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AZERBAIJAN

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

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Acknowledgments

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Abbreviations and Acronyms

AERA	Azerbaijan Energy Regulatory Agency
AFOLU	Agriculture, Forestry, and Other Land Use
ALMP	Active Labor Market Program
AMCGF	Azerbaijan Mortgage and Credit Guarantee Fund
BAU	Business as Usual
BELA	Biodiversity, Ecosystems, and Landscape Assessment Initiative
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CBA	Central Bank of Azerbaijan
CBAM	Carbon Border Adjustment Mechanism
CCDR	Country Climate and Development Report
CCS	Carbon Capture and Storage
CEE	Central and Eastern Europe
CGE	Computable General Equilibrium
CIF	Climate Investment Fund
CPRS	Climate Policy Relevant Sectors
CSA	Climate-Smart Agriculture
DRF	Disaster Risk Financing
ECA	Europe and Central Asia
ENVISAGE	Environmental Impact and Sustainability Applied General Equilibrium Model
ESG	Environmental, Social, and Governance
EU	European Union
FDI	Foreign Direct Investment
GCF	Green Climate Fund
GCM	Global Circulation Model
GDP	Gross Domestic Product
GEF	Global Environment Facility
GES	Green Exports Scenario
GGFR	Global Gas Flaring Reduction
GHG	Greenhouse Gas
GSS	Green, Social, or Sustainable
GTAP	Global Trade Analysis Project
HEP	Higher Energy Price
IEA	International Energy Agency
IFC	International Finance Corporation
IFI	International Financial Institution
IPPU	Industrial Processes and Product Use
IWRM	Integrated Water Resource Management
LEDS	Long-Term Low-Emission Development Strategy
LULUCF	Land Use, Land Use Change, and Forestry
MDB	Multilateral Development Bank
MoF	Ministry of Finance
MENR	Ministry of Environment and Natural Resources
MIGA	Multilateral Investment Guarantee Agency
MIS	Management Information System
MoE	Ministry of Energy
MRV	Monitoring, Reporting, and Verification
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
NPL	Nonperforming Loan
NPS	National Pledges Scenario
NZS	Net-Zero Emissions Scenario
OECD	Organisation for Economic Co-operation and Development
OPEX	Operating Expenses
PPP	Purchasing Power Parity
PV	Photovoltaic
R&D	Research and Development
RCP	Representative Concentration Pathway
RES	Renewable Energy Source
RWI	Relative Wealth Index
SAARES	State Agency on Alternative and Renewable Energy Sources
SBFN	Sustainable Banking and Finance Network
SEDS	Socio-Economic Development Strategy
SMEs	Small and Medium Enterprises
SOCAR	State Oil Company of the Republic of Azerbaijan
SOE	State-Owned Enterprise
SSCRA	State Statistical Committee of the Republic of Azerbaijan
SSP	Shared Socioeconomic Pathway
UMI	Upper-Middle-Income
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
WDI	World Development Indicators
WSI	Water Scarcity Index
WTP	Willingness-to-Pay
WUA	Water User Association

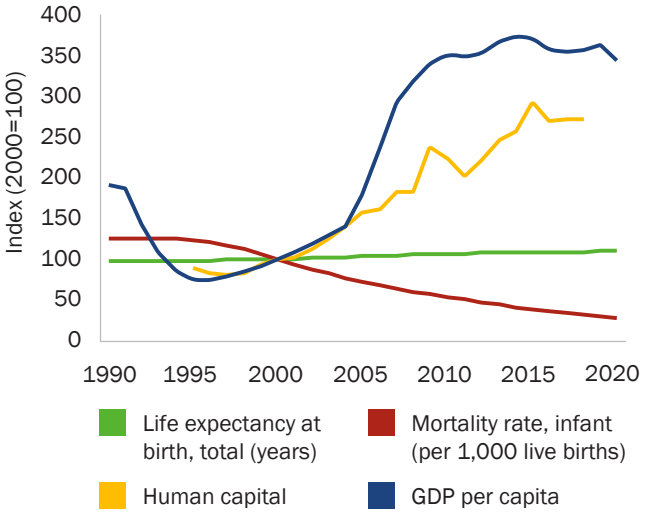
Executive Summary

I. Global decarbonization and climate impacts will exacerbate Azerbaijan's existing vulnerabilities

Although the hydrocarbon-fueled growth model has delivered substantial gains, Azerbaijan today acknowledges both its constraints and the opportunities arising from the clean energy transition. Azerbaijan's economy remains heavily dependent on fossil fuels. While the 2000–2010 surge in oil and gas production tripled per capita gross domestic product (GDP) and led to gains in poverty and human development (Figure ES.1), the 2014 collapse in oil prices triggered an economic contraction with GDP per capita falling back roughly 30 percent by 2021 compared to the 2014 peak. Oil and gas today still account for over 90 percent of exports and one-third of GDP (Figure ES.2). Although the surge in energy prices driven by Russia's invasion of Ukraine is yielding short- to medium-term windfalls and an uptick in growth, exposure to global energy price downswings remains a fundamental feature of Azerbaijan's economy. The non-oil private sector is held back by several constraints, including access to skilled labor and finance, and bottlenecks to market competition, with state-owned enterprises (SOEs) retaining a large presence in the economy. Recent policy statements — such as the Azerbaijan 2030: National Priorities for Socio-Economic Development' (Azerbaijan 2030)[1] and the 'Republic of Azerbaijan Socio-Economic Strategy for 2022-2026' (SEDS)[2] — acknowledge the limits of the hydrocarbon-fueled growth model. The 2022–2026 SEDS recognizes the country's limited progress in finding other sources of comparative advantage and lays out an ambitious program of economic diversification focused on digital technologies, human capital, and new areas of industrial exports. It also commits Azerbaijan to substantial investments toward the clean energy transition, including renewable energy, electric mobility, and energy efficiency, as well as enabling reforms such as cost-reflective energy pricing.

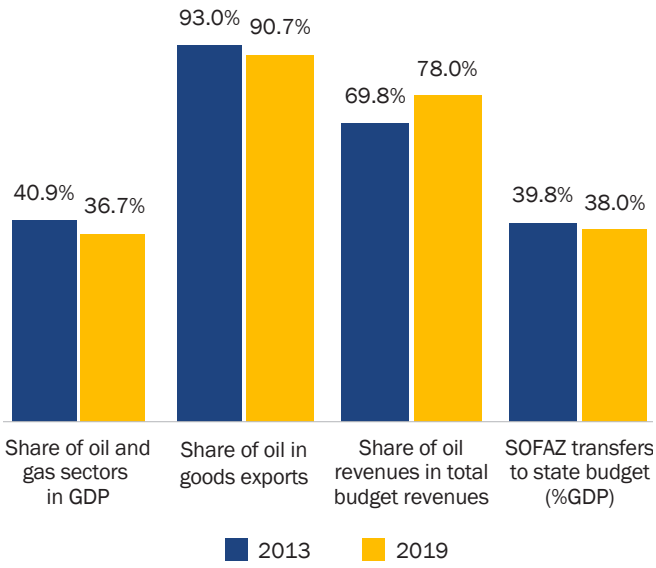
The economic imperative of diversification—already urgent in view of structural declines of oil export revenues—has become even more pressing as global climate policy efforts cut into global fossil fuel demand. Azerbaijan is directly exposed to reduced global demand for oil and gas despite the

Figure ES.1: Selected development indicators for Azerbaijan, indexed, 1990–2020



Source: World Development Indicators (WDI); UN Inter-agency Group for Child Mortality, World Bank 2021b, the Changing Wealth of Nations.

Figure ES.2: Oil and gas contribution to key aggregates



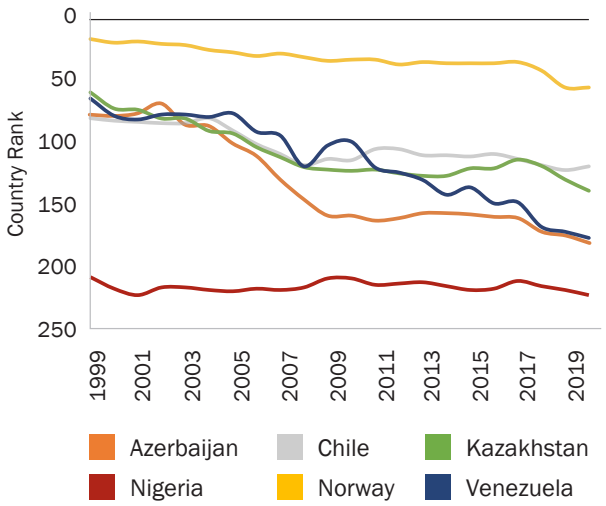
Source: WDI and State Statistical Committee of the Republic of Azerbaijan (SSCRA).

[1] President of the Republic of Azerbaijan Decree 2021 https://president.az/en/articles/view/50474.

[2] Government of Azerbaijan 2022a 'Republic of Azerbaijan Socio-Economic Strategy for 2022-2026,' *approved on July 21, 2022*, approved on July 21, 2022 https://static.president.az/upload/Files/2022/07/22/5478ed13955fb35f0715325d7f76a8ea_3699216.pdf.

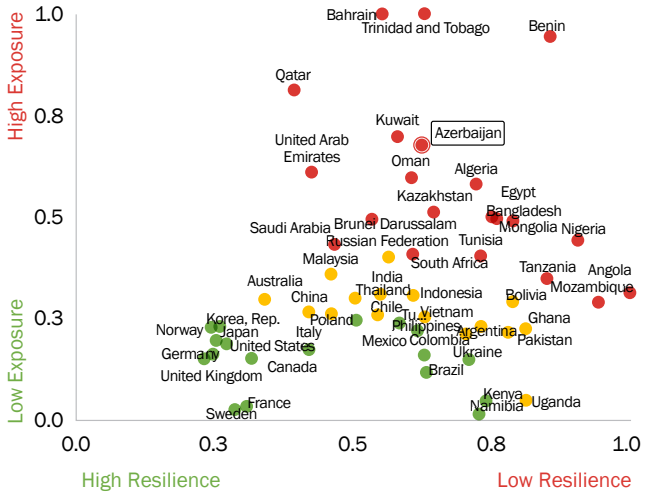
relatively favorable economics of domestic fossil fuel production (Figure ES.4). By 2060, a global net-zero economy would have reduced Azerbaijan's exports by close to 3.4 percent of GDP compared to business as usual (BAU), even if Azerbaijan meets its climate targets for 2030 and 2050. Moreover, indirectly, global decarbonization policies may also make it more costly to diversify and grow non-hydrocarbon sectors. Between 2016 and 2021, Azerbaijan ranked 115 out of 133 countries in terms of economic complexity.[3] Its export basket is among the least complex in the world—even among oil and mineral exporting comparator countries only Nigeria ranks lower than Azerbaijan (Figure ES.3).[4] Other hydrocarbon economies are already adjusting, anticipating that prime movers will reap the benefits of technology innovation and related investments. In the meantime, Azerbaijan's carbon intensity of GDP reached 0.24 $kgCO_2$ per 2015 US$ purchasing power parity (PPP) of GDP in 2020—more than 80 percent higher than EU-27 countries but 25–50 percent lower than other oil and gas producing countries (for example, Saudi Arabia, Kazakhstan, and Iraq). In a decarbonizing world, the carbon footprint of traded goods will increasingly be accounted for as economies act to avoid leakage. High carbon intensity will limit the prospects of sectors where productivity gains and new export revenues can be achieved, such as the chemical and petrochemical sector, where the country has potential to diversify away from primary extraction. The introduction of carbon-related trade instruments may further reduce growth and investment by 1 and 2 percent, respectively, by 2060. By then, the downward structural pressures on oil and gas receipts mentioned above will have constrained the government's ability to support diversification efforts and invest in new clean energy infrastructure.

Figure ES.3: Economic Complexity of Export Basket



Source: Based on BACI International Trade Database at the Product-level.
Note: Comparison countries selected based on similar export profiles.

Figure ES.4: Azerbaijan's resilience and exposure to transition



Source: Based on Peszko et al. 2020, data updated for 2022.
Note: Exposure index calculated from indicators, including share of fossil fuels exports in GDP and committed power sector emissions. Resilience index includes human capital, technology adoption, and net savings, among other indicators.

Agriculture and other physical asset-heavy new sources of growth will soon be constrained by more frequent and severe adverse climate impacts. Agriculture — a sector critical to Azerbaijan's non-hydrocarbon economy — shows significant potential for diversifying growth and export revenues. The sector contributes less than 8 percent of GDP but accounts for 36 percent of total employment, and between 2010 and 2019, 20 percent of all employment creation was in the sector. As almost half of the population lives in rural areas, the sector is crucial to vulnerable households' livelihoods. Segments such as horticulture (27 percent of gross value of agricultural production, 79 percent of agricultural exports, and 33 percent of non-oil exports) show strong export growth potential and resilience—the value of horticultural exports grew by 255 percent between 2010 and 2018 despite adverse national and regional economic conditions from 2013 to 2016.[5] The effects of temperature and precipitation changes on Azerbaijan's agriculture are already visible, and absent adaptation actions, they will thwart its future

[3] The Growth Lab at Harvard University based on 2019 data.

[4] World Bank 2022a.

[5] World Bank 2023. Country Private Sector Development Review: Horticulture Sector Deep Dive.

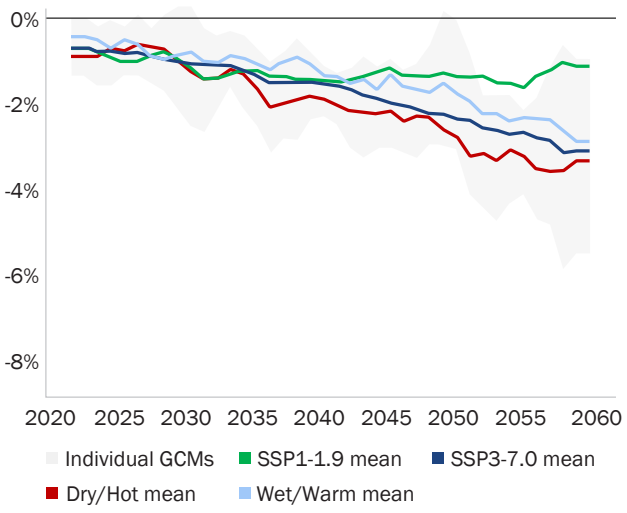
potential. Rain-fed crop yields are projected to decline between 14 and 20 percent by 2060 on average, with high-value crops showing higher declines (Figure ES.6). Irrigated crops are also at risk from projected water shortages with estimated losses of over 60 percent for some crops in southern regions and over 20 percent in the Eastern Lower Kura basin. Livestock is expected to be subject to similar trends, including through the direct effects on livestock health.

Imminent water security risks compound existing sector challenges, exacerbated by the country's dependency on transboundary sources. Azerbaijan already faces a permanent overall water resource deficit today. While future projections are characterized by inter- and infra-annual (seasonal) variability, water scarcity is projected to increase further across all major cropland areas. Coupled with climate change-induced variability, this will compound Azerbaijan's dependency on transboundary water sources. Between 50 and 70 percent of Azerbaijan's runoff enters the country from neighboring states which will be similarly facing additional water demand and projected water resources decrease over their own territories. Coupled with mounting water quality challenges, reduced availability of transboundary water will mean that regional competition for scarce water resources will likely increase.

Without adaptation investments, climate impacts on labor and water availability risk lowering productivity throughout the economy. The projected increase in the frequency and intensity of heat waves and extreme heat events will result in an increased risk of labor heat stress for workers not only in agriculture but across sectors, including construction, manufacturing, and extraction. As a result, overall labor productivity is expected decline in all scenarios (see Figure ES.5). Considering that a higher-than-average share of Azerbaijan firms already face constraints in water access and Azerbaijan already suffers from a permanent overall water resource deficit today, variations in water availability will place further downward pressures on productivity beyond agriculture.

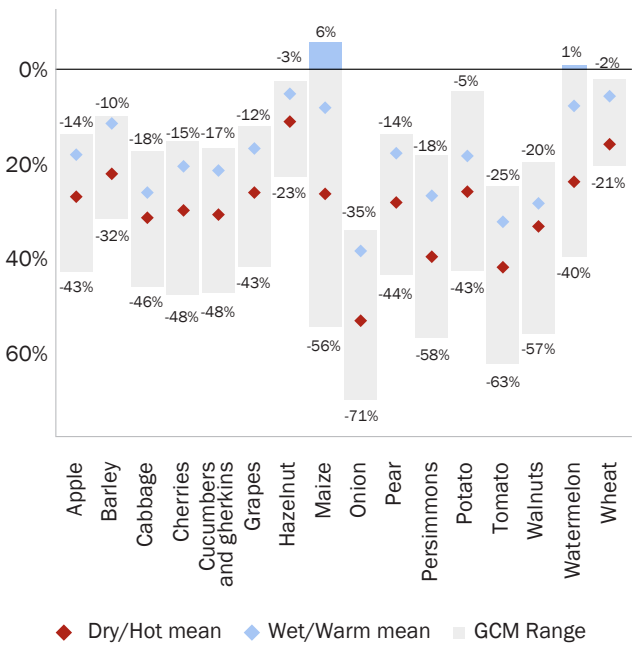
Failure to invest in resilience will entail significant economic and inclusion costs. More intense and unpredictable weather events as a result of climate change would likely hurt the rural poor the most. On average, riverine floods already affect 100,000 people annually,[6] and with more intense and unpredictable weather events, flooding is likely to increase in frequency and intensity. When natural hazards such as earthquakes are considered, extreme events can lead to emergency response costs of up to US$251 million with net government liabilities estimated at US$238 million. The lowest 40 percent of the income spectrum and rural households will suffer the most, given their reliance on agriculture sector revenues and higher vulnerability to shocks such as landslides, wildfires, and particularly floods.

Figure ES.5: Labor productivity loss from heat stress



Source: World Bank.
Note: Impact relative to 1995–2014 average productivity, assuming no adaptive response.

Figure ES.6: Projected rain-fed crop production change, 2051–2060



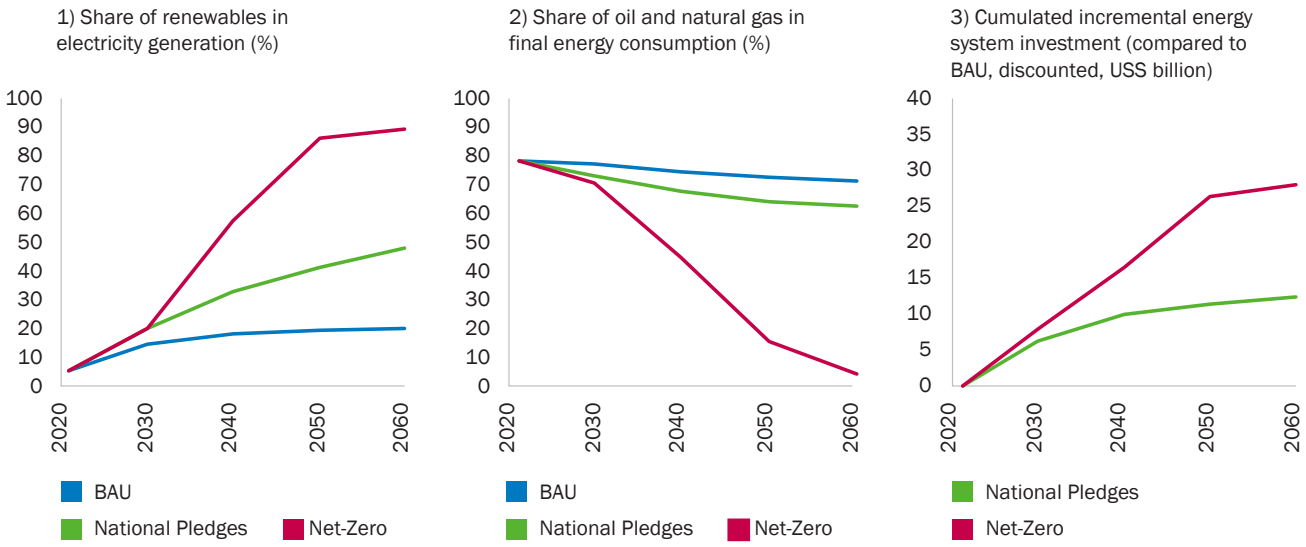
Source: World Bank.
Note: Impact relative to 1995–2014 average productivity, assuming no adaptive response.

[6] World Bank Group 2017. Europe and Central Asia (ECA): Country Risk Profiles for Floods and Earthquakes.

II. Ramping up investments in domestic decarbonization is in the country's economic interest, regardless of the pace of global decarbonization

Current policies will not deliver Azerbaijan's Nationally Determined Contribution (NDC) targets, but these could be achieved with relatively moderate additional efforts. Azerbaijan is currently not on track to achieve its NDC+ targets aimed at reducing greenhouse gas (GHG) emissions by 35 percent by 2030 and 40 percent by 2050 (over 1990 levels).[7] In a BAU scenario, energy-related and industrial processes emissions would be only 28 percent lower than 1990 levels in 2030 and only 30 percent lower in 2050. To achieve the NDC+ targets, renewable energy would need to account for about 20 percent of power generation by 2030 and 40 percent by 2050 (versus 7 percent in 2022, Figure ES.7, 1), and policies to support energy efficiency improvements across all end use sectors should be adopted to achieve a 5 percent reduction in final energy demand by 2030 and 15 percent by 2050 compared to the BAU case. More than half of the incremental GHG emission reduction to be achieved in the net-zero scenario compared to the BAU scenario needs to come from energy efficiency improvements. The abatement of fugitive emissions from fossil fuel extraction and transportation also represents a low-hanging fruit toward the achievement of the 2030 NDC target at a relatively low cost.

