what they can do to mitigate the impact of future disasters on their household.
- Respondents generally believe that the level of resources and training available in their village is insufficient to cope with the impacts of climate change.

Source: Uzbekistan Rural Infrastructure Development Project 2021 Survey.

Once they understand the issues, people favor investments in decarbonization and in climate change mitigation and adaptation. Ninety percent of respondents to the Listening to Uzbekistan December 2021 survey support public policies to reduce emissions, and 66 percent think that clean energy should receive public financial support even if it means reducing fossil fuel subsidies.[65] More than half the respondents support higher taxes on polluting activities. This is a good starting point for increasing public support and incentivizing behavior change. As Uzbekistan designs its climate change policies, it would be prudent to communicate a coherent message that climate change mitigation is aligned with social preferences and individual economic interests and that economic incentives penalize emissions through carbon pricing and reward mitigation-supporting behavior through lower prices and cost savings. The high cost of lowering emissions, especially in transport and buildings, argues for incentives for lower socioeconomic groups and less developed regions, which may face higher obstacles in adjusting their behavior.

6.4 Strengthening integrated information systems

Uzbekistan can benefit from investing in data and information gathering that can be used to better link climate change challenges to people's lives. Despite the country's efforts to collect statistical information through Labor Force Surveys and Household Budget Surveys, information cannot be easily established about climate-related challenges facing people. Surveys should include questions on air pollution, heat waves, flooding, and erosion and their impact on household livelihoods to understand the health, employment, poverty, and education impacts on people. Uzbekistan could benefit from conducting a shocks and resiliency survey to collect information on which shock affects households and what coping mechanisms they employ.

Better data collection and analysis can lead Uzbekistan to improve the coverage and ex ante climate vulnerability targeting of its social protection systems. The Social Protection Single Registry fails to reach three-quarters of the poorest share of the population. Social protection programs need to be linked to disaster risk management systems to reduce risk, strengthen and accelerate response, and support recovery. These developments should be leveraged in an ASP setting and incorporate both poverty and social protection indicators to better assess beneficiary targeting and program outcomes. Improving targeting ex ante to a shock is important to be adaptive and efficient.

[65] Seitz 2021.

Human development policies in education, social protection, health, and social cohesion will be crucial in bolstering resilience and helping people adapt to climate change and reduce carbon emissions. Such policies are also vital for integrating people into the green economy and for abating the unintended consequences of the green transition for vulnerable people. The needs of vulnerable groups should be at the center of the climate change agenda, to ensure that the transition is people-centered and inclusive. Policies should focus on ASP programs, knowledge and skills development, and awareness building to incentivize behavior change.

Chapter 7

Policy reform agenda on climate and development: Summary of recommendations

The central business district of Tashkent, Uzbekistan.
Photo by Uldis Laganovskis / stock.adobe.com

7.1 Urgent climate actions

The CCDR proposes a set of urgent actions to advance decarbonization and adaptation to climate change in Uzbekistan in the short term. The following actions include key policy and investment priorities to address the most critical challenges for unlocking a green transition in Uzbekistan.