Figure ES.7: Selected energy indicators in the BAU, national pledges (NDC+), and net-zero scenarios



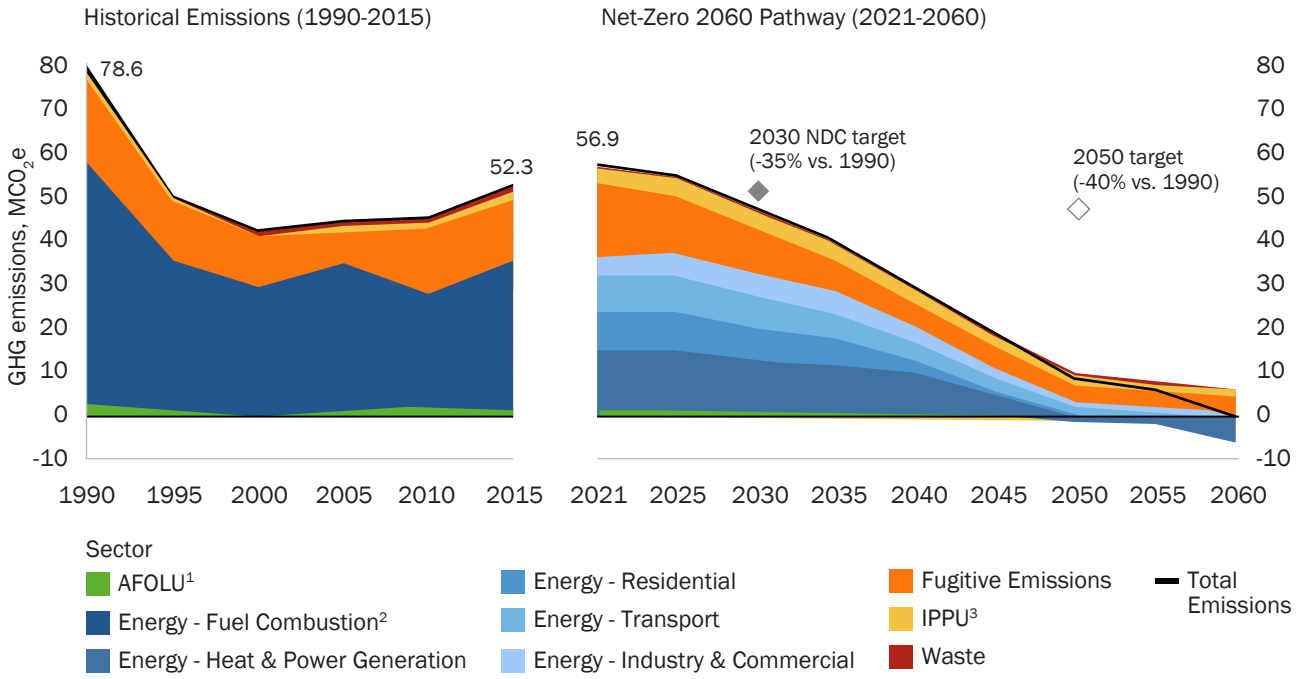
Source: World Bank Analysis.

Meeting the 2030 target would yield substantial economic benefits and put Azerbaijan on a pathway consistent with much deeper decarbonization by mid-century than the current 2050 target. Azerbaijan's 2030 emissions target (−35 percent compared to 1990) and its target of 30 percent renewable energy in the power generation mix by 2030 would require ramping up annual investments in clean energy quickly over the next decade to about US$0.8–1.0 billion per year by 2030. If it is maintained, such a high rate of annual investment would put Azerbaijan on track to decarbonize the power sector almost entirely by 2050 and also decarbonize other parts of the economy. Achieving net zero would require only an incremental increase in annual investment rates. Macroeconomically, despite higher energy system costs resulting from investments in decarbonization, economic growth and welfare would both increase, if clean energy investments are coupled with a phasing out of fossil fuels subsidies—a measure critical to achieving the transition.

[7] In this report, 'NDC+ targets' refers to Azerbaijan's NDC targets to reduce GHG emissions by 35 percent (versus 1990 levels) by 2030 and to the Glasgow COP26 announcement of a 40 percent reduction (versus 1990 levels) by 2050. The Fourth National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) (page 64), reports 2016 GHG emissions levels as 32 percent lower than 1990 levels, close to Azerbaijan NDC target of 35 percent. Since then, however, the country has registered a steady increase in emissions.

Achieving net zero by 2060 would entail a major transformation of the energy system (Figure ES.8). Continued investment in clean energy after 2030 to fully decarbonize the power sector by 2050 would need to be coupled with a continued aggressive reduction of fugitive emissions, large-scale electrification of end use sectors, massive efficiency gains, and the introduction of zero-carbon energy carriers in the sectors that cannot be electrified. Azerbaijan would have to install about 30 GW of wind and solar photovoltaic (PV) until 2060, in addition to storage capacity and carbon capture and storage (CCS) systems in biomass-fired power plants. In the transport sector, emissions would be mainly reduced through the adoption of vehicles powered by clean fuels (mainly electricity but also biofuels and green hydrogen), energy efficiency improvements, and the shift to less carbon-intensive modes of transport (especially rail transport). In 2060, total final energy demand would need to be almost half of the demand in the BAU scenario in the same year and electricity would account for about 60 percent of it.

Figure ES.8: A net-zero pathway by 2060 for Azerbaijan



Source: World Bank.

Note: 1. AFOLU = Agriculture, forestry, and other land use; 2. Fuel combustion emissions for historical values include heat and power generation, residential, transport, and industry and commercial emissions; 3. IPPU = Industrial processes and product use. Negative emissions from heat and power generation beyond 2050 are a result of the adoption of biomass-fired power plants equipped with CCS.

Early decarbonization can yield net economic benefits, even if global fossil fuel prices stay higher for longer. In a domestic net-zero scenario, natural gas resources available for export are projected to increase by 35 percent by 2060 as a smaller share of the gas production is consumed domestically, while they would remain essentially flat in a BAU scenario. Should international fossil fuel prices stay higher for longer than assumed in the domestic net-zero scenario (as currently is the case, as a consequence of Russia's invasion of Ukraine), a faster pace of domestic decarbonization would free up resources for export earlier. This would lead to up to 5–10 percent additional natural gas available for exports per year in the medium term (2030–2050) compared to the 'base' net-zero scenario, helping Azerbaijan capture gains from higher global prices. These increased natural gas exports would contribute to meeting the currently growing demand for natural gas as a transition fuel (especially in Europe), but their nature would remain temporary as global decarbonization is expected to eventually reduce demand for all fossil fuels.

Achieving net zero is likely to come at modest economic costs, partly mitigated by expected co-benefits. Domestic decarbonization investments would raise energy system costs only modestly (by up to 13 percent by 2060 in the net-zero scenario) if coupled with energy subsidy removal. At the same time, these investments would allow a continued reduction in domestic natural gas consumption and a significant increase in energy resources available for exports. In macroeconomic terms, achieving net zero domestically in a global net-zero world would entail a 1 percent loss of cumulative discounted GDP to 2060 compared to BAU. Major co-benefits

of the net-zero transition (for example, reduced climate damages, air pollution health co-benefits, reduced water and soil pollution, and improved biodiversity) are expected to offset most of the residual direct costs.

When implemented in tandem with adequate fiscal policies, energy price measures can be growth enhancing. When coupled with fiscal policies aimed at recycling revenues released from energy subsidy phaseout and carbon pricing to reduce taxes on production factors, such as labor, capital, and land, decarbonization investments to achieve net zero can promote structural change and diversification into non-fossil fuels sectors. Up to 40 percent of the direct economic cost of the net-zero transition (reductions in GDP annual growth rates estimated at around 0.1 percentage points) could be reduced by ancillary, but ambitious, fiscal policies.

Aggressive investment in renewables to produce green hydrogen and electricity for exports could further offset a decline in Azerbaijan's hydrocarbon export revenues, if technology developments over the next decade or so are favorable. The analysis presented in this report also includes a scenario to simulate how Azerbaijan can partially mitigate fiscal risks from the decline in conventional energy export revenues by aggressively expanding renewable electricity generation to export either electricity directly or in the form of green hydrogen or green ammonia produced from renewable power. In this scenario, by 2060 electricity generation would have to be almost double the value in the net-zero scenario and almost four times the value in the BAU, leading to exports of an additional 50 TWh of green hydrogen and 7 TWh of electricity per year by 2060. Because this scenario assumes the possibility of the rapid ramp-up of investment to produce and transport green hydrogen or green ammonia at industrial scale after 2040, which requires technology that is currently still in the development stage, these findings should be reevaluated regularly over the coming years to inform policy making in Azerbaijan.

Azerbaijan's agricultural sector faces vulnerabilities but also vast adaptation potential. Climate proofing the sector to higher temperatures and lower water availability starts with measures to improve irrigation efficiency through the rehabilitation and modernization of the country's hydraulic infrastructure and the introduction of climate-smart agricultural practices—one of the most effective approaches to improve productivity while building resilience to climate change and reducing emissions (Chapter 3). Current plans to expand the irrigation network—likely to create additional vulnerabilities—would need to be synchronized with investments toward improving water productivity. The total discounted investment effort required is estimated at US$16 billion until 2060.

III. Closing gaps in the short-term implementation and long-term ambition

Azerbaijan's short-term (2030) objectives for emission reduction and investments in clean energy and resilience are ambitious, but implementation is not on track as policies and institutions are not yet fit for purpose. The analysis presented in this report demonstrates that, from today's starting point, the target of reducing GHG emissions by 35 percent by 2030 compared to 1990 represents an ambitious deviation from the BAU trajectory. However, while many investment projects have been announced, on the ground Azerbaijan has made little progress toward this target since its adoption in 2015. The same is true for Azerbaijan's target of increasing the share of renewable energy in the electricity generation mix to 30 percent by 2030 and targets for the water and agriculture sectors. While line ministerial responsibilities are clearly assigned, these ministries often lack human and financial resources to develop and implement policies, and private sector investment frameworks are still too erratic to generate a pipeline of bankable and scalable projects. Azerbaijan will need to move from targets to implementation by devoting adequate resources to the respective institutions and improving accountability for results.

In contrast to its more ambitious 2030 target, Azerbaijan's current long-term climate target lacks the ambition to take advantage of the substantial economic benefits of decarbonization and resilience. Achieving the 2030 emission reduction target would place Azerbaijan on a track to much deeper decarbonization by mid-century with positive welfare gains. However, despite signing up to the Paris Climate Agreement's goals, the country has not yet committed to a net-zero target. Similarly, although the resilience challenges facing the country's water and agriculture sector are broadly understood, the long-term vision for how these sectors need to adjust is still missing.

Closing the implementation and ambition gap will start by strengthening institutions for economywide decarbonization and resilience planning. Azerbaijan's recent strategic documents do not account for the full scale of the decarbonization and adaptation challenges facing the country. A first no-regret step is to strengthen economywide planning and develop robust integrated assessments of Azerbaijan's economy. Such planning

exercises take time and should be started as soon as possible to provide a solid foundation for future targets and policies across all sectors of the economy. Mainstreaming a climate perspective within the overall strategic and planning direction of the country's development will allow the country to better minimize economic and social risks and capture the opportunities for decarbonization and resilience. Capacity exists within key institutions such as the Central Bank of Azerbaijan (CBA) and Ministry of Finance (MoF), although tools and skills need to be upgraded to increase capacities. The State Commission on Climate Change should be empowered to ensure the results of such planning inform the next generation of strategic documents and their implementation.

Azerbaijan should accelerate investment in sectors where decarbonization and resilience measures are already cost-effective today. As delaying action will limit their leeway to navigate the transition, the authorities can look to low-hanging opportunities for short-term reform and investments, which already make sense notwithstanding the transition. These include (a) removing energy subsidies to incentivize efficient use of energy throughout the economy and shifting the fiscal burden from production factors to pollutants and emissions to support growth and diversification; (b) closing the small financing gap in sectors such as onshore wind, solar PV, and hydro, where the introduction of de-risking instruments (such as offtake guarantees) may be sufficient to mobilize much needed private investments; and (c) reducing fugitive and emissions from fossil fuel production and transportation, particularly upstream, given that their current cost makes them a low-hanging fruit to reduce emissions with substantial co-benefits. Similarly, existing vulnerabilities are already making the economic case for adaptation. No-regret adaptation measures include (a) improving irrigation productivity through the reduction of nonrevenue water and irrigation efficiency investments; (b) introducing climate-smart practices for key crops; and (c) considering facilitating a shift to higher-value, more resilient, and export competitive crops by strengthening extension services and access to finance by rural small and medium enterprises (SMEs).

Azerbaijan's general economic reform agenda, aiming for diversification and overcoming constraints to private sector growth, will also be conducive for climate mitigation and adaptation. General economic policies to promote competitiveness and remove subsidies and other market distortions will incentivize firms to become more resource efficient. Shifting the state's role from dominating economic sectors to enabling private sector investments will not only improve macro stability and growth but also create the conditions for attracting decarbonization investments and reaping the benefits of the new energy economy. Similarly, enhancing access to finance for rural SMEs, ensuring that skills supply meets the private sector's demands will open opportunities for commercial investments in adaptation. Strengthening social protection systems is fundamental to protecting people from a variety of shocks, not only those induced by decarbonization policies and physical climate impacts.[8] Reducing informality in the labor market not only makes for better jobs now, but it will also allow for mitigating the impacts of carbon pricing policies through effective carbon revenue recycling options.

There are major opportunities for 'win-win' investments in Azerbaijan's agricultural sector to promote diversification of growth and exports with measures that will also yield resilience benefits. 'Win-win' measures to increase the sector's productivity are also foundational to improving resilience to future shocks. For instance, providing SME farmers who are responsible for 95 percent of production with better conditions to access inputs and finance and filling the skill gap they face in adopting new technologies and crops is conducive to higher growth today and to improving adaptative capacities for tomorrow.

[8] An in-depth exploration of these recommendations is contained in World Bank (2022a) and World Bank (2023).

Table ES.1: Economic costs, investment, and benefits of Azerbaijan's decarbonization and resilience 2060 pathway

Compared to BAU, until 2060	Net increase in CAPEX[9] (A) (US$ billions, discounted)	Net increase in OPEX (B) ($ billions, discounted)	Net economic costs (A + B) (US$, billions/% of GDP, discounted)	Annual net investment (US$, billions/% of GDP, discounted)	Estimated split of the net increase in investment, public/private (% / %)	Welfare Gains (% change compared to cumulative discounted GDP)	Estimated co-benefits (compared to cumulative discounted GDP), %
Decarbonization							
Electricity[10]	[7.6]	[6.2]	[13.8]/[1.0]	0.17/0.5	17/83		
Transport	11.2	−6.7[11]	4.4/0.3	0.34/1.0	51/49		
Residential	2.9	9.1	12.0/0.9	0.07/0.2	20/80		
Industry and Other	4.8	3.5	8.3/0.6	0.14/0.4	0/100		
Decarbonization total	**18.9**	**5.8**	**24.7/1.9**	**0.72/2.1**	**30/70**	**−0.17**	**[1.4]**
Resilience							
Water Efficiency	14.8	2.8	17.6/1.2	0.60/1.9	95/5	[>1]	
Climate Smart Agriculture	1.1	0.7	1.8/0.1	0.03/0.1	40/60		
Resilience total	**15.9**	**3.5**	**19.4/1.3**	**0.63/2.0**	**92/8**	**[>1]**	
TOTAL	**34.8**	**9.3**	**44.1/3.2**	**1.35/4.1**	**59/41**	**[0.83]**	**[>1.4]**

Note: OPEX = Operating expenses. Investment needs are not exhaustive.

However, meeting decarbonization and resilience needs will entail large investments, and the frameworks to leverage private capital for these investments still need to be put in place. For the sectors covered in this report, compared to a BAU scenario, the total estimated incremental discounted costs of decarbonization and resilience until 2060 amount to roughly US$44.1 billion (about US$24.7 billion for decarbonization and US$19.4 billion for resilience), or about 3.2 percent of the cumulative discounted GDP. The average incremental investment is estimated to be about US$1.35 billion per year (or about 4 percent of GDP), of which almost 60 percent is estimated to come from the public sector. While a range of measures for both decarbonization and resilience need to be supported by public resources (starting with energy system strengthening to enable renewable energy source (RES) penetration, or consolidation and maintenance of the current hydraulic infrastructure), a larger share (renewable energy investments and climate-smart agriculture [CSA] adoption) can and should be resourced from commercial and private sector financing. Azerbaijan has a successful track record of private investment in energy, but most of it has been focused on upstream oil and gas targeting export markets (where the bulk of the country's foreign direct investment [FDI] lies), while domestic energy sectors have seen marginal private sector participation. Enabling regulatory frameworks are required to leverage private

[9] CAPEX refers to the annual capital cost, that is, the annual equivalent of the (incremental) investment cost that factors in the economic lifetime of the asset and the discount rate.

[10] The incremental CAPEX and OPEX for electricity are already included in the OPEX for the three other sectors (transport, residential, and industry and other), as they are reflected into the cost of electricity that end use sectors face. Therefore, CAPEX and OPEX for electricity are excluded from the decarbonization total.

[11] The incremental OPEX in the net-zero scenario compared to the BAU is negative because electric vehicles have lower operation and maintenance costs (but higher CAPEX) compared to traditional internal combustion engine vehicles.

investment at scale through bankable projects away from the oil and gas sector. Without these, FDI targeting domestic clean energy resource development and resilience measures in the agriculture sector will continue to lag (Table ES.1).

Implementation of subsidy phaseout and carbon pricing measures is a precondition to decarbonization investments. Electricity and natural gas tariffs are currently well below their economic costs, due to the presence of significant implicit fiscal subsidies. Gradual fossil fuel subsidy phaseout by 2030 and the introduction of economywide carbon pricing are necessary elements of the economically most efficient path to remove the existing economic distortions and incentivize investment in decarbonization. This is best achieved through the gradual deregulation of natural gas, electricity, and fuel prices and the strengthening of regulators and market mechanisms in price setting.

Inclusion-oriented policies and investments will be needed to ensure the social acceptability of the transition. Pricing reforms will need to be implemented carefully and in conjunction with targeted social protection measures based on sound analysis. While recent social assistance reforms have achieved efficiencies, institutional bottlenecks still prevent adequate targeting, including the lack of adequate data. The creation of a single social registry would allow the government to respond to the shocks and alleviate the impacts of the transition period on workers. Revenue recycling measures aimed at alleviating the tax burden on production factors, including labor, would provide direct benefits through additional employment and indirect benefits through improved access to social assistance benefits. Moreover, the spatial concentration of Azerbaijan's climate vulnerabilities overlaps with higher poverty rates and households' lower relative wealth, reducing their capacities to adapt.

Political economy constraints need to be weighed against the risks of inaction. The level of state involvement in the economy provides it with a vantage point to steer decarbonization and resilience, but its dominance of the hydrocarbon sector also creates large incentives for institutional and policy inertia. Sectors of the economy key to the transition are controlled by state-owned monopolies. Only in a few other hydrocarbon economies does the value of publicly owned fossil fuel-related capital stock exceed the country's current GDP[12] as is the case in Azerbaijan, implying economic and political dependence on hydrocarbon revenues. Charting and implementing a clear decarbonization pathway is likely to face substantial opposition without a reconsideration of the government's role in the economy through additional participation by the private sector, whose buy-in can be elicited by the rapid cost declines for low-carbon technologies and leapfrogging opportunities. Although public support for more ambitious climate action is high, shielding the population and particularly vulnerable groups from the adverse effects of climate change and domestic decarbonization policies will be critical to preserve welfare and ease political economy constraints of the transition. Delaying action will however prevent the country from grasping the opportunities of domestic decarbonization, leaving it exposed to transition risk and climate impacts likely to reverberate beyond the economy.

[12] Babić and Dixon 2022.

Chapter 1

Azerbaijan's Prosperity in a Changing Climate

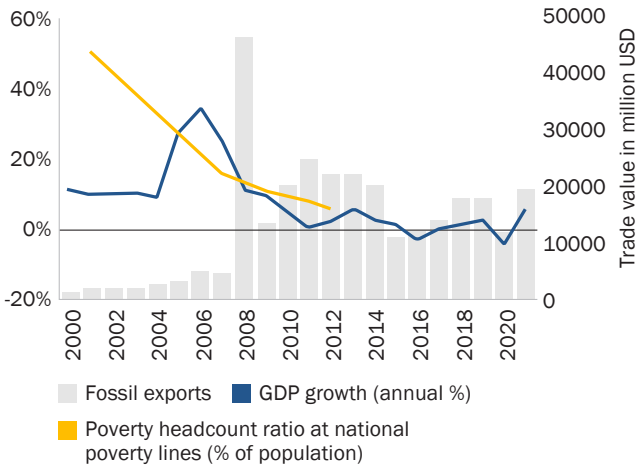
Editorial credit: illpaxphotomatic / Shutterstock.com

1.1. Future-proofing the growth model

Azerbaijan's development trajectory remains exposed to global energy markets' volatility. The late 1990s' increase in oil exports combined with the global surge in oil prices delivered unprecedented growth rates. Per capita gross domestic product (GDP) increased from US$663 in 2000 to a peak of US$7,991 in 2014[13] supported by oil and gas rents and high levels of public investment. A decade of unprecedented growth moved Azerbaijan from a lower-middle-income to an upper-middle-income (UMI) country, leading to substantial decline in poverty[14] (Figure 1.1). Deceleration and recession however followed. The 2014 collapse in oil prices triggered an economic contraction of 4.2 percent in 2016, and even after the return of favorable terms of trade in 2017, the economy only managed to sustain an average growth of 0.5 percent per year between 2015 and 2021, with GDP per capita falling back roughly 30 percent by 2021 compared to the 2014 peak.

Azerbaijan is now at a crucial juncture in its development journey. The country has set ambitious long-run goals, as highlighted in the Socio-Economic Development Strategy (SEDS) for 2022–2026.[15] The SEDS targets an annual GDP growth rate of 3–4 percent over the medium term, with close to 5 percent GDP growth targeted in the non-oil and gas sector, to enable the country to achieve the five main strategic priorities outlined in Azerbaijan Vision 2030. These objectives cannot be achieved with the current growth model—reliant on oil and gas rents and state investment.[16] Instead, the country needs a fundamentally new growth model driven by a dynamic private sector that is more integrated into the global economy, operates on a level playing field, and is supported by skilled human capital. Managing the risks and maximizing the opportunities associated with the energy transition will also be crucial to long-run development prospects, as highlighted in this report.

Figure 1.1: GDP, poverty rate, and fossil exports



Source: COMTRADE and WDI.

The continued prominence of the hydrocarbon sector has stifled development of other sectors and constrained the incentives to diversify. Between 1995 and 2007, oil and gas production jumped from 10 percent to 54 percent of GDP. In contrast, agriculture, as a share of GDP, fell from 25 percent to 6.5 percent, the share of manufacturing was halved, and services dropped from 50 percent to less than 33 percent of total GDP. By 2020, with oil and gas accounting for 85.2 percent of exports and 30 percent of GDP, Azerbaijan ranked 120 out of 133 countries on economic complexity, down from the 77th place in 2000. Underinvestment in key endowments such as human capital contributed to significant challenges faced by the private sector in getting access to the necessary skills. While non-oil sectors benefited from increased public investment during the boom period (consolidated budget spending amounted to 60 percent of non-oil GDP in 2019), they faced severe tightening in public spending after the oil price collapse in 2014.

The private sector is held back by several constraints, which prevent it from diversifying and taking advantage of the opportunities provided by the energy transition. As noted in the recently published Azerbaijan Country Economic Memorandum, they include (a) access to skilled labor, particularly for larger firms and exporters; (b) access to finance, particularly for small and medium enterprises (SMEs); (c) competition from the informal sector, particularly for small firms; (d) bottlenecks to market competition, particularly driven by state-owned enterprise (SOE) dominance, a weak legal framework for competition, and price controls; and (e) an investment climate undermined by weak governance standards.[17] SOEs continue to play a strong role

[13] World Bank national accounts data and OECD National Accounts data files.

[14] World Bank 2021b. The Changing Wealth of Nations 2021.

[15] Government of Azerbaijan 2022a 'Republic of Azerbaijan Socio-Economic Strategy for 2022-2026,' approved on July 21, 2022 https://static.president.az/upload/Files/2022/07/22/5478ed13955fb35f0715325d7f76a8ea_3699216.pdf.

[16] World Bank 2022a.

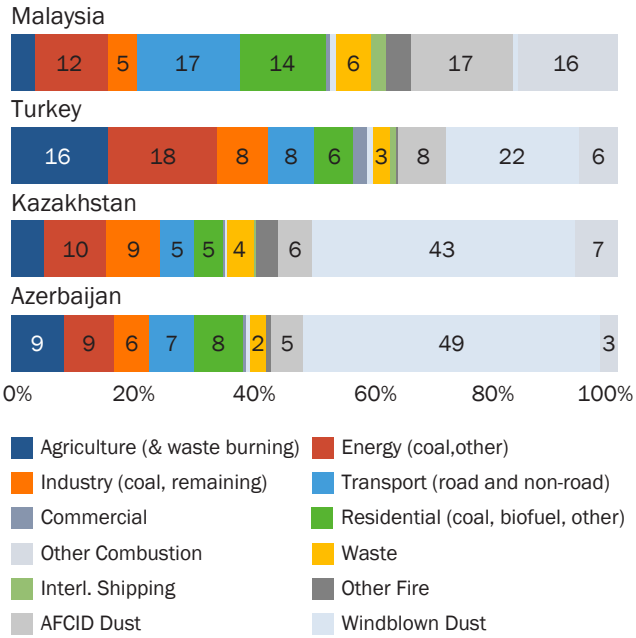
[17] World Bank 2022a.

in the economy, retaining a large presence in sectors that in other economies would typically be dominated by private participation, such as general manufacturing, construction, telecom, and agriculture.[18]

The country lags behind UMI peers on key environmental dimensions including renewable natural resource management, resource use efficiency, and energy and emission intensity across sectors. Azerbaijan scores below the UMI average in all eight assessed indicators on outcomes of renewable natural capital management. Energy intensity of GDP has shown a small but upward trend in the last decade, so has emission intensity of GDP.[19] Azerbaijan's environmental expenditures relative to GDP are 20 times lower than the European Union (EU) average and substantial energy subsidies have limited the incentives to invest in energy efficiency (Section 3.1). Meanwhile, fossil-based growth generates large economic externalities. Air pollution from fine particulate matter ($PM_{2.5}$) — largely windblown dust in addition to pollution from agriculture, energy, industry, and transport sources (Figure 1.2) — contributes 10–18 percent to non-accident mortality, corresponding to a welfare loss equivalent to 3–12 percent of GDP,[20] higher than the average in the Eastern and Central Europe region.

While the recent spike in energy prices will drive growth and wider welfare gains, Azerbaijan's vulnerabilities remain and have in fact intensified. The lack of decoupling of the non-oil and gas sectors from hydrocarbon prices keeps the economy structurally exposed to global volatility. In addition, Azerbaijan's oil reserves are estimated to last for about another 25 years,[21] with production from onshore fields already slowing down today.[22] While the last decade's investments in natural gas exploration and extraction opened an additional source of export revenues, this has only increased the countries' dependency on hydrocarbon exports. In addition to high exposure to impacts of global decarbonization due to the role of hydrocarbons in the economy, resilience as measured by human capital, financial market capitalization, or technology absorption, among other indicators, is low in Azerbaijan. Remaining prey to commodity cycles and facing a depleting oil asset base, Azerbaijan's economy will be tested by the headwinds brought by global decarbonization.

Figure 1.2: Sectoral contribution to $PM_{2.5}$



Source: Based on McDuffie et al. (2021).

1.2. Readiness to address global decarbonization's risks and opportunities remains low

Failure to increase the pace and depth of decarbonization will directly and indirectly affect growth, firstly through a reduction of hydrocarbon rents. A world transitioning to net zero will lead to reduced demand for the country's hydrocarbon exports, including—in the medium term—gas (Chapter 3). In addition to affecting the country's trade position, a weaker export performance of the oil and gas sector will also affect non-hydrocarbon sectors still reliant on it. Lower fossil fuel revenues will constrain investment and the capacity to support diversification. With an average of 60 percent of the government budget financed by oil and gas revenues,[23] critical public investments, including to non-hydrocarbon sectors, will be curtailed. A reduced fiscal space

[18] Ibid.

[19] International Energy Agency (IEA) country pages.

[20] Global Burden of Disease 2019. Air Pollution Exposure Estimates http://ghdx.healthdata.org/gbd-2019; World Bank 2022b.

[21] According to bp Statistical Review of World Energy 2021 (https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf, Azerbaijan has proven oil reserves of 7,000 million barrels of crude oil, which corresponds to a reserves-over-production life (R/P) of 26.7 years. The proven gas reserves are 88.4 trillion cubic feet (tcf) or 14,737 barrels of oil equivalent (boe), corresponding to a reserves-over-production life (R/P) of 96.9 years.

[22] IEA 2021 https://www.iea.org/reports/azerbaijan-2021.

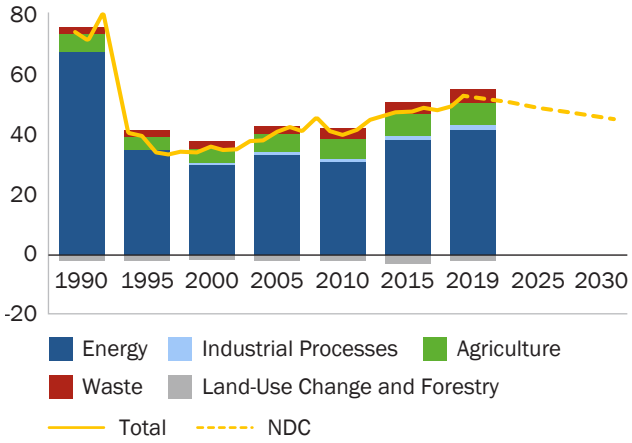
[23] IEA 2021, Azerbaijan 2021 Energy Policy Review.

will also constrain the country's capacity to mitigate and address the significant risks of asset stranding induced by continued lock-in of carbon-intensive technology, increasing economywide losses.

Current policies will not achieve Azerbaijan's decarbonization ambitions for 2030 and 2050. Azerbaijan has signed and ratified the Paris Climate Agreement but has not yet committed to a net-zero target. Its NDC+ targets of 35 percent by 2030 and 40 percent by 2050 (over 1990 levels)[24] will not be reached based on current policies (Figure 1.3 and Chapter 4). Emissions from transport more than tripled between 2000 and 2019, while emissions from electricity and heat stayed relatively constant over the same period as the second largest source of emissions. The International Renewable Energy Agency (IRENA) estimates that the country's economically viable renewable energy potential at current technology costs and market prices stands at 5.5 GW onshore and 7.2 GW offshore but remains largely unexploited.[25] The Azerbaijan Renewable Energy Agency estimates the economically viable onshore wind and solar potential to be even higher, at 27 GW. From a current level of 7 percent, reaching the government's target of 30 percent for the share of renewable energy sources in the country's electricity production by 2030[26] will require a change of pace.

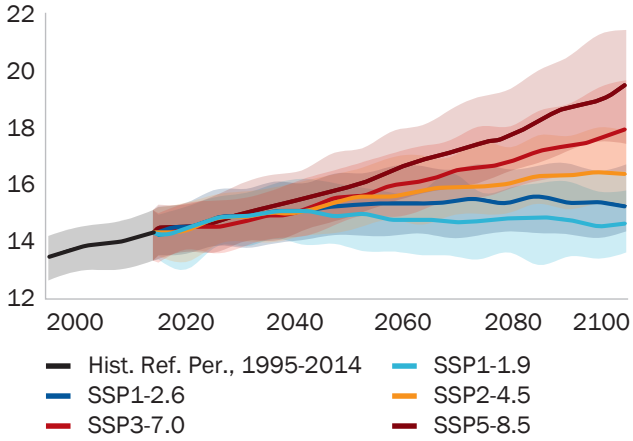
Methane emissions (mainly fugitive emissions from the production and transportation of fossil fuels) account for about 30 percent of the Azerbaijan's total net GHG emissions. According to the national GHG inventory, in 2016, the country's methane emissions were about 17.1 $MtCO_2eq$.[27] More than 50 percent of these emissions were fugitive emissions from the production and transportation of fossil fuels, while the agriculture and waste sectors respectively accounted for 40 percent and 8 percent of the total.

Figure 1.3: Historic GHG emissions by sector and path to NDC, total emissions



Source: Climate Watch Climate Analysis Indicators Tool (CAIT) and NDC. *Note:* GHG = Greenhouse gas; NDC = Nationally Determined Contribution.

Figure 1.4: Projected average annual temperature in Azerbaijan under different scenarios



Source: WBG Climate Change Knowledge Portal (CCKP 2022) and Azerbaijan Climate Data.
Note: Shading represents the model range, 10th and 90th percentile, with solid lines presenting the median of the multi-model ensemble for each Shared Socioeconomic Pathway-Representative Concentration Pathway (SSP-RCP). The reference period is 1995–2014.

1.3. Failure to address physical climate impacts will constrain diversification efforts

Recent changes in temperatures and precipitation regimes are projected to worsen, affecting water availability in water-dependent sectors including agriculture and energy. Since 1960, mean temperatures in Azerbaijan have increased at an average of 0.3 °C per decade coupled with annual mean precipitation declines of 3.5 mm per decade. Projections show a steady temperature increase under most scenarios (Figure 1.4), with the western regions most affected (up to 2.49 °C increase by mid-century under SSP 5–8.5). Annual mean

[24] NDC+ targets refer to Azerbaijan's NDC target of a 35-percent GHG reduction by 2030 and the Glasgow COP26 announcement of a 40-percent reduction by 2050 compared to 1990 levels.

[25] IRENA 2019.

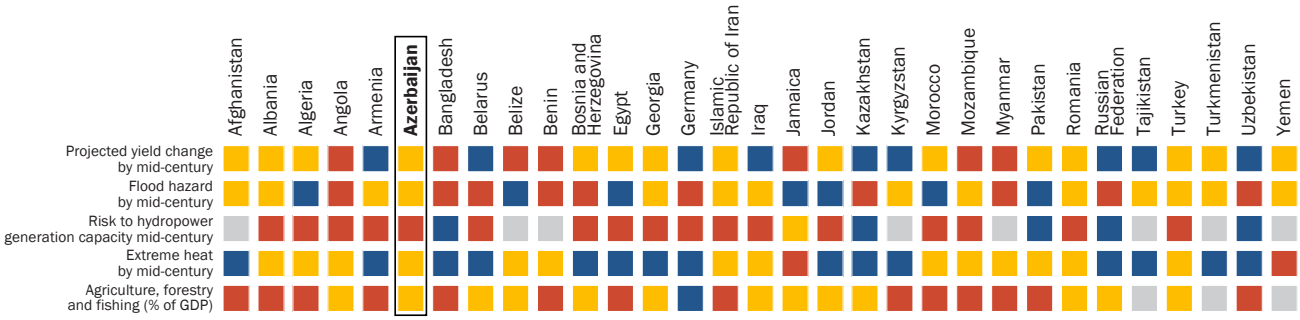
[26] Ministry of Energy of the Republic of Azerbaijan 2023 https://minenergy.gov.az/en/alternativ-ve-berpa-olunan-enerji/azerbaycanda-berpa-olunan-enerji-menbelerinden-istifade.

[27] Based on the reported methane emissions of 815 kt of CH_4 (as per Azerbaijan's Fourth Annual Communication to the UNFCCC) and on the Global Warming Potential factor of 21 (which is in line with the UNFCCC decision 4/CP.1).

precipitation is projected to further decrease over the same time horizon, with the Guba-Khachmaz region likely to experience the highest decline in annual precipitation levels (55 mm decline).[28] Significant shifts in extremes such as consecutive dry days (approximate increase by 2 days during summer months) and peak temperatures (5 additional monthly summer days above 35°C) are projected to occur. The growing season's length could reach 328 days by 2059, up from 278 days on average in 2014.[29]

Azerbaijan is historically vulnerable to climate hazards, with annual losses already estimated at 0.3 percent of GDP today. Almost the entire country is prone to riverine or urban flooding, with the central and south-eastern regions facing the highest risks. Every year roughly 100,000 people on average are affected,[30] 8 percent of transport infrastructure at high risk.[31] With more intense and unpredictable weather events, flooding is likely to increase in frequency and intensity especially in the Yevlakh area. The occurrence of other extreme climate events such as extreme heat is expected to increase in the next decades, albeit not significantly more than in peer countries (Figure 1.5). Warming and shifts in precipitation patterns will increase the occurrence and severity of droughts, further exacerbating desertification and soil salinity and lowering agricultural yields.

Figure 1.5: Climate risks in Azerbaijan and selected countries



Source: Various.
Note: Countries are rated using a benchmark approach: those rated at high risk (red) are in the top third, medium risk (yellow) are in the middle third, and low risk (blue) are in the lowest third of the full country sample (192 countries). Grey indicates no data.

Ongoing stresses on key natural endowments further increase climate vulnerability. The depletion of soil moisture, desertification, and overgrazing have already led to the degradation of rangelands and pasturelands, reducing their ability to support livestock and agricultural production. Oil and gas extraction activities have also contributed to land degradation and contamination of water resources. The construction of roads, pipelines, and other infrastructure associated with these activities has often led to habitat fragmentation and biodiversity loss.

Agriculture is an important yet vulnerable backbone of the economy. Azerbaijan's natural capital wealth has been increasing in the last decades, driven by increased agricultural output and revenues. While agriculture contributes around 6 percent to Azerbaijan's GDP, it employs over 35 percent of the population and utilizes around 55 percent of land area. Close to 82 percent of farmers have less than 2 ha (in total 1,108,000 small farmers) and practice primarily semi-subsistence agriculture.[32] Up to 70 percent of Azerbaijan's agricultural land is rain-fed.[33] In contrast, farms with >500 ha accounted for 7 percent of total area farmed in 2015, often forming vertically integrated agro-complexes which dominate domestic and export markets. Small agricultural holdings are more likely to lack access to improved seeds and seedlings, technology, and crop insurance, but with sufficient investment into resilience building and intensification, agriculture could become a new driver of sustainable growth (Section 3.2).[34] In the absence of adaptation, however, the bottom 40 by income and rural

[28] All projections are based on the 2040–2059 period, multi-model ensemble under SSP5-8.5.

[29] World Bank Group Climate Change Knowledge Portal https://climateknowledgeportal.worldbank.org/.

[30] World Bank Group 2017 Europe and Central Asia (ECA): Country Risk Profiles for Floods and Earthquakes https://documents.worldbank.org/en/publication/documents-reports/documentdetail/958801481798204368/europe-and-central-asia-country-risk-profiles-for-floods-and-earthquakes.

[31] Hallegatte, S.; Rentschler, J. and Rozenberg, J. 2019.

[32] Zezza 2021.

[33] FAOSTAT. Accessed on 11 April 2020.

[34] Industrial Economics Incorporated 2013.

households will suffer the most, given their reliance on agriculture sector revenues and higher vulnerability to shocks such as floods, landslides, and wildfires.

Decarbonization and resilience investments are aligned with the country's diversification needs and objectives. The low-carbon transition can support the stated diversification objectives of the authorities (Chapter 2) by shifting the traditional capital-intensive growth model to a more labor- and knowledge-intensive economy. In parallel, adaptation investments will be needed to protect and drive innovation in non-oil and gas sectors. This Country Climate and Development Report (CCDR) highlights decarbonization and resilience measures strictly aligned with the government's objectives by focusing on the energy system and end use sectors (transport, building, and industry) and the water and agricultural nexus. The report's focus does not neglect that resilience building needs go beyond water and agriculture to affect all sectors of the economy with varying urgency and that achieving net-zero emissions will require mitigation action beyond the energy system, specifically also covering land use and waste management. The remainder of the report is structured as follows. Chapter 2 assesses Azerbaijan policies and institutional capacities to address the challenges arising from the transition and physical climate impacts. Chapter 3 explores the country's options to speed up the pace of decarbonization as well as the challenges faced by agriculture—a sector crucial to Azerbaijan's current and future prosperity—in building climate resilience. Chapter 5 concludes with prioritized policy and investment recommendations.

Country Climate and Development Report Outline

Chapter 1 - Azerbaijan's prosperity in a changing climate		
Chapter 2 - Policies and institutions for the transition	Chapter 3 - Decarbonization and resilience	Chapter 4- Macroeconomic and financial policies for climate action
Chapter 5 - From assessment to action		

Chapter 2

Policies and Institutions for Transition

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2.1. A gap in long-term ambition and short-term implementation

Azerbaijan is stepping up its commitment to climate action. As a party to the United Framework Convention on Climate Change (UNFCCC) since 1995, Azerbaijan signed up to the Paris Agreement's goal to keep global warming well below 2°C in 2016. Its 2017 NDC targeting a 35 percent GHG emission reduction by 2030 was complemented by the country's COP26 announcement of an additional reduction target of 40 percent by 2050.[35] In October 2023, the country submitted an updated NDC targeting a 40-percent conditional (GHG) emissions reduction by 2050 compared to 1990 levels. A National Adaptation Plan (NAP) has been under development since its announcement in its Third National Communication to the UNFCCC (2015). Global commitments are however slowly being translated into domestic strategic statements. The green energy transition constitutes a pillar of Azerbaijan's development vision as set forth in 'Azerbaijan 2030: National Priorities for Socio-Economic Development'[36] as well as in its most recent articulation — the SEDS for 2022-2026.[37] The latter acknowledges the downward pressures on fossil fuel demand posed by the global decarbonization transition as well as the risks to food security brought about by a warming world.

Table 2.1: Azerbaijan's decarbonization commitments

	Date	Time frame	Coverage	Mitigation target	Other targets	Adaptation coverage
INDC	January 9, 2017	2021–2030	CO_2, CH_4, N_2O, HFC, CF_4—all sectors excl. industry	−35% by 2030 (compared to 1990)	Sectoral measures	Addressed
Revised target	November 10, 2021 (COP26 statement)	2022–2050	TBC	−40% by 2050 (compared to 1990)	Carbon neutral liberated territories	No
NDC update	October 2023	2023-2050	CO_2, CH_4, N_2O, HFCs, PCFs—all sectors	−40% by 2050 (compared to 1990)	Sectoral measures	No
LEDS	Under preparation	TBD	TBD	TBD	TBD	n.a.

Source: UNFCCC, Government of Azerbaijan.
Note: LEDS = Long-Term Low-Emission Development Strategy.

On both dimensions of decarbonization and resilience, however, the country faces a gap in terms of long-term ambition and actual implementation. Not only do Azerbaijan's strategic objectives still fail to reflect the long-term challenges posed by decarbonization and resilience needs, but also—with few exceptions—existing targets are not yet supported by policy and investments. While the State Program for the Use of Alternative and Renewable Energy Sources has incorporated the SEDS targets (renewable energy source [RES] expansion to 24 percent by 2026), other SEDS objectives on energy efficiency and transport sector decarbonization—as well as, crucially, energy subsidy phaseout—are still to be reflected into actual policy. The implementation gap is also evidenced by the lack of an NDC roadmap and LEDS which has remained in the making for several years. Despite initial plans to pilot a monitoring, reporting, and verification (MRV) system to around 70 emitting facilities, an effective MRV system is not yet in place, and an early pilot applying to 70 companies was suspended.[38]

[35] At COP26, the country also joined a number of international emission reduction initiatives including the Glasgow Leaders Declaration on Forest and Land Use, the Breakthrough Agenda Statement, the Green Grids Initiative, the Global Ocean Alliance, and the Joint Declaration on Zero Emission Vehicles.

[36] President of the Republic of Azerbaijan Decree 2021 https://president.az/en/articles/view/50474.

[37] Government of Azerbaijan 2022a 'Republic of Azerbaijan Socio-Economic Strategy for 2022-2026,' approved on July 21, 2022 https://static.president.az/upload/Files/2022/07/22/5478ed13955fb35f0715325d7f76a8ea_3699216.pdf.

[38] IEA 2021, Azerbaijan 2021 Energy Policy Review.

Ambition and implementation gaps reflect institutional weaknesses complicating the implementation of structural reforms. Despite high levels of centralization in decision-making, coordination of institutional responsibilities in key sectors such as water, agriculture, and energy faces fragmentation, and sectoral and core government mandates still need to reflect the actual challenges brought by the transition. The State Commission on Climate Change was revived in 2020 with strengthened technical capacities and chairmanship after remaining inactive since its initial establishment in 1997.[39] As national focal point for the climate change agenda, the Ministry of Environment and Natural Resources (MENR) is responsible for UNFCCC reporting but not for setting and steering the country's strategic vision.

Cities and municipalities are increasingly committing to decarbonization and adaptation objectives, although actual implementation shows similar delays. With over 53 percent of its population in urban areas, it is notable that in recent years a growing number of Azerbaijan's cities and municipalities[40] have joined the Global Covenant of Mayors for Climate and Energy—the largest global alliance for city climate leadership with over 10,000 city and local government members. However, while all signatory cities have committed to a climate change mitigation target of 30 percent by 2030, most of them still have to develop their energy and climate action plan, and none has an adaptation plan in place to date.

2.2. The planned clean energy expansion requires a suitable policy framework

Capturing low-hanging fruits in energy sector decarbonization has not curbed the rise in carbon intensity. Over the last two decades, the country successfully implemented measures to increase power and heat generation efficiency and limit methane leaks from oil and gas production. Combined with an overhaul of the country's power plant stock allowing for the replacement of fuel oil with natural gas, these measures contributed to reducing the emission intensity of the sector. However, energy-related emissions have been on the rise since the early 2000s (see Chapter 1), highlighting the fact that achieving deeper decarbonization will require establishing a conducive legal and institutional framework and adopting additional and more ambitious measures.[41]

Recent energy sector legislation is ending a period of policy stagnation, but energy sector reforms remain incipient. Although the core of energy sector legislation dates to the late 1990s, in recent years the significant fossil fuel price fluctuations encouraged policy development. The Azerbaijan 2030 strategy led to new legislation aimed at (a) accelerating the deployment of renewable energy sources; (b) supporting the energy efficiency market; and (c) advancing electricity market reforms through unbundling the sector and competitiveness measures.[42] This legislation however is characterized by important gaps which will constrain its implementation and effectiveness. It does not set energy efficiency targets or regulatory improvements to increase private sector participation in renewable energy development. Nor does it set forth measures to limit the growth in transport sector emissions (starting with fuel efficiency standards), energy price reforms to incentivize energy efficiency and clean energy development, or the introduction of GHG tracking and reporting systems. Additional policy efforts and investment will also be required to further reduce fugitive emissions from the production and transportation of fossil fuels (see Box 2).