Priority area	Recommended action
Cross-cutting climate action	✔ **Adopt more ambitious NDC targets and carbon-neutrality targets.** It would be important for the government to issue more ambitious NDC targets and formally adopt carbon-neutrality targets for the energy sector and the overall economy. Current targets could also be consolidated into an overarching NZ2060 action plan.
Cross-cutting private sector development	✔ **Continue and accelerate existing reform programs to improve business dynamism, enhance the investment environment, and strengthen the private sector.** Underdeveloped market institutions and an excessive state presence in the economy must be addressed to enable the private sector to lead the way in a green transition. Reforms are already under way and need to continue, including reforming state enterprises; ensuring fair competition and a low burden of doing business; and establishing a clear, fair, and inviting environment for foreign investment.
National green taxonomy, monitoring, reporting, and verification	✔ **Develop a national green taxonomy and monitoring, reporting, and verification system.** A foundation for identifying and targeting green policy and regulatory measures should be established, along with robust monitoring of green criteria (to prevent greenwashing or policy inconsistency, for instance).
Energy pricing	✔ **Complete energy sector subsidy reforms.** It would be important for the government to adhere to the commitment of tariff reforms to achieve full cost recovery for gas and electricity by 2026, while protecting the vulnerable population.
Buildings/Energy Efficiency	✔ **Accelerate the implementation of energy efficiency programs in buildings.** Energy efficiency measures require a scale-up from the current levels and increase to a coverage of close to 0.8 percent of existing building stock annually. Heat pumps are a critical and mature decarbonization technology that could be supported in the short term. Bulk procurement of efficient technologies could be rolled out in the near term to improve efficiency and reduce emissions in buildings and industry sectors.
Power sector/natural gas	✔ **Continue to scale up competitive and private driven renewable energy generation.** Adhere to the commitment of no new coal development, while limiting natural gas to domestic use, prioritizing power and industry sectors. With natural gas production expected to peak in 2023 and then decline, limited natural gas should be reserved for domestic use, driven by economy and efficiency consideration, and prioritized for power and industry sectors. Systems should be developed that will enable the country to cope with increasingly limited gas availability in future winters (emergency response protocol).
Natural gas	✔ **Reduce losses, fugitive emissions, venting, and incomplete gas flaring.** Measurement campaigns and detailed studies are needed to identify strategies and action plans to reduce fugitive emissions, venting, incomplete gas flaring, and gas losses.

Priority area	Recommended action
Green urban development	**Focus on green urban development.** Recognizing cities as engines of growth, Uzbekistan has set sustainable urbanization as a priority agenda. Compact development and systematic green development should be adopted as the main drivers of reform while applying biodiversity planning, green master plans, urban mobility plans, and efficient delivery of public transport.
Water resources and irrigation management	**Increase the efficiency of water use in irrigation.** To promote efficient use of water resources and adapt to increasing water scarcity, it will be important to promote the adoption of water- and energy-efficient technologies, in combination with complementary measures and climate-aligned agriculture policies.
Climate-smart agriculture and land policy	**Strengthen incentives for investments in climate-smart agriculture.** From a climate perspective, it is important to strengthen land tenure security, allow farmers to choose what to cultivate on their land, and promote land conservation investments and other investments in climate-smart agriculture. As planned by the government, that will require enhancement of land tenure security, improvements in land leasing arrangements, and reform of the crop placement system.
Landscape restoration	**Prioritize investments in adaptation and landscape restoration.** Investments in adaptation and landscape restoration need to be prioritized based on the potential for adoption of climate-smart technologies, the speed of investment recovery, and socioeconomic factors. The highest potential for such investments is in eastern Uzbekistan. Alternative investments need to be considered in other areas, to attain regional development and social objectives.
Foundational skills	**Develop foundational skills and upskill workers to better integrate workers into a green economy.** Many of the skills required to enable a green transition are foundational, helping people interpret new situations, adapt their thinking, collect information, and make decisions under uncertainty. For that reason, the quality of formal education is a critical contributor to green skills. The government is committed to upgrading formal education curricula.
Social protection	**Make the social protection system more adaptive to enable crisis preparedness, faster crisis response, and greater resilience among people.** Develop a framework of adaptive social protection, including policy goals, institutional arrangements, data, program adjustments, and financing for emergency response. Social assistance and insurance delivery systems should allow to identify climate-vulnerable households, allow automatic enrolment for fast post-shock support response; operational processes to guide the implementation of crisis response need to be developed and adopted; active labor market policies—notably professional skills training and public works—should be adapted to support workers that are vulnerable to job losses due to the green transition; and integrate them into the green economy.
Subnational governance of climate action	**Increase the responsibilities of the municipal government.** Empower subnational governments, including mahallas and regional Uzhydromet offices, to support appropriate local climate policy design and implementation. This would entail more clearly defining roles, responsibilities, and accountabilities of subnational administrations across tiers of territorial administration, aligned with their fiscal and administrative capabilities, and increasing resources for local climate development action.

7.2 Medium-term climate actions

This CCDR proposes a set of medium-term actions to tackle the more challenging and longer-term reform needs across sectors that are most critical to advancing decarbonization and climate adaptation objectives. The priority recommendations include strengthening institutional arrangements and coordination mechanisms for climate change policies and investments at the central and subnational levels, instituting national implementation planning (such as through the Long-term Strategy on climate change), and tightening regulation (including the adoption of legally binding national climate targets).