The sector's existing institutional framework is not yet conducive to energy system transformation. The Presidential Administration, the Cabinet of Ministers, and the Ministry of Energy (MoE) are the energy sector's main government institutions, while individual subsectors are controlled by several state-owned monopolies.[43] The Azerbaijan Energy Regulatory Agency (AERA, established in 2017) regulates producers, transmission

[39] The MENR, Ministries of Economy, Energy, Agriculture, the State Statistics Committee, and other relevant state bodies.

[40] Current signatories include the cities of Gazakh, Ganja, Sheki, Khachmaz, Mingachevir, Shamakhi, Yevlakh, Khirdalan, Icherisheher.

[41] The State Agency on Alternative and Renewable Energy Sources (SAARES) under the MoE serves as the principal authority regulating alternative and renewable energy.

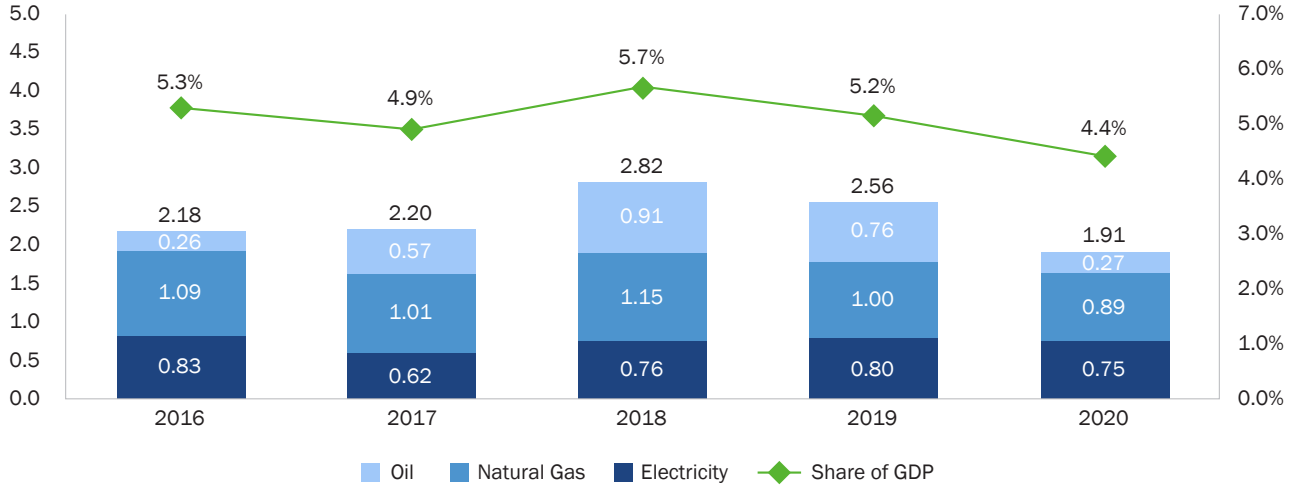
[42] Law on the Use of Renewable Energy Sources for Electricity Generation, adopted on May 31, 2021, https://minenergy.gov.az/en/qanunlar; Law on Power Engineering," the draft "Law on Regulator in Energy and Public Utilities," and the draft "Law on Electricity Market"; Law on the Rational Use of Energy Resources and Energy Efficiency" (adopted in May 2021).

[43] The State Oil Company of the Azerbaijan Republic (SOCAR) is the country's national oil and gas company, actives in all segments from upstream to downstream operations. The State Oil Fund of the Republic of Azerbaijan (SOFAZ) is the sovereign wealth fund administering and reinvesting oil and gas revenues. Azerigaz is in charge of natural gas distribution. In the power sector, AzerEnerji is in charge of power generation and distribution, while Azerishiq is the transmission system operator.

operators, distributors, suppliers, and consumers in the fields of electricity, district heating, and gas supply and can propose tariff adjustments, although the final authority on tariff setting lies with a Tariff Council that determines the retail and wholesale tariffs for electricity, gas, district heating, and refined petroleum products as well as purchase tariffs for renewable electricity. In 2009, the government established the State Agency on Alternative and Renewable Energy Sources (SAARES). To accelerate energy system transformation, the country will need to transition from a vertically integrated system owned and operated by the government to competitive markets with a significant share of private sector participation. This transition would be crucial to support private sector-led renewable energy development. Clearer distinctions among the state's roles as owner, policy maker, and regulator are a prerequisite for facilitating the transition. This would require separating decision-making from ownership responsibilities of the state, while granting the SOEs operational independence and strengthening the AERA's independence and regulatory powers.

Recognition of the need to remove pricing distortions has not yet translated into tariff reform and subsidy phaseout. End user tariffs for electricity, natural gas, and oil remain low due to implicit and explicit subsidies. Over 2016–2021, explicit energy subsidies averaged US$2.3 billion or 5.1 percent of GDP (Figure 2.1). Although recent strategic documents called for addressing these distortions,[44] the lack of progress continues to affect the long-term viability of the sector, by limiting resources to finance much-needed investments in modernizing electricity, heat, and gas infrastructure. In addition to limiting investments in critical infrastructure, the lack of competition, fossil fuel subsidies, and low end user tariffs weaken the incentive framework for private sector investment in renewables and energy efficiency.

Figure 2.1: Explicit energy subsidies in Azerbaijan (constant 2021 US$ billion)



Source: IMF 2021.

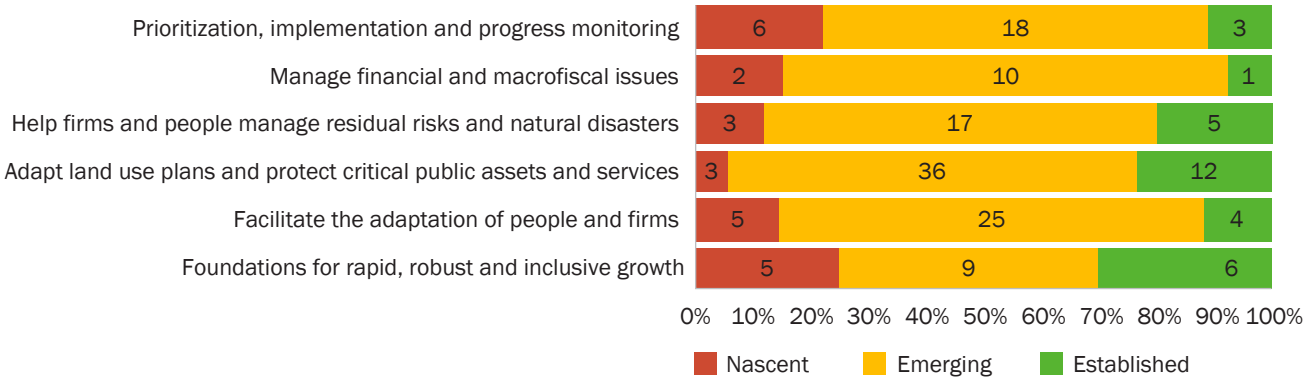
2.3. Policies for resilience and risk management remain incipient

Progress in enhancing adaptation and resilience capacities faces limits across key dimensions. Enhancing resilience entails systemic actions which make sense even before accounting for climate impacts—such as limiting the exposure of the macroeconomic fundamentals to exogenous shocks, enhancing access to finance for SMEs, removing gender-specific barriers to adaptation, and improving social protection measures for the poorest.[45] An assessment of Azerbaijan's adaptation capacities (Figure 2.2) shows progress in some of these cross-cutting areas. On adaptation-specific capacities however, the country lags in the development and implementation of key measures. These include (a) introducing measures to encourage adaptation mainstreaming and (b) moving from a focus on climate risk response to one centered on prevention, including through (c) strengthening early warning systems and their utilization and (d) empowering city-level adaptation.

[44] The Strategic Plan of the State Agency for Alternative and Renewable Energy Sources for 2015–2018 envisaged actions for the determination of optimal tariff prices, and the "Social and Economic Development Strategy of Azerbaijan Republic for 2022–2026" (approved on July 22, 2022) called for the phaseout of energy subsidies.

[45] These aspects are addressed more in depth in Chapters 3 and 4.

Figure 2.2: Criticalities in Azerbaijan's adaptation and resilience capacities



Source: Based on the Adaptation and Resilience Principles Assessment Framework https://www.worldbank.org/en/news/feature/2020/11/17/the-adaptation-principles-6-ways-to-build-resilience-to-climate-change.
Note: Numbers within bars indicate performance [established/emerging/nascent], by number of indicators) by capacity dimension.

An increased understanding of future climate risks is yet to translate into proactive adaptation policy and planning. While the government has embarked on the development of an NAP since 2017, the current lack of an overarching strategy weakens the mainstreaming of adaptation consideration at the sectoral level. Line agencies' resources for adaptation and resilience investments remain confined within the boundaries of standard budget allocations for environmental management, without consideration to the additional resources needed to move from a response-oriented outlook to a proactive one based on prevention. In agriculture, for instance, the country's existing insurance and compensation mechanisms remain substantially oriented to ex post response rather than preparedness, and analytical capacities including those of the National Hydrometeorological Service under MENR focused on disaster and damage evaluation rather than risk assessment, in addition to its early warning functions. The Agricultural Insurance Fund has put in place further ex post support procedures as well as proactive measures aimed at introducing differentiation by types of crops and geographical location. However, neither climate change scenarios nor climate-related loss damage projections are considered when determining prioritization.

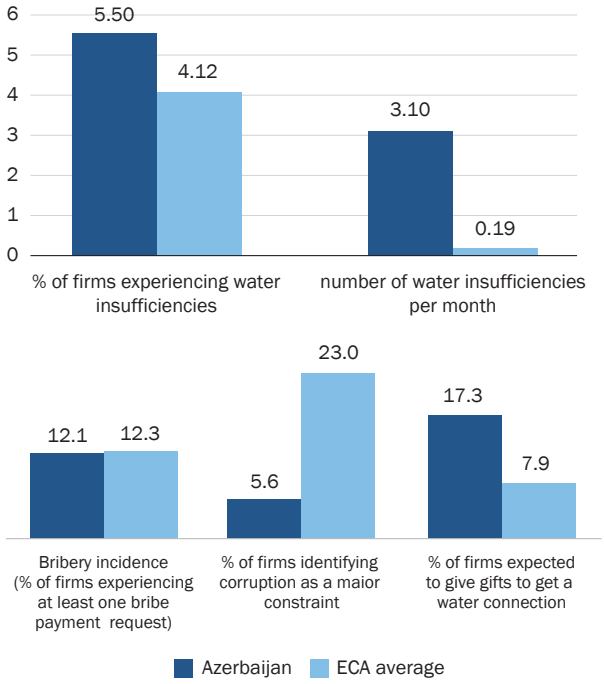
Lack of institutional coordination translates into overlapping roles and responsibilities preventing effective action in key sectors. While the water sector suffers from high dependency and variation on transboundary water inflows coupled with large nonrevenue water losses (Chapter 3), the fragmentation of institutional accountabilities affects policy and investments' effectiveness. An update of the Water Code would provide the Integrated Water Resource Management (IWRM) program with legal footing and potentially defragment overlapping functional responsibilities. Mainstreaming climate change policy objectives into public financial management instruments limits the potential role of economic decision-making agencies such as the MOE in influencing other departments. Currently, although the Ministry of Finance is considering the introduction of a climate budget tagging system, there is no procedure or mechanism ensuring the integration of climate resilience and decarbonization into public investment planning. This signals and reinforces a lack of strategic vision, resulting in resilience considerations remaining absent across infrastructure governance processes, regulations, strategies, and planning.

Strengthening early warning systems will be critical to protect lives and assets. Such systems not only give citizens and economic actors more lead time to protect their lives and assets but also empower communities to take ownership of the systems. In Azerbaijan, the National Hydrometeorological Service within MENR carries out hydro-meteorological observations that can support climate monitoring, but significant gaps in data and monitoring persist. To increase adaptive capacity to climate change in Azerbaijan, such gaps in climate information will need to be filled.

2.4. The private sector is not yet grasping the transition's opportunities and challenges

Sectors key to Azerbaijan's resilience and decarbonization face marginal private sector participation. Azerbaijan's energy sector is dominated by state-owned monopolies,[46] and publicly owned/controlled SOEs also dominate other key sectors. The water sector is an example. Although private companies have invested in water utilities, infrastructure, and treatment services, the percentage involvement of the private water companies remains limited, with over 80 percent of water supply and wastewater treatment managed by government-owned water utilities. At the same time, firms in Azerbaijan face more water insufficiencies relative to regional peers (Figure 2.3).

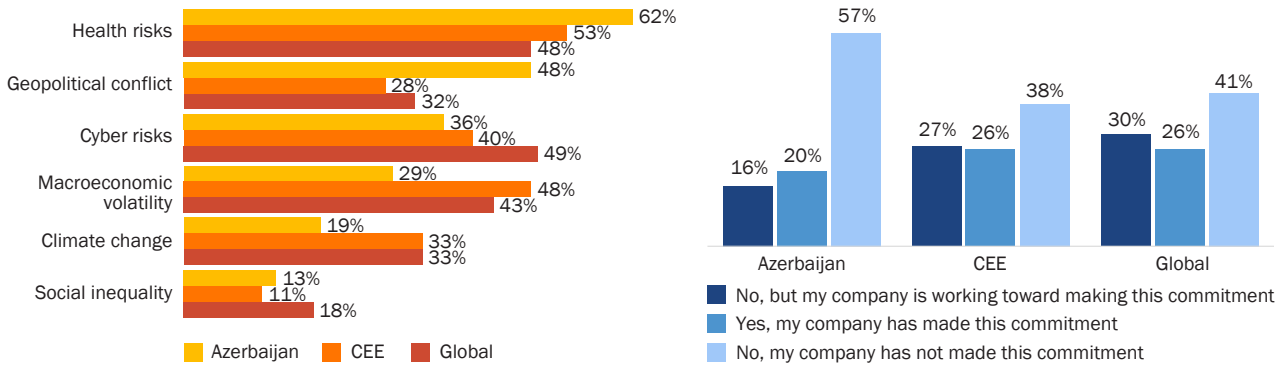
Figure 2.3: Firms in Azerbaijan face more water insufficiencies relative to regional peers and are more likely to pay bribes to obtain a connection



Source: World Bank Enterprise Survey.

The country's private sector lags in the incorporation of climate considerations in business strategies. Alongside countries' national commitments, banks and investors globally are aligning their portfolios with net-zero commitments. Of the world's 2,000 largest publicly traded companies, 696 have set net-zero targets. Azerbaijan's private sector representatives lag their global and regional peers in terms of their perception of the risks posed by the transition as well as their intentions and actions to decarbonize their operations. While globally and within the Central and Eastern Europe (CEE) region 33 percent of chief executives consider climate change to pose a key risk to their operations, in Azerbaijan this share is at 19 percent.[47] Globally, 56 percent of companies have made or stated that they are planning to make carbon neutrality commitments, yet the figure for Azerbaijan's companies is only 36 percent.

Figure 2.4: Azerbaijan firms trail regionally and globally in perceptions of transition risks and climate



Source: PwC 2022.
Note: Survey question: "What are the key risks facing your firms' operations?"

Note: Survey question: "Does your company have a carbon neutrality commitment?"

[46] SOCAR (oil refining, natural gas distribution and supply), Azerenergy (Azerenerji, electricity generation and transmission), Azerishiq (electricity distribution and supply), and Azeristiliktejhizat (district heat) (IEA 2021; World Bank 2023).

[47] PwC 2022.

The private sector's incentives toward climate action face structural constraints due to governance and economic barriers. The large market presence of publicly dominated SOEs,[48] a weak innovation and entrepreneurship environment[49] and limited economic diversification stifle the potential for start-up growth in promising areas, such as renewables and horticulture. At the firm level, investment decisions aimed at reconverting industrial processes toward low-carbon solutions are discouraged by skewed energy pricing. Most firms lack the capacity to detect climate risks, they do not have the right instruments for adaptation and resilience, and very few firms have developed frameworks for climate change adaptation and business continuity plans in their operations.[50] Without addressing such structural constraints, not only will navigating the transition be more challenging for Azeri firms, but also the country will fail to attract the level of foreign investment needed to finance adaptation and mitigation actions.

2.5. Leveraging citizen engagement to generate the momentum for climate action

Public action on climate seems to trail citizens' perceptions of the urgency of the problem. A recent survey on international public opinion[51] spanning over 160 countries about climate change found a majority of Azeri citizens to be concerned, with 73 percent of respondents considering it either a very serious or somewhat serious threat over the next two decades and up to 57 percent of people considering it a high or very high government priority. About 40 percent of Azerbaijan's citizens support emission reductions regardless of what other countries do, with another 17 percent supporting action if other high-emitting countries also take action and a majority believing that the transition will come with positive or neutral effects on growth and job creation.

Considerable levels of public awareness pointing to a demand for climate action can be an important asset for the government in garnering and maintaining support for the transition. Experience shows that proactive citizen engagement measures including through communication campaigns and behavioral approaches can open up the space for ambitious reforms, and nurturing citizen participation, including through investments in education, can be a critical asset for maintaining social support during the transition process. Both MENR and the National Hydrometeorological Service have responsibilities in sharing climate-related information such as GHG/air pollution levels and climate-related hazards, but to this day there is no specific procedure for the public to participate in the identification and formulation of climate policies. The Public Council under MENR could be effectively used to this effect.

[48] World Bank 2023.

[49] World Bank 2021a.

[50] https://unece.org/fileadmin/DAM/project-monitoring/unda/16_17X/A2.1_Implement_Natl_CS/Azerbaijan_SE_e.pdf.

[51] Leiserowitz et al. 2022.

Chapter 3

Decarbonization and Resilience

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3.1. Deep decarbonization of Azerbaijan's energy system is achievable

Azerbaijan has achieved major reductions in the energy and carbon intensity of its economy since 2000, but progress has stalled in the last decade and energy sector emissions are currently increasing proportionally with GDP. According to IEA data, Azerbaijan managed to reduce the energy intensity of its GDP from the peak value of 0.41 toe per '000 2015 US$ PPP in 1995 to 0.05 toe per '000 2015 US$ PPP in 2010. Among other things, this reduction was made possible by the gradual replacement of oil with natural gas as the main energy source for electricity generation combined with the rehabilitation of several power stations and the shift to more efficient combined cycle gas turbines. Over the same time, the carbon intensity of energy remained essentially stable, around 100 tCO_2eq per TJ of final energy consumption. As a result, the carbon intensity of GDP (that is, the product of the carbon intensity of energy and the energy intensity of GDP) significantly decreased over that period. However, since 2010, Azerbaijan's decarbonization efforts have stalled, as indicated by the fact that both the carbon intensity of energy and the energy intensity of GDP have stayed relatively flat. This deep dive investigates what Azerbaijan would need to do to get back on track to achieve

An energy system[52] - wide modeling analysis was carried out to assess sectoral decarbonization pathways for Azerbaijan's economy.[53] Three main scenarios were modeled, with scenario variations to assess specific policy choices (Box 1). GDP growth and the economic structure in all scenarios are aligned with the business as usual (BAU) of the macroeconomic modeling presented in Chapter 4. All assumptions related to global fossil fuel prices should be understood as scenarios rather than projections. Azerbaijan's assumed future fossil fuel production is derived from the results of the IEA's net-zero scenario, which models supply responses to demand and considers that global demand for fossil fuels declines.[54] All additional methodological details and assumptions as well as an in-depth discussion of results are presented in the Mitigation Background Note accompanying this CCDR.

Box 1: Scenarios for the quantitative energy system analysis

The **BAU** reflects the continuation of the current trends of Azerbaijan's energy system until 2060 and includes the policies adopted by 2021 and the projects that are already in the pipeline. This scenario serves as a baseline to assess and quantify the incremental effects of the decarbonization scenarios described below.

In the **national pledges scenario (NPS)**, Azerbaijan achieves its climate pledges, that is, a 35 percent reduction by 2030 versus 1990 levels and a 40 percent reduction by 2050 versus 1990 levels. In absolute terms, this corresponds to GHG emissions for the energy system (including IPPU) of 49 $MtCO_2eq$ in 2030 and 45 $MtCO_2eq$ in 2050. In addition to the policies adopted by 2021 and the projects that are already in the pipeline (included in the BAU), this scenario assumes the adoption of additional measures required to achieve these climate pledges.

The **net-zero emissions scenario (NZS)** aims to approximate net-zero GHG emissions in the broader energy sector (including energy-related and IPPU emissions) by 2060. The main mechanism to achieve decarbonization in the model is the introduction of a carbon price serving as a proxy for any form of economically efficient decarbonization policy, accompanied by a gradual phaseout of natural gas and oil subsidies (coupled with social tariff), the adoption of vehicle emission standards in the transport sector, and the provision of subsidies for energy efficiency in the tertiary and the residential sectors. Two variations to the NZS have been considered:

- The **higher energy price (HEP) scenario** models a scenario that achieves net-zero emissions in Azerbaijan by 2060 and assumes higher international fossil fuel prices than those assumed in the NZS. This scenario serves to investigate the impact of global fossil fuel prices on incentives for Azerbaijan to decarbonize domestically. The additional natural gas exports unlocked by Azerbaijan through faster domestic decarbonization are marginal compared to the EU's gas demand, so they are assumed not to affect global gas prices.
- The **green exports scenario (GES)** presents a net-zero scenario in which Azerbaijan expands its export infrastructure for low-carbon energy carriers, allowing it to exploit the full economic potential for domestic clean energy resources for export.

[52] The 'energy system' here encompasses energy production and all major energy-consuming sectors, including transport, residential buildings, industry, and the commercial sector.

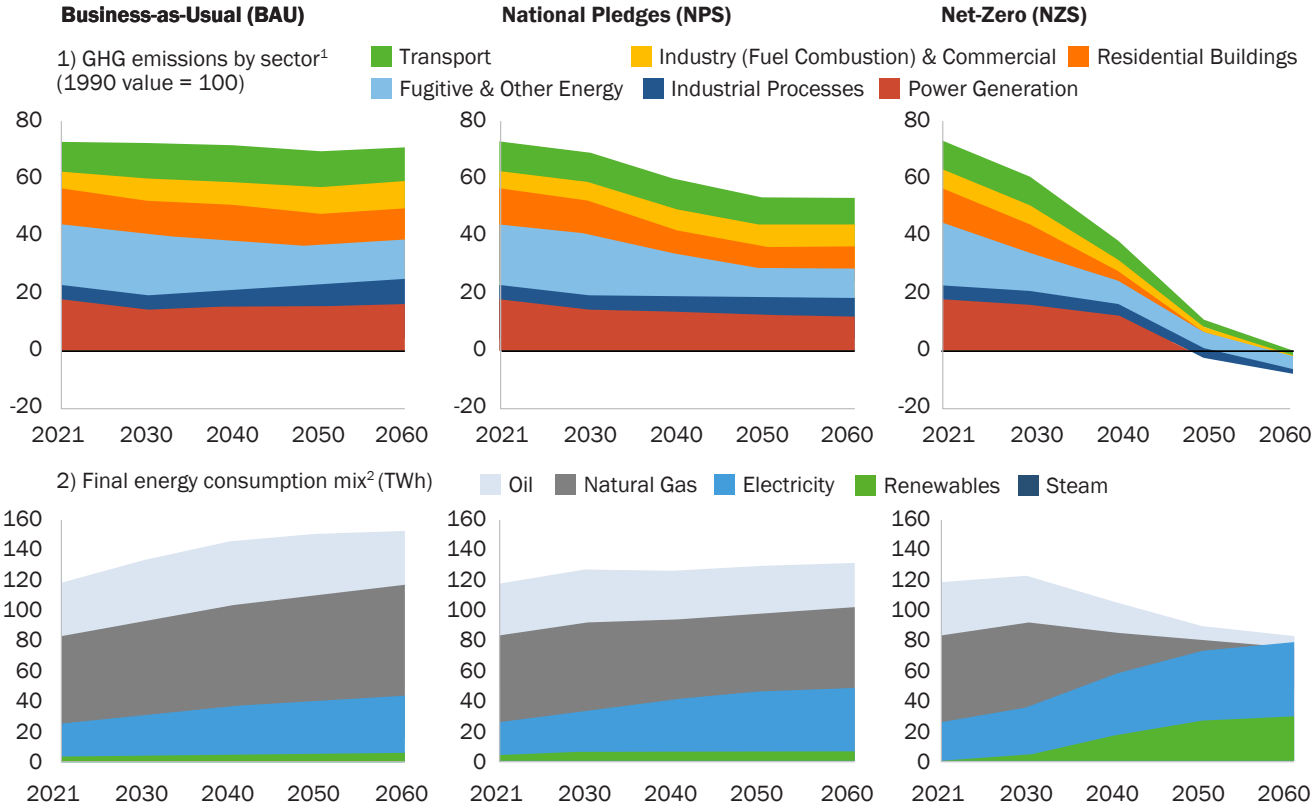
[53] The analysis was conducted using the CompactPRIMES model, a partial market equilibrium model used to assess the impacts of energy and climate change mitigation policies. The analysis estimated projected energy-related GHG emissions (that is, fuel combustion) as well as emissions from industrial processes and product use (IPPU). Fugitive emissions from the oil and gas sector were analyzed separately and integrated ex post into the analysis.

[54] IEA 2022b.

3.1.1. Azerbaijan is not on track to achieve its NDC+ emission reduction targets, despite the relatively modest effort required

The implementation of the policies announced so far is not sufficient for Azerbaijan to achieve NDC+ targets. In the BAU, Azerbaijan's energy-related and IPPU GHG emissions would plateau at around 53 $MtCO_2eq$ in 2050–2060, in line with 2021 emissions (see Figure 3.1, 1). Emissions would be only 28 percent lower than 1990 levels in 2030 (falling short of the NDC target of 35 percent) and 30 percent lower in 2050 (compared to the conditional target of 40 percent announced in Glasgow). In this scenario, Azerbaijan's energy mix would remain essentially unchanged, with an energy system dominated by natural gas and a limited penetration of renewable energy sources, which would reach a meager 5 percent of total primary energy supply in 2060.

Figure 3.1: Systemwide indicators across the three main scenarios (BAU, NPS, and NZS)



1. Emissions exclude non-energy emissions from the agriculture, waste, and forestry sectors. In the NZS, power generation emissions are negative in 2050-2080
2. Electricity refers to the consumption of electricity in end-use sectors (e.g., heat pumps, electricvehicles), while renewables refers to the direct use of renewable energy sources in end-use sectors

Source: World Bank analysis.

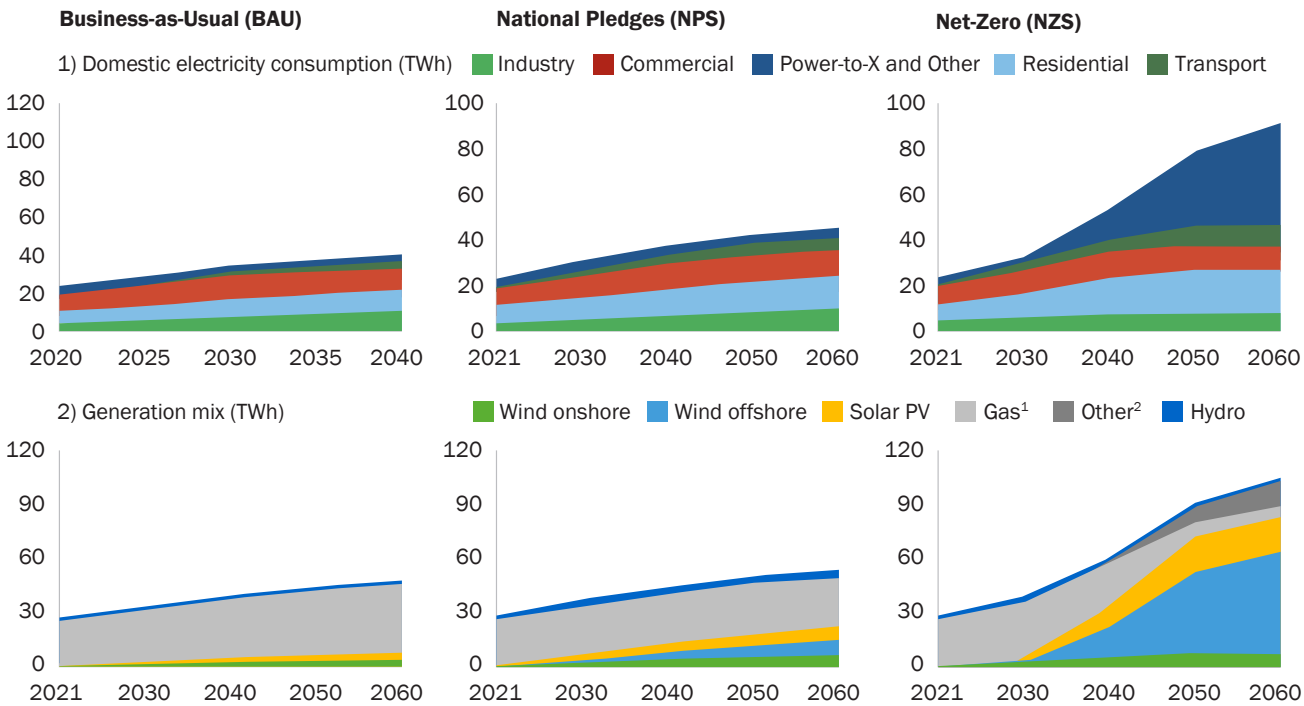
Current targets for 2030 and 2050 could be achieved by moderately scaling up RES, supporting energy efficiency improvements, and reining in fugitive emissions. In the NPS, energy-related and IPPU emissions would be 48.9 $MtCO_2eq$ in 2030 (about 35 percent lower than 1990 levels) and 39.7 $MtCO_2eq$ in 2050 (47 percent lower than 1990 levels). To achieve this, the carbon intensity of power generation would have to decrease through a moderate level of renewable energy deployment, reaching about 20 percent of power generation by 2030 and about 40 percent by 2050 (versus 6 percent in 2021; see Figure 3.2, 2). In terms of installed capacity, this would require installing 1.2 GW of wind and 1.1 GW of solar by 2030 and 3.6 GW of wind and 4.1 GW of solar by 2050. The adoption and implementation of policies to support energy efficiency improvements across all end use sectors (for example, energy efficiency standards for buildings and industry, fuel efficiency standards for vehicles) would be crucial to achieving the targets. In 2050, final energy demand in the NPS would be about 15 percent lower than in the BAU, which corresponds to more than half of the incremental GHG emission reduction required in the NPS compared to the BAU, which is about 23 percent in 2050 (Figure 3.1, 1). Specific attention would need to be paid to the abatement of emissions from fossil fuel extraction and distribution, where emission abatement cost is likely the lowest overall (see Box 2).

Additional supply-side and demand-side investments would be required to achieve net-zero emissions in the newly liberated territories by 2050. While the energy system model does not provide the spatial resolution to separately model these territories, the analysis shows that for this region to achieve net zero, the region's full resource potential for onshore wind, solar, hydro, and geothermal would have to be developed, together with energy efficiency and investments to fully electrify heat and transport demand. After accounting for the effects of supply-side policies such as vehicle emission standards, energy efficiency mandates, and renewable energy targets in the power sector, achieving the climate targets for 2030 and 2050 would also require (a) fully phasing out fossil fuel subsidies by 2030 and (b) introducing a carbon price climbing to US$25 per tCO_2 in 2035 and US$62 per tCO_2 in 2050. Overall, in the NPS, Azerbaijan would need to invest an additional US$6.3 billion in the energy system over 2022–2030 (on top of US$58.1 billion required in the BAU) and US$12.4 billion during 2022–2060 (on top of US$116.1 billion required in the BAU), all expressed at present values. The incremental discounted investment compared to the BAU is equivalent to about 1.2 percent of the cumulative discounted GDP over 2022–2030 and 0.9 percent over 2022–2060.

3.1.2. Meeting the 2030 target would put Azerbaijan on track to net zero, but beyond 2030 the energy system would need a radical transformation

Meeting the short-term 2030 NDC target would put the country on a pathway toward much deeper decarbonization by mid-century, while meeting the 2050 target appears insufficient. Until 2030, the development of the key energy and power sector indicators in the NZS is relatively similar to that of the NPS (as shown in Figure 3.1 and Figure 3.2), while the two scenarios diverge substantially beyond 2030. This suggests that achieving the 2030 NDC target would set Azerbaijan on track toward a much more ambitious decarbonization pathway than is implied by the current 2050 target of a 40 percent reduction compared to 1990 levels. However, the divergence after 2030 between the NZS on the one side and both the NPS and BAU scenarios on the other also implies a much more rapid and deep transformation of Azerbaijan's energy sector compared to the current policy and investment landscape.

Figure 3.2: Electricity sector indicators for the three energy system scenarios



Source: World Bank analysis.

Note: 1. By 2060, fossil natural gas is fully replaced by synthetic methane and hydrogen in the NZS. 2. 'Other' includes biomass-fired power plants (with and without carbon capture and storage [CCS]), batteries, and other rapid-response technologies.

Achieving net zero by 2060 would require full decarbonization of the power sector by 2050. Power sector emissions would have to decrease from almost 14 $MtCO_2eq$ in 2021 to −1.5 $MtCO_2eq$ in 2050 and −6.0 $MtCO_2eq$ in 2060, achieving negative emissions through an accelerated deployment of renewable energy and the use of CCS technologies applied to biomass-fired power plants. In this scenario, the variable generation from wind and solar photovoltaic (PV) would act as a 'fuel saver' in the power grid and produce synthetic methane[55] and hydrogen when production exceeds demand. In 2060, these two technologies would represent 71 percent of total installed generation capacity (30 GW, compared to nearly zero today) and 81 percent of generation (82 TWh; see Figure 3.2, 2). The high level of wind and solar penetration would have to be combined with a mix of (a) 'fast flexing' technologies (for example, batteries, hydro reservoirs, demand-side response, and fast-response gas combustion using synthetic methane) that ramp up and down in seconds to counterbalance short-term fluctuations of wind and solar and (b) 'dispatchable base' generation (for example, combined-cycle gas turbines using synthetic methane and biomass) to counterbalance the seasonal, longer-term variability of wind and solar. Achieving such a high level of renewable energy penetration would also require significant investments in strengthening the power transmission grid.

Box 2: Addressing fugitive emissions to support climate targets and maintain oil and gas competitiveness

Azerbaijan's fugitive emissions from the production and distribution of fossil fuels remain high. Total fugitive emissions (mainly methane leakage in oil and gas operations and gas distribution and CO_2 emissions from natural gas flaring) have almost tripled since 2000 and today account for about one-quarter of the country's total GHG emissions. According to SOCAR, total upstream methane emissions were equivalent to 3.1 million tCO_2eq in 2021. As a partner to the World Bank's Global Gas Flaring Reduction Partnership (GGFR), SOCAR has been taking steps to reduce the practice of gas flaring toward the goal of zero routine flaring by 2030. However, while the amount of flared gas in Azerbaijan decreased from 333 million m^3 in 2012 to 134 million m^3 in 2021, it increased again to 198 million m^3 in 2022, according to satellite-based estimates made by GGFR. At the same time, natural gas losses in the distribution network also remain far above international benchmarks (7.4 percent in 2021), despite improvements since 2015 and a recently announced effort to further reduce them.

Additional policy efforts and investments would be required to reduce fugitive emissions from the production and transportation of fossil fuels and support the achievement of the target of net-zero GHG emissions by 2060. In the NZS, fugitive emissions would have to decrease from about 15 $MtCO_2eq$ in 2021 to about 3 $MtCO_2eq$ in 2060, which is about one-third of the emissions for the same year in the BAU. Achieving this target would require the full elimination of gas leakage and flaring in upstream and midstream operations as well as the rehabilitation of the gas distribution network. These measures represent low-hanging fruits on the path toward decarbonization, as they can reduce GHG emissions at a relatively low cost in the short to medium term and make a significant contribution toward the achievement of the 2030 NDC target. Effectively reducing fugitive emissions would also require the implementation of systems to accurately monitor and measure them. With support from GGFR, SOCAR has developed new techniques for calculating gas flows and GHG emissions into the atmosphere. However, more efforts would be needed at the SOCAR and government levels to further improve the accuracy and transparency of the measurement and reporting systems.

Reducing fugitive emissions can also help Azerbaijan's oil and gas industry maintain its 'license to operate' in global markets. The carbon intensity of oil and gas production and transportation is likely to affect their competitiveness in export markets that adopt climate policies, especially the EU. It would also increasingly affect investment choices of international oil companies under pressure to reduce their emissions. Despite its high level of fugitive emissions, Azerbaijan's oil and gas value chain is less carbon intensive than the one of other major producers. In 2015, the upstream crude oil carbon intensity was 6.3 gCO_2eq per MJ (Masnadi et al. 2018), compared to 9.7 gCO_2eq per MJ for the United States and 9.7 gCO_2eq per MJ for the Russian Federation and Kazakhstan. However, Azerbaijan would have to further significantly reduce fugitive emissions to compete with the lowest-emission producers, especially Middle Eastern countries (for example, Saudi Arabia with 4.6 gCO_2eq per MJ).

[55] Synthetic methane is produced from green hydrogen and CO_2 captured from the air using green electricity, so its life-cycle emissions after combustion are zero. The production of synthetic methane is relatively costly, but the modeling results suggest that this fuel is more cost attractive and technically feasible than green hydrogen for certain applications, especially power generation and other applications that require gas distribution, since the cost of rebuilding a 100 percent hydrogen-based gas infrastructure would be significantly higher.

The least-cost pathway to achieving net zero by 2060 requires massive energy efficiency improvements and the large-scale use of electricity and zero-carbon energy carriers in end use sectors. In 2060, the final energy demand in the NZS would need to be almost half of the demand in the BAU in the same year or about 30 percent lower than in 2021 (Figure 3.1, 2). Achieving this target would require even more ambitious policies to support energy efficiency improvements across all sectors. At the same time, the final energy mix would be completely different in the NZS compared to the BAU scenario. About 60 percent of final energy demand would be met by electricity (especially in the transport and heating sectors), while zero-carbon energy carriers (for example, biogas, synthetic methane, green hydrogen and biofuels) would account for another 25 percent. The production of the zero-carbon energy carriers requiring electricity (that is, 'power-to-X' applications) would consume about 40 percent of total electricity generation, which would have to reach about 100 TWh in 2060, more than double the amount in the BAU scenario and almost four times the 2021 value. In the NZS, Azerbaijan would also have to pursue more ambitious policies to support the abatement of fugitive emissions from fossil fuel extraction and transportation, as described in detail in Box 2.

The decarbonization of the buildings sector would require energy efficiency improvements, combined with higher levels of electrification of demand and a switch to cleaner heating sources. The implementation of energy efficiency measures (such as insulation of buildings and adoption of efficient heating devices) could reduce final energy demand for space heating and cooling in the residential sector by more than 60 percent in 2050 in the NZS compared to the BAU. Natural gas-based heating would be almost completely phased out. Gas would account for about 10 percent of final energy demand in the residential sector (including heating, cooling, cooking, and other appliances) by 2050 compared to almost 80 percent in the BAU in the same year and almost 85 percent today. Moreover, gas used in households would be a blend that includes clean gas, biogas, and hydrogen, so that the share of fossil natural gas would be only 20 percent of the total. In the NZS, electricity would account for about 65 percent of final energy demand in the residential sector by 2050, due to the widespread adoption of heat pumps for space heating and cooling and electric cooking stoves. Solar water heaters would also be adopted to produce sanitary hot water from solar energy and could account for about 15 percent of final energy demand in the residential sector by 2050.

In the transport sector, GHG emissions would be mainly reduced through the combination of a shift to less carbon-intensive modes of transport ('shift' strategies) and the adoption of clean fuels and energy efficiency measures ('improve' strategies). To support the decarbonization of the sector, in the NZS, rail transport is expected to play a bigger role than in the other scenarios, partially displacing road transport and achieving a modal share of 13 percent for passengers and 36 percent for freight in 2060 (compared to 2 percent and 24 percent respectively in 2021). At the same time, conventional fuels would be almost fully phased out by 2060 (with some residual use mainly in the aviation sector) and the fuel mix would be dominated by electricity, biofuels, and hydrogen. In addition to the switch to clean fuels, the transport sector would have to achieve significant energy efficiency improvements. In the NZS, by 2060 the specific energy consumption (measured in terms of fuel energy consumption per vehicle-kilometer) would have to be about 65–70 percent lower than in 2021 in all transport segments, compared to just 15–25 percent lower in the BAU. While the energy system model did not explicitly represent this, additional measures that could be taken to support the decarbonization of the transport sectors would be measures that reduce the demand for motorized transport (for example, promotion of cycling and walking, optimization of freight routes), often referred to as 'avoid' strategies.

Digitalization investments can contribute to decarbonization by greening the digital sector itself and deploying digital applications across GHG producing sectors. Two key sets of actions that can support the reduction in GHG emissions across the digital value chain are (a) improving the energy efficiency of connectivity infrastructure (for example, through the use of energy-efficient materials and green electricity to power the digital infrastructure and the adoption of infrastructure sharing practices to minimize the deployment of passive infrastructure) and (b) attracting investments in green data infrastructure, building on Azerbaijan's ambition to become a key player in the interregional digital connectivity and data exchange market between Europe and Asia. Digital technologies can also serve as an enabler to improve energy efficiency across sectors and services and help reduce GHG emissions and monitor the emissions footprints better at the sectoral and national levels. For instance, big data and advanced analytics can be applied across sectors to improve energy efficiency through smart energy management or predictive analytics on building energy consumption monitoring, design smart and sustainable urban and infrastructure planning, and build traffic control systems for smart mobility and long-haul transit planning.

3.1.3. Deep decarbonization would require a major transformation of Azerbaijan's energy system but could yield substantial economic benefits

Overall, compared with the baseline scenario, Azerbaijan would need to invest an additional US$7.9 billion in the energy system over 2022–2030 and US$28.1 billion during 2022–2060 (expressed at present values) in the NZS. This investment is incremental to the discounted investments required in the BAU, which amount to US$58.1 billion over 2022–2030 and US$116.1 billion during 2022–2060. The incremental investment by 2060 (US$28.1 billion) is composed of investments in transport (US$13.2 billion), the power sector (US$6.5 billion), the residential sector (US$2.7 billion), and the industrial and commercial sectors (US$5.5 billion). The incremental discounted investment is equivalent to about 1.5 percent of the cumulative discounted GDP over 2022–2030 and 2.1 percent over 2022–2060. Mobilizing this investment would require an ambitious economywide policy agenda on top of the announced policies.

Energy sector decarbonization would allow Azerbaijan to reduce domestic natural gas consumption and increase energy exports, partially offsetting the projected decrease in oil exports in the main decarbonization scenario (NZS). In the NZS, oil exports are projected to decline to about 94 TWh in 2060, that is, about one-quarter of today's levels (more than 350 TWh in 2021) or about one-third of the 2060 exports in the BAU, mainly due to the lower global demand for oil and the lower productivity of Azerbaijan's oil fields. On the other hand, in the NZS, in response to the domestic shift toward renewable energy, natural gas exports are projected to increase by 35 percent until 2060 (from about 210 TWh in 2021 to 286 TWh in 2060), a significantly higher increase than in the BAU (214 TWh in 2060). The stronger uptick in gas resources available for exports in the NZS compared to the BAU, either directly or in the form of hydrogen or other carriers, is the result of lower domestic demand for natural gas (3 TWh versus 71 TWh in 2060). These increased natural gas exports would contribute to meeting the currently growing demand for natural gas as a transition fuel (especially in Europe), but their nature would remain temporary as global decarbonization is expected to eventually reduce demand for all fossil fuels.

Azerbaijan would have incentives to decarbonize faster if international fossil fuel prices stayed higher for longer than assumed in the NZS. The HEP models the effects of variations in international fossil fuel prices on Azerbaijan's decarbonization pathway. In the HEP, crude oil prices are assumed to plateau at around US$30 per MWh, or US$51 per barrel, in the long term (compared to about US$12 per MWh, or US$20 per barrel, in the NZS), while natural gas prices are assumed to plateau at around US$26 per MWh (compared to US$10 per MWh in the NZS). This scenario could be the result of a higher global demand for fossil fuels, for example, if CCS technology is scaled up more rapidly or if investments in supply dry up. In the HEP, the large-scale deployment of renewable energy and the electrification of end use sectors in Azerbaijan would be accelerated, due to the better cost-effectiveness of RE compared to the more expensive fossil fuels. GHG emissions would decrease faster, especially in the years between 2035 and 2050, when they would be about 15–25 percent lower than in the NZS. The accelerated domestic decarbonization process in the HEP would allow Azerbaijan to increase its energy exports in the medium term (especially natural gas) by 10 percent in 2040.