Objective and policy area	Recommended action
Decarbonization	
Energy sector	**Accelerate the market transition through a new wave of reforms.** Form an independent energy regulator, establish tariff-setting mechanisms, commercialize NEGU, and develop institutions to support a wholesale energy market.
Power sector	**Continue decommissioning old and inefficient thermal plants, expand the use of renewables, and strengthen energy system infrastructure.** Build on earlier successes and continue to scale up renewable energy and decommission old thermal power plants. Upgrade transmission infrastructure to enable large-scale penetration of renewable energy and ensure reliable energy supply, enhancement of regional interconnectivity, and increased electricity trade.
Buildings, sustainable heating, and industry	**Promote new energy efficiency programs, strengthen standards, and deploy innovative financing mechanisms.** Increase the scope of energy efficiency programs to residential buildings and scale up construction of low-carbon housing and settlements through policies and regulations for low-carbon housing, dedicated funding to support building retrofitting, and investments in Uzbekistan's district heating systems. Establish minimum energy performance standards for industry and for all types of energy-using equipment to achieve efficiency gains and support energy security objectives.
Transport	**Define targets, standards, and incentives for the transport sector, including standards for fuel economy, electrification targets, and the provision of incentives to promote a shift from internal combustion engines to eVs.** By 2030, consumers will require incentives to adopt eVs or retrofit older vehicles, especially with the gradual phase out of compressed natural gas in the transport sector.
Methane emission reduction through improved waste management	**Implement waste management strategy.** To reduce methane emissions, waste collection systems need to minimize open dumping and uncontrolled landfilling, manage GHG emissions from landfills, and divert organic waste from landfills. Establish regulatory and institutional frameworks to facilitate compliance, accountability, and efficient enforcement.
Methane emissions reduction in livestock	**Decarbonize agriculture through climate-smart livestock management to reduce methane emissions.** Strengthen the implementation and monitoring mechanisms for commitments on climate change in the strategy of agricultural development; develop a system to monitor progress on farmers' adoption of the Uzbekistan Code of Good Agricultural and Environmental Practices.
Air quality	**Develop an integrated air quality management program for improving air quality while reducing GHG emissions and increasing adaptation.** This triple objective must be informed by an analysis of tradeoffs and synergies between air quality management, adaptation strategies, and decarbonization options, and integrated solutions should be identified for achieving all three objectives, when possible.

Objective and policy area	Recommended action
Adaptation: water, agriculture, forests, and land nexus	
Water	**Promote regulatory reforms to improve management of service delivery and increase water-use efficiency.** Implement government plans to transfer irrigation and drainage network management to voluntary associations of agricultural producers and other water consumers, private companies, or agricultural clusters. Reduce reliance on taxes and transfers to finance delivery of water services and instead increase direct cost recovery from water users. Implement recent plans to introduce flexible water allocation mechanisms, formalize a system for exchanging water entitlements, modernize infrastructure, and improve the water accounting system.
Agriculture	**Optimize livestock management.** Accelerate efforts to increase livestock productivity through improvements in animal health, management, and breeding programs, combined with measures to control the growth of the livestock herd and a reorientation toward lower-emitting species like fowl.
Forestry and land management	**Promote sustainable land restoration.** Identify adaptation priorities spatially for the maximization of ecosystem services and deployment of climate-smart and resilient livestock husbandry, soil management, and agricultural practices associated with increasing vegetation. Incentivize climate-smart technologies adoption with access to green finance to achieve economic efficiency for high, climate-resilient, and inclusive agricultural growth and restore degraded productive lands.
People	
Skills for a green transition	**Make skill development a cornerstone of adaptation and the green transition.** Improve the quality of the basic and secondary education systems to ensure the acquisition of foundational skills and partnerships with industry. Support new vocational education and training and higher education programs delivering skills for a green economy.
Skills for health sector	**Prepare medical workers to respond to climate-induced diseases.** Enhance curriculums for the training of medical workers on managing waterborne and vector-borne and respiratory diseases to provide adequate response to the climate risks in health sector in Uzbekistan.
R&D and innovation policy	**Develop human capital to support the adoption of technologies and enable the creation of local solutions through R&D.** Enhance partnerships between industry, research institutions, and universities to support particular niche technologies related to climate change and green transition. Increase the level and the efficiency of investment in agriculture science, extension services, and innovation.
Health sector preparedness	**Implement an integrated 'One Health' approach throughout the public health system for adequate preparedness, detection, and response to the climate-induced health threats, especially an increased risk of communicable diseases.** The 'One Health' approach represents a collaborative and multisectoral framework, that allows health systems to provide adequate prevention and response to the health threats shared by people, animals, and the environment.