More aggressive investment in renewables to produce green hydrogen and electricity for exports compared to the NZE, if technological developments allow, can further offset the decline in oil and gas export revenues. The GES assumes that large-scale hydrogen production and transportation technology becomes available in the mid-2030s and simulates how Azerbaijan can partially mitigate fiscal risks from the decline in conventional energy export revenues by more aggressively expanding renewable electricity generation to export[56] either electricity directly or green hydrogen produced from green power. In the GES, electricity generation would increase from 27 TWh in 2021 to 174 TWh in 2060, almost double the projected generation in the NZS (101 TWh in 2060). The incremental investments would be about 0.5–1.0 percent of GDP per year over 2035–2050 and would include investments in additional electricity generation capacity, green hydrogen production capacity, and strengthening of the power transmission network to support electricity exports (for example, through the construction of the proposed Black Sea submarine cable). As a result, Azerbaijan could export an additional 50 TWh of green hydrogen and 7 TWh of electricity per year by 2060. Scaling up green

[56] To approximate Azerbaijan's competitive position compared to other low-cost producers, the model assumes that resources can only be economically developed if they allow for green hydrogen production and transport to Europe at cost that are no higher than the expected delivered cost from the lowest-cost global producers. Water availability for catalyzers involved in green hydrogen production is not assumed as a constraint in Azerbaijan because the primary electricity source would be offshore wind in the Caspian, where water could be made available through desalination. The model does not include the additional cost and RE capacity required for the desalination, but the impact of desalination on the overall hydrogen cost and electricity generation capacity is estimated to be very small (less than 1-2 percent).

hydrogen production would increase water consumption needed for the electrolysis process. However, the increase in water consumption from green hydrogen production is estimated to be relatively small (less than 10 percent of current water consumption by the energy sector in Azerbaijan).[57] Moreover, this increase would be more than offset by the reduction in water consumption brought about by the large-scale shift to non-water-intensive sources (solar and wind), which is estimated to be about 80 percent compared to today's levels (as discussed in Section 3.2.2). Because this scenario assumes the possibility of the rapid ramp-up of investment to produce and transport green hydrogen (or potentially green ammonia) at industrial scale after 2040, which requires technology that is currently still in the development stage, these findings should be reevaluated regularly over the coming years to inform policy making in Azerbaijan.

3.1.4. The transition will entail social and financial risks requiring careful management

Socially acceptable implementation of the required energy subsidy reforms and carbon pricing is one of the most important implementation challenges for achieving Azerbaijan's climate ambitions. Electricity and natural gas tariffs are currently well below their economic costs, due to the presence of significant implicit fiscal subsidies. In both the NPS and the NZS, fossil fuel subsidies would have to be fully phased out by 2030. In the NPS, the carbon price would have to reach US$25 per tCO_2 in 2035 and US$62 per tCO_2 in 2060, while in the NZS it would have to be US$30 per tCO_2 in 2035 and then increase steeply to US$280 per tCO_2 in 2060. In both scenarios, average end user electricity tariffs would increase from US$44 per MWh in 2021 to almost US$70 per MWh in 2060, which corresponds to an increase of more than 50 percent. However, in the medium term (between 2040 and 2050), tariffs would reach a peak of around US$75 per MWh, mainly due to the early replacement of gas power generation with renewables, which would lead to underutilized thermal capacity and an increase in overall capital costs of the power sector. Azerbaijan would need to manage energy price increases carefully, by assessing their impacts on the population and businesses and implementing social security measures targeting lower-income and vulnerable consumers. An analysis of the implications of domestic decarbonization on poverty (limited in scope due to microdata unavailability) is presented in Section 4.4.2.

The risk of stranded assets is expected to be manageable in the upstream oil and gas and power sectors, even in the NZS, but it may be significant for the gas distribution grid and specific state-owned companies. Oil production is on a sharply declining trajectory in Azerbaijan even in the BAU, and new investments in natural gas are unlikely to materialize in Azerbaijan without secured long-term offtake agreements. In the power sector, the use of zero-carbon gases blended[58] with fossil natural gas means that the projected capacity and capacity utilization of thermal power plants is only marginally declining in the NZS. However, the technologies to produce zero-carbon gases are still emerging, so the risk could be higher if these technologies do not achieve commercial scale and viability. On the other hand, the risk of stranded assets appears material for the gas distribution network, which was built up with substantial investments over the past decades. While the gas grid is largely decarbonized in 2060 in the model, consumption of piped gas is projected to decline sharply by 2040 in the NZS as a result of the wholesale shift by households to electricity for heating. This implies major losses of revenue for the SOEs involved in the domestic natural gas market, which in turn would entail substantial financial risks and fiscal contingent liabilities.

3.1.5. The energy system is well suited to attract private sector capital to close the mitigation investment gap

Sectoral reforms would have to continue and accelerate to attract private capital to close the climate mitigation investment gap, combined with targeted support for public-private partnerships, demonstration, and pilot investments. Figure 3.3 presents an indicative categorization of discounted incremental investment volumes (that is, the investment difference between the NZS and BAU), categorized by the level of investment risk (x-axis) and the level of commercialization of the subsector in Azerbaijan (y-axis). For certain subsectors such as onshore wind, solar PV, and hydro, the level of commercialization is already high, and the risk is low. Therefore, the policy gap needed to mobilize private investments in those sectors is small and includes measures such as strengthening competition, fostering competitive neutrality, ensuring transparency, and improving market contestability. In subsectors such as rail, public transport, and residential energy efficiency, the level

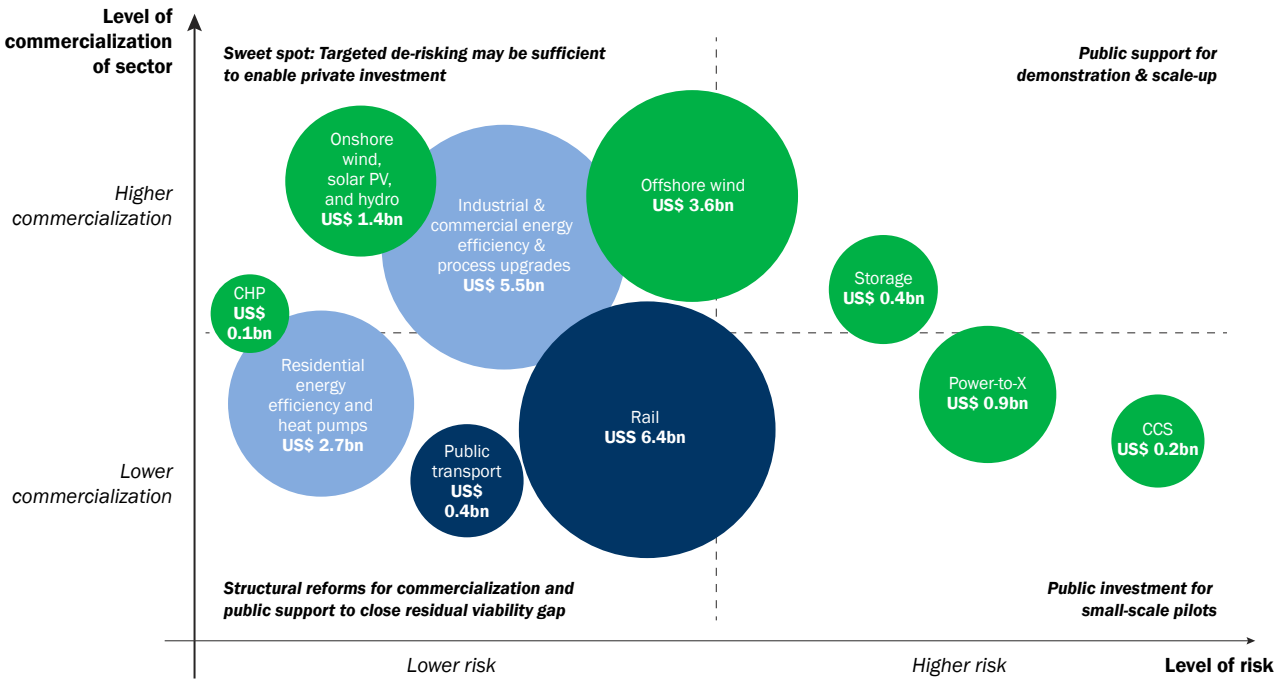
[57] Estimated based on water consumption of 20-30 liters/kg of hydrogen produced (or about 1 liter/kWh).

[58] The additional investment cost to accommodate these blends in the gas grid is not considered in the model. Since hydrogen is the only gas in the blend with substantially different properties and the share of green hydrogen is only 4 percent in 2060, this assumption is expected to have minor implications for the results.

of commercialization is lower. Thus, the policy support may have to involve a combination of structural sector reforms with public support to close the residual viability gap. Public-private partnerships may be well suited to delivering discrete assets with limited complexity and risks, such as cogeneration facilities for district heating, particularly at the municipal level. In the public transport sector, separate PPP structures could be used for fleet provision, operation, and maintenance, isolating the implementation, demand, and performance risks. Having separate capitalization models for each subcomponent of the public transport system can facilitate private sector participation in the parts of the system with higher commercial viability. A third category of subsectors includes those where public support for demonstration and scale-up could help create the conditions for scalable private investment (for example, storage). Lastly, power-to-X and CCS represent subsectors where technology development is still nascent and public investment in demonstration projects would be a precondition for further development in Azerbaijan. In these cases, the use of public-private partnerships for the implementation of pilots, with the support of concessional finance and guarantees, can provide a safe environment for the private sector to participate in riskier projects. Overall, when including private road transport and freight, the discounted investment volumes in highly commercialized sectors add up to about US$17 billion or about 60 percent of the total discounted investment of US$28 billion until 2060.

International debt financing is likely to be critical to enable private investment at scale for domestic clean energy resource development, which has implications for project development and risk allocations. Azerbaijan has a successful track record of private investment in energy, but most of it has been focused on upstream oil and gas targeting export markets, while domestic energy sectors have experienced marginal private sector participation. The existing onshore wind and solar projects have been financed with a combination of balance sheet equity from Azerbaijani public entities and some debt raised from local state-owned banks, but this was only possible due to the modest size of the projects. It is likely that Azerbaijani banks would not be able to provide a significant percentage of the debt required for large projects at a cost-effective rate. Most of the financing would have to come from international banks and financial institutions, in line with what is observed globally. Project structuring, environmental and social risk management, and financial risk allocation will need to adopt international best practices to make projects bankable for this kind of debt financing..

Figure 3.3: Discounted investment gap until 2060 for selected subsectors in the energy system (difference between NZS and BAU), with indicative categorization by level of risk and commercialization in Azerbaijan[a]



Source: World Bank analysis.
Note: a. Private road transport (US$5.8 billion) and freight transport (US$0.7 billion) are omitted here because of the already high level of private investment.

3.2. Building resilience through climate-smart investments

3.2.1. Deeper water security concerns will dampen the agriculture sector's prospects

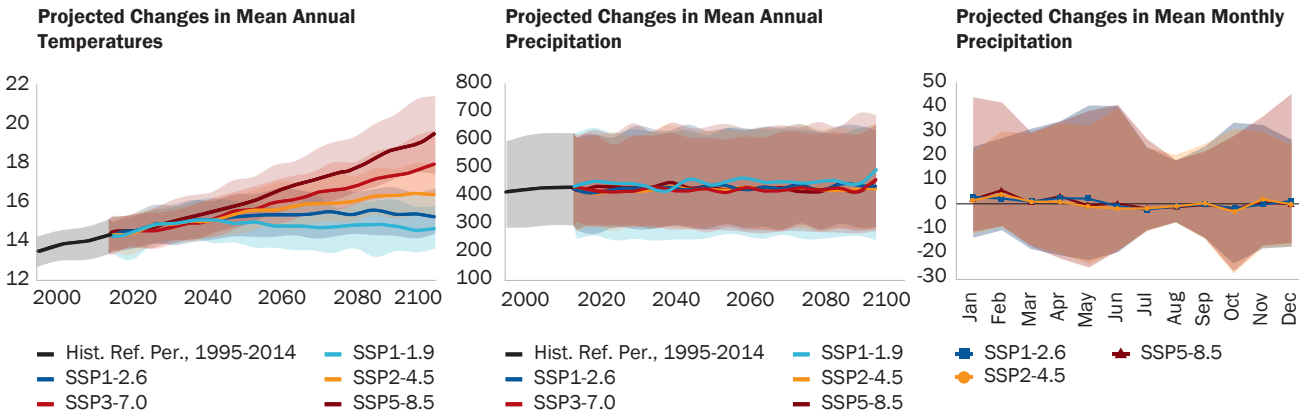
Agriculture is central to growth and social inclusion but is also the sector most exposed to the implications of a warming world. Agriculture is the second sector in terms of exports and the most important in terms of employment, contributing 4.8 percent of GDP (2022) and accounting for about 35 percent of total employment. Although emerging subsectors such as horticulture have proven the sector's potential to turn into a growth driver, Azerbaijan's agriculture lags in productivity compared to principal competitors, primarily due to poor agronomic practices, and increased exposure to production risks, particularly weather variability. Without proactive actions, the expected effects of climate change are likely to keep weighing down on the sector's prospects.

Azerbaijan already faces a substantial water deficit, characterized by spatial and seasonal imbalances. With 80 percent of farming in arid or semiarid areas and irrigated crops contributing up to 80 percent of total agricultural output, agriculture already faces severe water security concerns, with an aggregated deficit (demand versus availability) ranging from 3.7 to 4.9 BCM. With a country average warming rate of 0.7 °C, additional evapotranspiration rates, and water demand, the overall deficit becomes acute in the summer/spring and in dry years, when resources can drop 22 to 23 km3 from a 30.5 km^3 on average.

The uncertainty in future precipitation trends creates challenges for water sector investments and policy. While temperatures in Azerbaijan show a clearer increasing trend over the next decades with projections between 2 and over 4 °C by the end of the century, precipitation is more uncertain, with mean annual precipitation over the next years and decades ranging between 210 and 650 mm compared to a historical mean annual precipitation of 425 mm per year—a range of about +40 percent to −50 percent over the baseline. Wide ranges also characterize projections of intra-annual (seasonal) variability, particularly during the rainy seasons (April–June and October).

However, water scarcity is projected to increase across major cropland areas even under optimistic climate scenarios. Although country-level projections of average annual precipitation are characterized by a degree of uncertainty, the same is not true for Azerbaijan croplands. The latter are projected to be exposed to higher levels of water scarcity consistently across all climate scenarios considered.

Figure 3.4: Projected changes in temperature and precipitation in Azerbaijan over this century

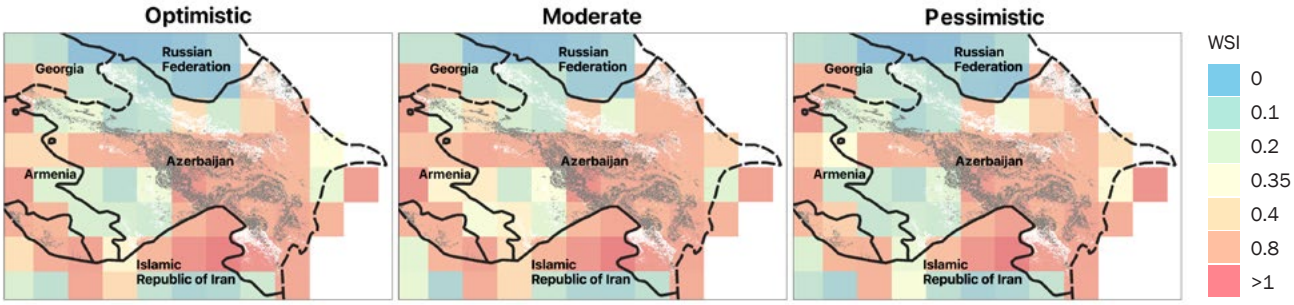


Source: Based on World Bank Group Climate Change Knowledge Portal https://climateknowledgeportal.worldbank.org.

Note: Coupled Model Intercomparison Project 6 (CMIP6)climate projections and models. Shaded areas denote uncertainty intervals around mean estimations. Reference period: 1995–2014.

Even under an optimistic climate scenario (SSP 2–2.6), most of the croplands in the central districts of Azerbaijan will be facing water scarcity. Rain-fed croplands in the central and southern districts (Bərdə, Ağcabədi, Saatlı, Kurdəmir, Biləsuvar, Netfçala, İmişli, Yevlax, Sabirabad, and Salyan) and in mountainous areas unequipped with irrigation schemes (Karabakh, Shaki-Zagatala, and Daghlig Shirvan) will feel the most significant impacts. Southern areas (Cəlilabad and Masalli) are equally at risk.

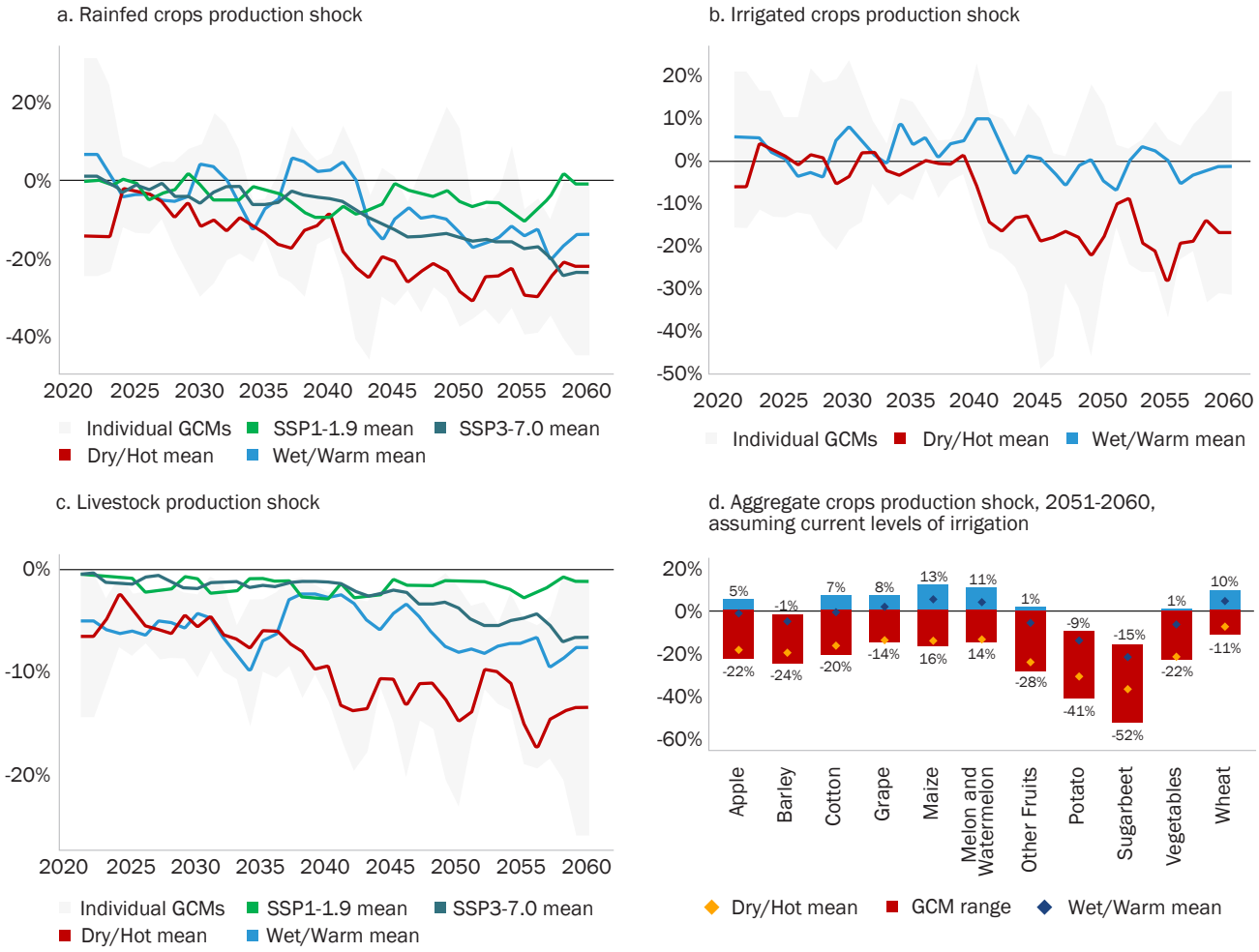
Figure 3.5: Spatial distribution of water scarcity according to different climate scenarios



Source: Based on GCAM simulation.
Note: Water Scarcity Index (WSI) as calculated by an Integrated Assessment Model, GCAM IAM, (WSI > 0.4 denote conditions of scarcity) by 2050 for irrigated (grey shades) and rain-fed (white shades) areas in Azerbaijan. The three climate scenarios used here are Optimistic (SSP 1–1.9), Moderate (SSP 2–4.5), Pessimistic (SSP 3–7.0).

Climate impacts will compound already existing stressors on rain-fed crop and livestock production. Land use change driven by urbanization will continue to affect rain-fed crop production, by directly reducing the availability of land and indirectly through soil erosion and degradation. Projected climate shifts will add additional stressors, leading to a gradual but sharp decline of rain-fed crop productivity of up to 30 percent by 2051–2060 (over 1995–2014 baseline) according to model results (Figure 3.6a). The decline will affect most crops, with

Figure 3.6: Projected shock on crops and livestock production



Source: World Bank.
Note: 3.13a–c are three-year moving averages.

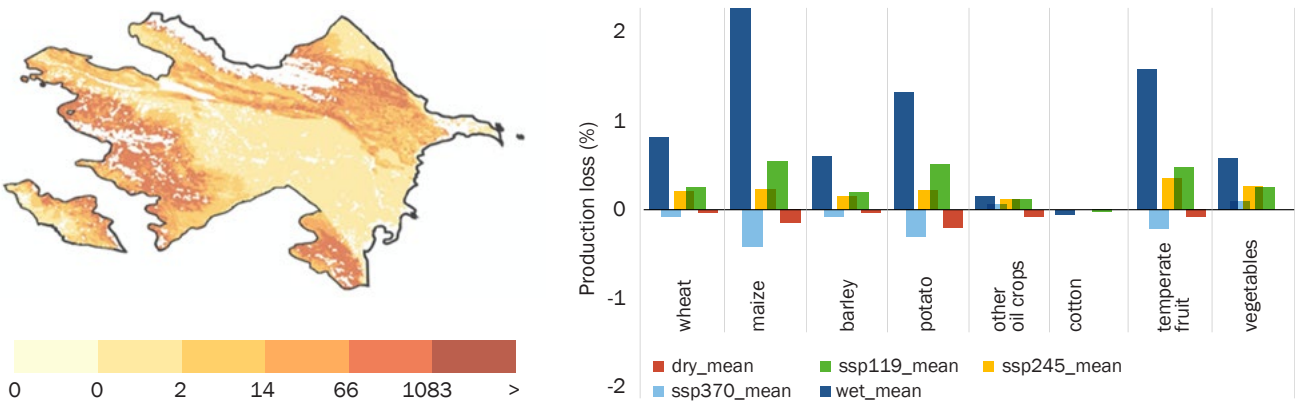
potatoes, sugar beet, and fruit most adversely affected. Livestock production could similarly be affected, mainly due to impacts on fodder availability and animal health, with productivity estimated to be declining by up to 17 percent (over 1995–2014 baseline) (Figure 3.6c). Some irrigated crops could see small boosts to productivity of less than 10 percent in the next decade, although these would be reversed beyond 2040 and losses of up to 29 percent depending on crops may occur under the most pessimistic scenario.

Soil erosion is already reducing agricultural productivity and is expected to worsen in the future because of climate change. Soil erosion is causing productivity losses for important crops such as wheat, barley, and cotton. Erosion-induced productivity loss is expected to increase under the more pessimistic climate scenarios considered (SSP 3–7.0, dry/hot), with important long-term consequences due to the low reversibility of impacts. Sustainable land management practices, such as conservation tillage and the use of cover crops, can help mitigate the effects of erosion and improve soil health, leading to more sustainable and productive agriculture.

3.2.2. Improving irrigation efficiency is a precondition to extending coverage

To sustain the agricultural sector's growth, the authorities are planning an expansion of the already extensive irrigation network. Irrigated agriculture already represents 70–75 percent of the total cropped area. Irrigated area has grown steadily to 1.5 million ha in 2022. Irrigation schemes support major crops such as wheat and barley (48 percent), fodder (28 percent), and cotton (9 percent) and are key to sustaining high cropping intensity (between 85 percent and 95 percent) and, therefore, farmers' livelihoods. The 2022–2026 SEDS foresees an expansion of irrigated land by an additional 10 percent—an ambitious objective, given that based on existing soil, water resources, and topography, the country's total irrigation potential is estimated at 1.72 million ha, and 1.45 million ha (84 percent) is already covered.

Figure 3.7: Soil erosion risk (tons of soil lost per ha/year), 1995–2020 and projected yield loss by crop by 2050



Source: World Bank.
Note: Bar at the bottom shows soil erosion risk (tons/ha/year). If the area is planted, soil erosion risk is the amount of topsoil that leaves the field per year. This does not take into account topsoil generation, soil deposits from any overland flow, or field management practices that reduce topsoil loss.

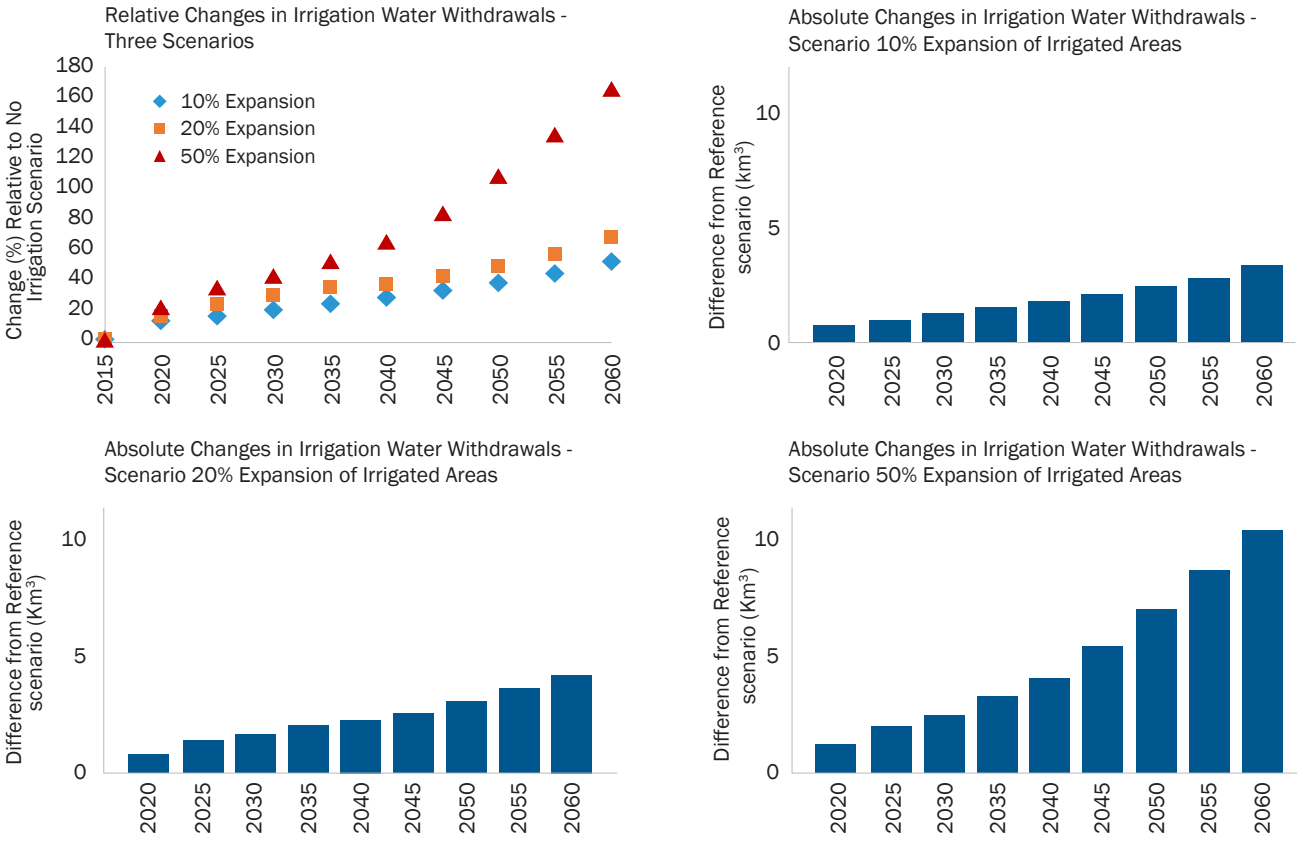
An expansion of irrigation would place additional pressures on the country's water resources. At 5.7 BCM, water for irrigation already represents 68 percent of total consumption. Already under current conditions, achieving the SEDS 2022–2026 target is likely to create significant trade-offs with other uses, starting with industry, where Azerbaijani firms already lament water access challenges. Under climate change conditions, expanding irrigated areas by just 10 percent from current levels would lead to a surge in total water withdrawals by about 40 percent by 2050 (or 2.5 km^3 per year; Figure 3.8). A 20 percent increase would result in water withdrawals increasing by about 50 percent by mid-century (or about 8.5 km^3 per year).

Climate-induced variability coupled with increased demand from irrigation agriculture will compound Azerbaijan's dependency on transboundary water sources, which themselves are at risk. The largest share (60–70 percent) of Azerbaijan's runoff enters through 21 transboundary rivers from three neighboring states:[59] Georgia 11.9 km^3, Iran 7.50 km^3, and Armenia 5.97 km^3. About two-thirds of the country's rivers are river basin tributaries of the Kura and Araz Rivers, both transboundary. The Samur River, with a total flow of 2.36 km^3 per

[59] Rzayev 2017.

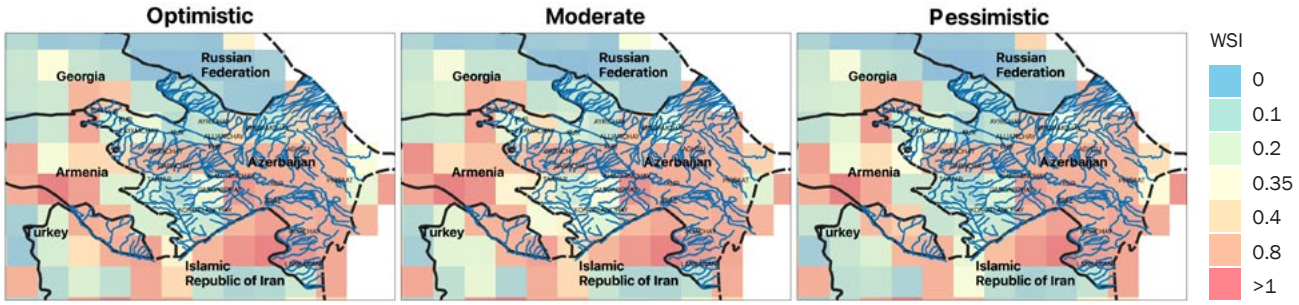
year, forms the border between Azerbaijan and Russia. Future water availability will depend on future abstraction in neighboring countries to meet their growth demand, the impacts of climate change on runoff in river basins, and the actions taken by riparian countries to adapt to those impacts. In the Kura River at the border between Azerbaijan and Georgia, total annual runoff may change compared to historical conditions between +15 and −20 percent, depending on the choice of climate scenario. But despite the uncertainties, water scarcity conditions in neighboring regions are projected to deteriorate (Figure 3.9, WSI > 0.4). This in turn suggests that competition for scarce water resources in these countries, and indeed the region, would increase, particularly during future dry months and years.

Figure 3.8: Increase in total water withdrawals due to expansion of irrigated areas in the country



Source: Based on GCAM simulations, based on three 'increase hypotheses': a 10 percent increase in irrigated croplands from current levels, a 20 percent increase, and a 50 percent increase.

Figure 3.9: Projected water scarcity in neighboring countries



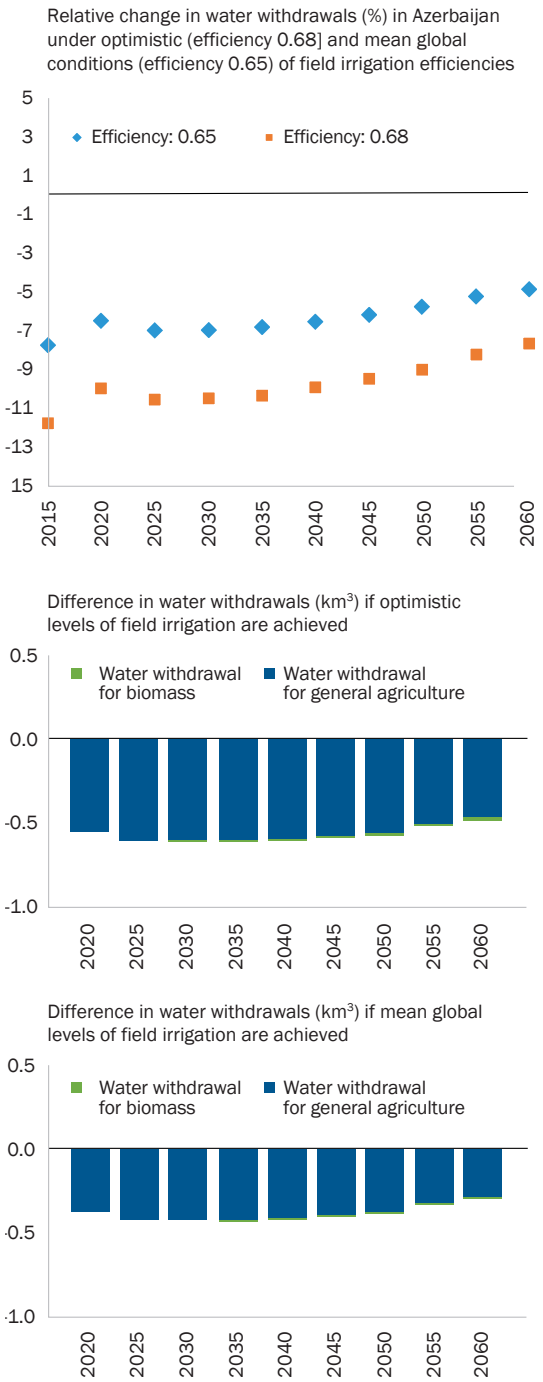
Source: Results from an Integrated Assessment Model, World Bank.
Note: Regional Water Scarcity Index (WSI > 0.4 denotes conditions of scarcity) by 2050 under three climate scenarios. The three climate scenarios used here are Optimistic (SSP 1–1.9), Moderate (SSP 2–4.5), Pessimist (SSP 3–7.0).

An expansion of irrigated land would require increased capacity of water storage infrastructure, while addressing its current safety gaps and imbalanced spatial distribution. Uncertainty about future intra- and inter-annual precipitation trends compounds the importance of water storage infrastructure and makes planning and investments more challenging—particularly once considering the age and spatial distribution of existing reservoirs. Nominal storage capacity stands at approximately 21 BCM but over time the maximum usable (live volume) share has been reduced to only 14.5 BCM —30 percent less. The spatial distribution of storage remains imbalanced: while 129 reservoirs contain 10 percent of the national storage, 6 reservoirs account for 19 BCM[60] — 30 percent less. The spatial distribution of storage remains imbalanced: while 129 reservoirs contain 10 percent of the national storage, 6 reservoirs account for 19 BCM[61] (90 percent of the total) with the Mingachevir reservoir built in 1952 across the transboundary Kura River representing 75 percent of the national storage capacity. Current storage infrastructure presents safety concerns—a 2010 flood necessitated a larger than normal release from the Mingachevir reservoir to protect the safety of the dam, resulting in 70,000 ha of inundated land. The projected increased occurrence and severity of floods calls for assessing and investing in storage infrastructure's safety.

Increasing overall irrigation efficiency is critical to meeting future water demand. Given the existing and future limits facing the planned expansion of irrigation, achieving higher water productivity through reduction of losses from reservoirs to irrigated fields appears critical to increasing agricultural output under future scarcity conditions. The entire hydraulic infrastructure—which in addition to reservoirs, includes nearly 52,000 km of irrigation canals and almost 1,000 pumping stations—is characterized by significant losses. The system is characterized by low productivity as losses of the irrigation system are estimated to reach 2–3 BCM of water per year, or 30–50 percent of the total water supplied to the sector.[62] Reaching average global water field efficiency levels would release the equivalent of 7 percent of current water withdrawals. Should more ambitious efficiency targets (replicating high field efficiency rates achieved by countries such as the United States, Spain, or Brazil) be pursued, this would increase to 11 percent. Naturally, broader interventions in the system beyond improving field water efficiency (for example, improving efficiency in water transport systems, distribution canals, optimizing operational rules of reservoirs, maintaining infrastructure regularly, and others) would also release additional water.

Rehabilitation and modernization of irrigation schemes is key to improving water productivity. Over the past decade, the authorities have invested heavily in rehabilitation and modernization of irrigation schemes at both on-farm and off-farm levels, with over 118,000 ha being rehabilitated between

Figure 3.10: Changes in water withdrawals due to increased irrigation efficiencies



Source: Based on GCAM simulations.
Notes: The reference level of water efficiency in Azerbaijan is 0.6 (Rohwer, Gerten, and Lucht 2007). Two scenarios of improved efficiency are considered: (a) irrigation efficiency in Azerbaijan achieves global averages (level: 0.65) and (b) irrigation efficiency in Azerbaijan achieves higher levels such as those observed in the United States, Spain, or Brazil (level: 0.68).

[60] Water Resource Agency – Ministry of Emergency data (2023).

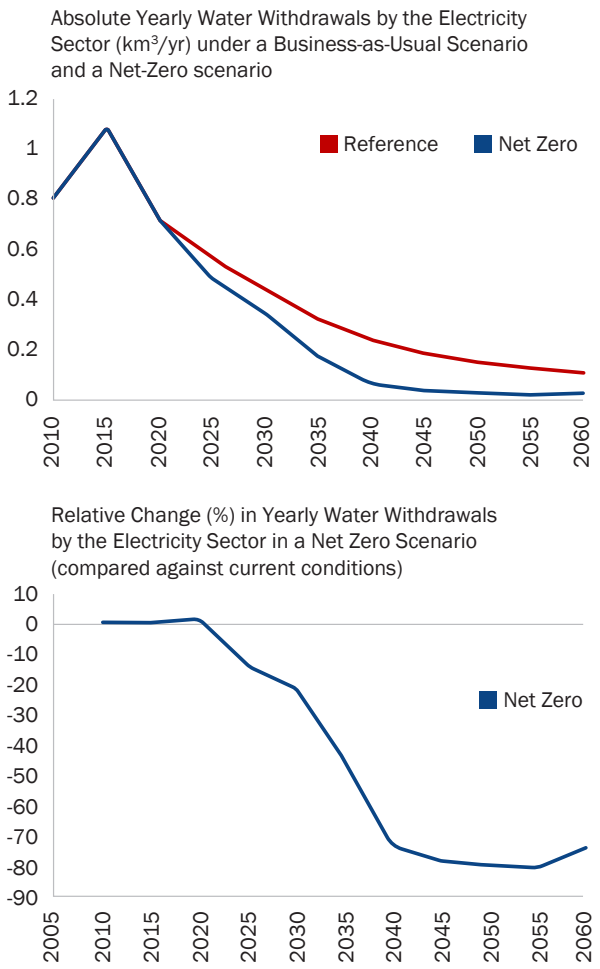
[61] Volume (Million CM): Mingaçevir (15,750), Shamkhir (2,677), Takhtakorpu (268), Ceyranbatan (186), Yenikand (158.5), Varvara (67).

[62] Ahmadov 2020.

2011 and 2017.[63] Despite the high cropping intensity, many farmers lack access to quality irrigation services, notably because of infrastructure degradation and salinization—in 2017 over 600,000 ha was affected by salinization. Only half of the irrigated areas are equipped with drains, and most on-farm infrastructure is made of earth canals. Lastly, the water user associations (WUAs), which are legally responsible for providing irrigation service, require sufficient capacities to operate and maintain typically hydraulically complex systems.

Deploying drip irrigation brings promises but faces constraints. About 57 percent of the current irrigated land uses gravity surface irrigation, while the remaining 43 percent employs sprinkler irrigation.[64] While still marginal, drip irrigation has been gaining popularity in Azerbaijan, particularly in regions with limited water resources, due to its effectiveness in conserving water and increasing crop yields. Scaling up drip irrigation however has known constraints. Drip is most suitable to perennial crops, notably fruit trees, but not to cereals. As the former currently does not exceed 1 percent of the total irrigated area,[65] drip technology adoption is typically coupled with policies to accompany crop production shifts, notably toward higher-value crops. Investment costs may deter farmers—particularly SME famers—from adoption. Global experience shows that subsidizing adoption can rapidly increase uptake and lower investment costs, but Azerbaijan's State Subsidy Policy does not currently cover subsidies for drip irrigation. Instead, Azerbaijan's farmers using drip irrigation pay the same amount for water usage as farmers using flood irrigation, despite a 70 percent reduction in water consumption per ha. Lastly, maintenance requirements and operation methods require skills that remain lacking within the SME farmer community and need to be supported by extension systems which currently do not focus on encouraging drip technology adoption.

Figure 3.11: Change in water withdrawals under a BAU scenarios and a net-zero scenario



Source: Based on GCAM simulations.
Note: The BAU scenario assumes the implementation of thermal cooling technologies, which shift from the water-intensive once-through systems to recirculating systems over time.

The transition to a decarbonized economy would alleviate projected pressures on water availability. The energy sector is currently the second largest water user (11 percent of total demand). Under a net-zero scenario, the large-scale deployment of non-water-intensive RES technologies such as wind and solar PV would lead to an 80 percent reduction of the energy sector's water consumption (equivalent to about 1 km³ per year) over 2040–2060 (Figure 3.11). When coupled with savings from increasing irrigation efficiencies, decarbonization policies would also help ease water allocation trade-offs, particularly during years of low precipitation and low flows.

3.2.3. Azerbaijan's agriculture holds vast adaptation potential, but readiness to adopt new technologies is low

Beyond improving irrigation efficiencies, reducing the sector's climate vulnerability will require the introduction and rollout of climate-smart agriculture (CSA) practices (Box 3). Conservation agriculture (mulching, minimum tillage, crop rotation) and drip irrigation are CSA practices already present in Azerbaijan. Coupled with the adoption of climate-resilient crops (such as early maturing cereal crop varieties, heat-tolerant

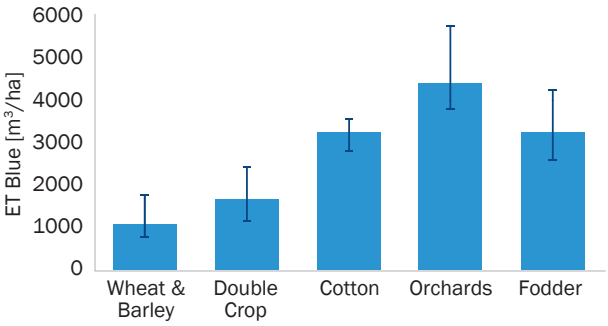
[63] Feasibility Study for Repair and Rehabilitation of On-farm Irrigation & Drainage Infrastructure Project; AIM-Texas 2018.

[64] Jägermeyr et al. 2015.

[65] Hydrosolutions 2023, unpublished analysis.

varieties, drought-tolerant legumes or tuber crops, crops or varieties with enhanced salinity tolerance, or rice with submergence tolerance), they can help farmers better cope with climate shocks. But while large commercial farms are already implementing CSA practices, their adoption within small farms remains low to nonexistent due to a lack of knowledge and practice and limited financial resources. Making vegetable production more resilient will require investment in improved greenhouses on approximately 9,800 ha at an investment cost of US$3.81 billion. Adopting conservation agriculture (minimum tillage) technology on 0,5 million ha of cropland (for wheat, maize, cotton, and vegetables) requires a relatively modest investment of US$10.1 million. This moisture-saving technology can reduce soil erosion and improve soil structure and fertility. Further investment in knowledge transfer and training will also be required. Adaptation investments in climate-resilient agriculture have economic benefits that compensate for their costs, and therefore there is a role for both public and private investments in financing adaptation technologies and measures. Public investments in subsidies or incentives may constitute 30–40 percent of investment costs and would primarily be aimed at supporting smallholders with limited access to finance and low capacity for adoption of the adaptation technologies and measures. The existing farm extension service will need to deliver new knowledge through training and technical assistance to farmers and facilitate the process of adoption of new technologies and management practices.

Figure 3.12: Net water requirements by types of crops (average 2017–2022)



Source: World Bank.
Notes: Cotton and fodder require three times more water than irrigated wheat. Double crop (wheat – other) requires less irrigation water (50 percent) than cotton or fodder. Irrigation requirements of orchards exceed those of fodder and cotton on average (130–170 percent).

A key cross-cutting barrier to Azerbaijan's agricultural sector resilience is SME farmers' skill gaps. The ability of SME farmers to raise productivity is constrained by their limited knowledge of modern production systems and market requirements. The same applies to the introduction of technologies and practices to increase resilience, such as drip irrigation and other CSA practices. SME farmers in Azerbaijan still rely on traditional farming practices and are not aware of the benefits of CSA, such as increased yields, improved soil health, and reduced environmental impact. Lack of education and awareness constraints the introduction of new crops combining the potential for increased resilience and higher profits.

Box 3: CSA's role in Azerbaijan's mitigation and adaptation objectives

CSA practices increase the resilience of agriculture systems to climate change and reduce emissions, while increasing productivity, ensuring food security, and improving livelihoods. CSA includes a range of management practices and technologies, such as the use of drought tolerant and water-efficient crop varieties, introduction of water-saving irrigation technologies, conservation agriculture, agroforestry, improved water management, and sustainable livestock management. Conservation agriculture is one of the most essential CSA practices that focuses on moisture retention and soil regeneration, reduced tillage to retain soil structure, mulch application to retain moisture, and crop rotation, all of which not only preserve soil carbon and reduce GHG emissions but also improve soil health and water conservation. Along with traditional practices and nature-based solutions, CSA may also include modern technologies such as precision agriculture that is based on real-time data using earth observation and localized soil information and information generated by field sensors, allowing perfectly timed and tailored application of farm inputs, and taking preventative measures as and when adverse weather conditions are predicted. A number of conservation agriculture measures, namely mulching, minimum tillage, crop rotation, drip irrigation, and the use of drought-resistant crop varieties, represent the main CSA practices implemented by larger farm in Azerbaijan. However, adoption rates remain low among small farms and will require transfer of knowledge and technologies.