Objective and policy area	Recommended action
Climate awareness	**Build public awareness of climate change to support a sustained green transition.** Disseminate information about climate change and the threats it poses to individual well-being, households, and communities can be a catalyst for behavioral change.
Financing and enabling environment	
Green financial regulation	**Develop systems to manage financial sector risk.** The central bank could develop a regulatory framework that incorporates a climate risk strategy that considers climate-related and environmental risks and that discloses banks' exposures to these risks; develop green and sustainability dashboards and publish systemwide analyses. A taxonomy along with sustainability reporting standards (GHG accounting standards) and appropriate institutional arrangements would be needed to properly disclose and monitor green investments and their green impact.
Green financial products	**Develop financial markets and new products.** Implement foundational reforms to improve the financial sector's capacity to raise financing, including deposit insurance law and bank restructuring law. Support is needed to encourage development of the insurance market, including disaster risk insurance. Green financial support programs are needed (such as national developmental financial institution, state-owned commercial banks, and Uzbekistan fund for reconstruction and development).
Disaster risk and climate adaptation financing framework	**Develop a financing framework to manage climate risk and fund only critical needs.** A financing framework is needed that covers major sources of funds (from the public sector, development assistance, carbon markets, and private finance) and identifies public expenditure requirements that cannot be met by the private sector. This should be complemented by fiscal risk analysis that includes medium- to longer-term climate risks and risks arising from climate-induced and climate-exacerbated natural disasters and which is embedded in a broader fiscal framework.
Market-based incentives	**Develop market-based incentives, such as a carbon tax.** To ensure a private sector-led transition, private actors need to initiate change in response to market incentives. This calls for carbon pricing measures such as a carbon tax that can be implemented upstream and that can generate a revenue stream to support public finances.
International trade	**Reduce barriers to international trade in goods, services, and intellectual property.** To access green markets abroad and the quality inputs needed for higher value-added/low-carbon activities at home, Uzbekistan needs an effective and comprehensive trade framework. joining the world trade organization is an important step, as is the associated alignment of procedures and minimization of the burdens of tariffs and other regulatory and practical constraints to trade.
Improve public expenditure management	**Improve public expenditure management and increase its efficiency to create fiscal space for financing some of the costs of the green transition.** A strong consolidation strategy to move toward fiscal balance will be important to create space for the transition.
Public investment management	**Mainstream climate concerns into public investment decisions.** This entails incorporating climate criteria into public investment management appraisal and selection and integrating climate change risks into infrastructure regulation and land zoning. Climate objectives need to be incorporated into core infrastructure governance and asset management.

Objective and policy area	Recommended action
Climate data, governance, and coordination across sectors	
Institutional arrangement and capacity	**Streamline institutional responsibilities for climate action.** There are gaps and overlaps between the institutional arrangements for the green economy and the climate functions of the Ministry of Ecology, Environmental Protection and Climate Change. Finalizing the national climate change strategy and establishing a unified regulatory framework under a national climate change law would strengthen the legal basis for climate change policy and action.
Climate data infrastructure	**Improve data infrastructure.** Transparent, integrated, and smoothly functioning climate data infrastructure is needed at the national and subnational levels. Capacity building and training are also needed in measurement, evaluation, hydrological modeling, and statistical analysis for decisions in managing risk and vulnerability. Some of the support could be targeted to the Statistics Agency and Uzhydromet.
Climate action	**Empower mahallas, the lowest tier of territorial organization in Uzbekistan, to promote local climate action.** Government capacity building for mahalla specialists on climate change risks and strategies for mitigation, combined with devolving financing to mahallas, can enable mahallas to raise awareness of climate change in the community, develop local climate actions plans, and implement local initiatives that strengthen community resilience and capacity for adaptation.

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