SMEs need support on skills development and extension services to improve productivity and build resilience against climate change. In addition to farmers' access to inputs, especially seeds and fertilizers, meeting these challenges relies on an extension system that lacks the human and financial resources to respond. As there are no current government measures to strengthen this capacity, various private sector actors respond with ad hoc

measures of their own. Some of the larger agribusiness enterprises bring in international experts to train their own staff and supplier farmers. A number of commodity associations formed to support horticultural development are doing the same. However, newly formed associations lack experience and resources to provide support to the sectors. So, although welcome, these initiatives are limited in scope (reaching few farmers relative to demand), short-term, and commodity specific.

Redressing the imbalances between fiscal support to large-scale farms and SME farmers is the prerequisite to increasing adaptive capacity of Azerbaijan agriculture. Although large-scale farms and agro-complexes drive agricultural growth, including in key sectors such as horticultural production, they account for only 5 percent of production versus 95 percent for SME farmers. The former tend to benefit from favorable access to subsidized credit, subsidies for orchard development, tax exemptions, and government support for agro-parks including adaptation-related technologies such as greenhouses and modern irrigation systems. Broadening the investment base and including SME farms would not only facilitate stronger sector growth but also strengthen the climate resilience of the sector.[66]

As the resilience and productivity of agricultural lands increase, significant improvements in carbon sequestration and biodiversity levels could be achieved. Spatial land use modeling taking into account all land use types in Azerbaijan shows that Azerbaijan's land holds additional carbon sequestration potential of approximately 116 million tons of CO_2eq, which is equivalent to 1.5 years of Azerbaijan's GHG emissions in 2018, under optimal land allocation. To unlock this potential, significant reallocation of land would be required, including the returning of 85 percent of grazing land to natural land and partially cropland, among other transformations. These estimates suggest that total levels of economic returns of land use could be maintained, and total land use transition cost could also be covered due to parallel intensification of around 40 percent of remaining croplands through sustainable and economical irrigation investments and increased use of best available inputs.[67]

[66] World Bank 2023.

[67] World Bank analysis in collaboration with the Biodiversity, Ecosystems, and Landscape Assessment Initiative (BELA) at the National Capital Project in Stanford.

Chapter 4

Macroeconomic and financial policies for climate action

Photo credit: tenkl / Shutterstock.com

As a fossil fuel-dependent economy, Azerbaijan is both vulnerable to climate impacts and exposed to global mitigation efforts. Meeting the climate challenge requires a fundamental transition in the structure of the economy away from fossil fuels (Chapter 1). This transition can be supported by domestic decarbonization (Section 3.1). At the same time, investments into adapting to the physical impacts of climate change (Section 3.2) are required.

This chapter assesses the economic costs of climate change, costs and benefits of selected adaptation measures, and the economic trade-offs associated with different policy choices for domestic decarbonization. Section 4.1 illustrates the potential long-run economic impact of climate change in Azerbaijan, highlighting the economic impacts of climate change and the costs and benefits of different strategies for adaptation. Section 4.2 focuses on the costs imposed by global decarbonization and the economic trade-offs of different policy choices to achieve domestic decarbonization (complementary to the analysis presented in Chapter 3). Section 4.3 focuses on the impact of climate change on people with a discussion of labor market and welfare impacts, to the extent feasible given data constraints. Finally, Section 4.4 discusses the issue of financing the climate transition, focusing on the readiness of the financial sector and climate change-related risks posed to financial stability.

The macroeconomic analysis is conducted using the Environmental Impact and Sustainability Applied General Equilibrium model (ENVISAGE), a dynamic and global computable general equilibrium (CGE) model. This model is calibrated to the Global Trade Analysis Project (GTAP) 10 Power Data Base (Aguiar et al. 2019; Chepeliev 2020). The NZS for the macroeconomic modeling is calibrated to the net-zero scenario under the energy system modeled (Chapter 3), with some adjustments made for exogenous emission capture by land use activities and CCS (as these are not explicitly represented in the ENVISAGE model). Detailed methodology, scenario design, alignment with energy modeling, and data sources are provided in a background paper supplementing this report.

4.1. Macroeconomic impacts of climate change

4.1.1. Physical climate impacts will impose severe economic costs, starting in the agriculture sector

The physical impacts of climate change are expected to be moderate overall in the long run for Azerbaijan. As highlighted in Chapter 1, Azerbaijan will experience warming and shifts in precipitation patterns and increased occurrence and severity of droughts, further exacerbating desertification and soil salinity and lowering agricultural productivity, as well as increased occurrence and severity of floods, landslides, and extreme heat events. While there are many ways in which climate change affects an economy, this report considers four impact channels of climate change selected for their relevance to Azerbaijan: damages from increased occurrence and severity of inland flooding, labor productivity loss due to heat stress in exposed sectors, livestock production losses due to heat stress, and reduced pasture productivity and crop yield changes due to changes in climate and precipitation and erosion.[68] a scenario with a moderate degree of climate change (SSP 2–4.5), the modeling suggests that the assessed four impact channels alone could lead to output per capita by 2060 being 1 percent lower in a wet and warm world and 1.8 percent lower in a hot and dry world, compared to a world with no climate impacts in the same year.

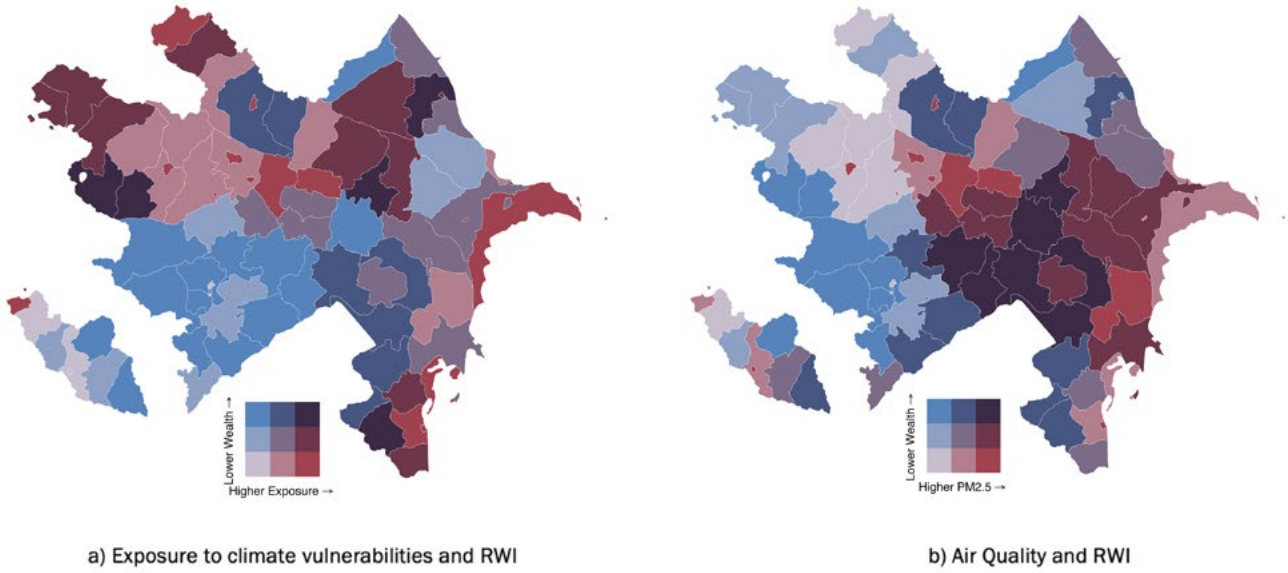
However, at the sectoral level, agriculture is likely to be severely affected by climate change, raising welfare concerns. Modeling suggests that cattle activity sees the most substantial decline in output by 2060—a 6–12 percent loss depending on climate scenarios—driven by heat stress on livestock and increased cost of feed due to lower pasture yields. The food processing sector also experiences substantial reductions in output by 2060 (3–6 percent) as the cost of primary inputs increase, while workers in these sectors are also affected by heat stress. This, in turn, raises welfare concerns as, first, a large share of population is employed in the sector (36.3 percent in 2021) and, second, those employed in the sector tend to have limited resilience to risks.[69] Other expected impacts of climate change on agriculture are indirect, such as reduced school retention rates after extreme events.

[68] Estimated climate impacts should be understood as a lower bound only, as only a subset of climate impact channels was assessed.

[69] The sector has the highest share of informal employment in the economy, with 97 percent of jobs in the sector classified as informal in 2021. The sector plays a valuable social role as a source of own production for food and a rudimentary source of seasonal savings.

Climate impacts will be more pronounced than modeled in this report, given the likelihood of increased frequency of catastrophic events not modelled here. Only a subset of channels in which climate change will have direct and indirect impact on economies is modelled here, meaning that results should be understood as lower bounds. Importantly, extreme events such as floods, droughts, or storms were not modelled. A probabilistic assessment of economic impacts of earthquakes[70] and floods for 2022–2050 shows that extreme events with long return periods can generate high asset losses in between US$420 million and US$1,582 million depending on the liability scenario.[71] Moreover, impacts on poor and vulnerable populations can be substantial, with the risk of a significant increase in transient poverty after large shocks.

Figure 4.1: Colocation maps for various vulnerabilities



*Source: B*ased on relative wealth index (RWI) constructed by the 'UC Berkeley's Center for Effective Global Action and Facebook's Data for Good' and climate impacts estimated for this report. Darker colors: lower wealth, higher exposure.

Vulnerability to catastrophic events is spatially concentrated, with relatively poorer areas likely to be impacted more severely. Figure 4.1 shows the extent of correlation in spatial variation in the correlation of risks of various natural disasters and climate-related hazards with the relative wealth (RWI).[72] Municipalities in the north and south borders (Astara, Lenkeran, Lerik, Balaken, Zagatala, Guba, Shabran, and Tovuz) are subject to both high overall exposure, climate vulnerabilities, and poverty. In terms of individual natural disasters, Balaken, Lerik, and Zagatala experience significant risk of floods. Astara, Goychay, Ismailli, Lenkeran, and Masalli are most affected by earthquakes according to historical earthquake records.

Climate impacts can be partly reduced by appropriate cost-effective adaptation measures. Aggregate climate impacts of the channels analyzed above could be approximately halved by investments of US$0.2 billion annually up to 2060. For this estimation, this report considers adaptation measures across the selected four climate change impact channels, specifically a 25 percent increase in the air conditioning use compared to BAU (to reduce the labor heat stress), improvements to the irrigation infrastructure to address water stress, and an

[70] The discussion on resilience and adaptation also includes geophysical risks, particularly earthquakes. While earthquakes are not a climate-related hazard, most policies and measures to manage risks—from construction norms to disaster risk finance instruments—have to consider the full range of threats. Ignoring geophysical risks would also obscure important synergies and risks.

[71] Under the low-liability scenario, the government is expected to reconstruct damaged housing of low-income uninsured households (based on World Bank at risk of poverty rates), reconstruct all public assets (with one-third of these assets insured), and cover emergency response costs. In contrast, a high-liability scenario assumes that the government will reconstruct damaged housing of all uninsured households (which is often the case after the most destructive disasters), reconstruct all public assets (with no public asset insurance in place), and cover emergency response costs.

[72] RWI is constructed by the team from UC Berkeley's Center for Effective Global Action and Facebook's Data for Good. The index predicts the relative standard of living within a country using nontraditional data sources, including satellite imagery and deidentified Facebook connectivity data. The index is validated using ground-truth measurements from the Demographic and Health Surveys. The data are provided for over 130 low- and middle-income countries at 2.4 km resolution, including Azerbaijan. The datasets have been used, for example, in World Bank projects in Nigeria and Togo. See Relative Wealth Index (dashboard), Humanitarian Data Exchange, United Nations Office for the Coordination of Humanitarian Affairs, New York, https://data.humdata.org/dataset/relative-wealth-index.

increase in use of fodder for livestock to address pasture feed losses. Jointly, these measures are estimated to avert direct economic losses of up to US$0.3 billion annually on average up to 2060, corresponding to a benefit cost ratio of 1.7. This ratio would be further improved by better tailoring the measures to local circumstances, such as rehabilitation of irrigation infrastructure mixed with crop switching to promote climate resilient crops rather than more extensive irrigation expansion (see Section 3.2). The optimal amount and sequencing as well as prioritization of investments into adaptation remain to be assessed on a measure-by-measure basis.

4.2. Economic trade-offs for domestic decarbonization

This report models decarbonization scenarios corresponding to levels of global and domestic action on decarbonization. The baseline BAU extrapolates the current global and country-specific emissions trajectory, with no additional actions to meet NDCs or achieve net zero domestically or globally. The detailed assumptions for each scenario are highlighted in the CCDR macroeconomic modeling background paper, while Table 4.1 provides an overview of the various decarbonization scenarios considered. Section 4.2.1 highlights the cost of domestic inaction on decarbonization in the face of increasing global policies on decarbonization. Sections 4.2.2 and 4.2.3 then highlight the costs and benefits of different domestic decarbonization actions in response to global decarbonization actions.

Table 4.1: Modeling scenarios for global and domestic decarbonization, with estimated CAGR and cumulative discounted GDP to 2060

		Global decarbonization actions		
		No action	**NDC**	**Net zero**
Domestic decarbonization actions	**No action**	Baseline BAU (Global BAU - Azerbaijan BAU)	World achieves NDCs, BAU for Azerbaijan (Global NDCs – Azerbaijan BAU) (−0.91% / −0.09 pp)	World achieves net zero by 2060, BAU for Azerbaijan (Global net zero – Azerbaijan BAU)
	NDC	BAU for world, Azerbaijan achieves NDC (Global BAU – Azerbaijan NDC)	World and Azerbaijan achieve NDCs (Global NDCs – Azerbaijan NDC) (0.00% / −0.03 pp)	World achieves net zero by 2060, Azerbaijan achieves NDCs (Global net zero – Azerbaijan NDC) (−1.52%/−0.21 pp)
	Net zero	BAU for world, Azerbaijan achieves net zero by 2060 (Global BAU – Azerbaijan net zero)	World achieves NDCs, Azerbaijan achieves net zero by 2060 (Global NDCs – Azerbaijan net zero)	World and Azerbaijan achieve net zero by 2060 (Global net zero – Azerbaijan net zero) (−0.85%/−0.12 pp)

Note: CAGR = Compound annual growth rate; PP = Percentage point.
Brackets indicate (a) percentage difference in discounted cumulative GDP to 2060 from BAU and (b) percentage point difference in CAGR compared to BAU.

4.2.1. Domestic decarbonization can attenuate the significant economic costs of global decarbonization policies

In the absence of domestic decarbonization, global efforts toward achieving NDCs are expected to significantly lower resource rents and hurt Azerbaijan's economy. Modeling estimates highlight that, in the absence of domestic decarbonization policies, global efforts to achieve NDCs ('Global NDCs – Azerbaijan BAU') will lower real GDP by 3.3 percent by 2060 compared to the BAU (Figure 4.2). The key channel of impact is a reduction in economic activity (sectoral value added) associated with fossil fuel extraction sectors (Figure 4.3). Complementary sectors, such as trade and construction (due to reduced investments), are also expected to be affected significantly. At the same time, some of the production resources (labor and capital) freed from fossil fuel extraction activities are expected to be reallocated to cleaner sectors, moderately boosting sectors such as

light manufacturing and air transportation. However, this increase in other sectors is unlikely to compensate for the reduction in fossil fuel extraction (Figure 4.3). Additionally, driven by the reduction in fossil fuel revenues, exports are expected to decline by close to 3.3 percent and fiscal revenues by 4 percent in real terms with respect to BAU by 2060.

Figure 4.2: Even a moderate pace of global mitigation is expected to have a significant impact on Azerbaijan...

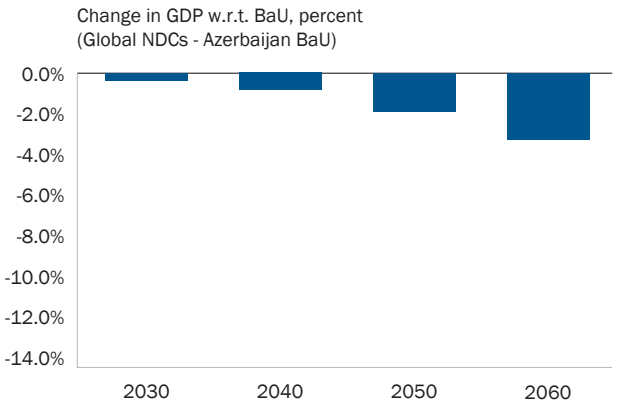


Figure 4.3: ...driven by reduction in the fossil fuel sector

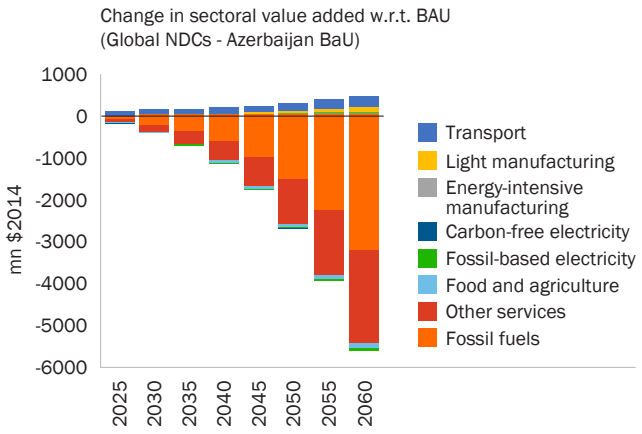


Figure 4.4: More ambitious global mitigation is expected to affect GDP further...

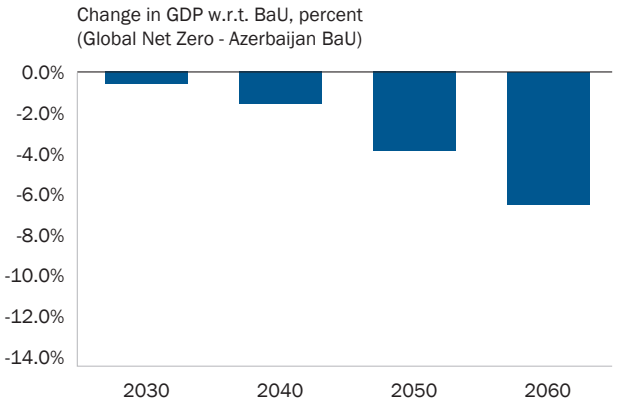
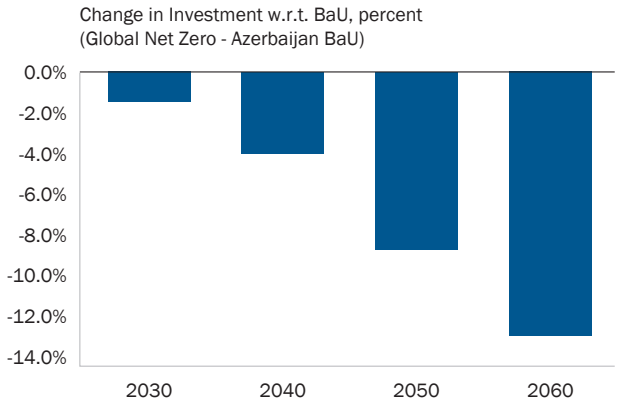


Figure 4.5: ...and significantly depress investment



Source: World Bank, Center for Global Trade Analysis at Purdue University based on Envisage Modeling.

Additional global policies beyond the NDCs, such as the introduction of a Carbon Border Adjustment Mechanism (CBAM) by the EU, will affect carbon intensive sectors beyond fossil fuels and increase the economic cost of domestic inaction. As noted in Chapter 3, despite progress in recent years, Azerbaijan's energy mix is still dominated by fossil fuels. As a result, demand for goods produced in Azerbaijan using fossil fuel-intensive energy is likely to face increasing barriers as global climate policies, such as the EU's CBAM, are implemented.[73] Modeling suggests that the introduction of CBAM will reduce Azerbaijan's real GDP by an additional 1 percent compared to the 'Global NDCs – Azerbaijan BAU' scenario or 5 percent compared to the BAU by 2060. By affecting energy-intensive manufacturing exports, CBAM will also shape future opportunities

[73] The CBAM, intended to limit carbon leakage and support the EU's GHG mitigation efforts, is set to level import duties based on the emission intensity of iron and steel, cement, fertilizers, aluminum, and electricity starting in 2026. In this report, additional assumptions are made regarding future CBAM rollout. Between 2031 and 2035, the CBAM is modeled to (a) expand to Scope 2 emissions, additionally covering petroleum products and non-metallic minerals, and (b) be imposed not only by the EU but also by the United States, Japan, Australia, Canada, the Republic of Korea, and other high-income countries. Starting from 2036, the CBAM is modeled to cover all three emission scopes (all other features are the same as in 2031–2035). All middle- and lower-income countries (including China) are modeled to face the CBAM, as their level of mitigation ambition and applied carbon prices is assumed to be lower than in the high-income countries.

for export diversification.[74] One key example is Azerbaijan's chemical and petrochemical sector. As noted in previous studies,[75] this sector provides a key diversification opportunity. In addition to its abundance of raw materials, Azerbaijan benefits from a strong industry base, competitive utility costs, and proximity to large regional markets. However, given its carbon intensity, the sector remains deeply exposed to policies such as CBAM, thus potentially limiting its competitiveness.

More ambitious global decarbonization to achieve global net zero by 2060 is expected to significantly worsen the economic impacts of domestic inaction. Global net-zero efforts are modelled through an increase in global carbon prices, with 2060 carbon prices ranging between US$490 per tCO_2 and US$660 per tCO_2. These efforts are expected to reduce Azerbaijan's resource rents significantly, with real GDP declining by 3.3 percent compared to the 'Global NDCs - Azerbaijan BAU' scenario or 6.5 percent compared to the BAU by 2060 (Figure 4.4). Investment is expected to be more severely affected than GDP, given the capital-intensive nature of the fossil fuel sector, declining by nearly 13 percent compared to the BAU by 2060 (Figure 4.5). The impacts are more pronounced post-2040, as the projected global demand for fossil fuels declines more substantially in the longer term due to increased global decarbonization efforts.

4.2.2. Achieving the 2030 NDC target by phasing out energy subsidies is in Azerbaijan's self-interest, regardless of the pace of global decarbonization

Eliminating subsidies and gradually introducing carbon pricing is the most efficient path toward achieving the NDC+ targets. The modeling exercise considers different policy options to achieve NDCs in Azerbaijan, as discussed in depth in the background paper.[76] A combination of fossil fuel policy removal and carbon pricing, with a corresponding reduction in factor taxes, is found to be the most efficient option. The elimination of two-thirds of current fossil fuel subsidies is sufficient to achieve the 2030 NDC target. Additional mitigation efforts are needed to comply with the 2050 NDC+ target, including elimination of all fossil fuel subsidies and the introduction of carbon pricing (carbon price of around US$41 per tCO_2 by 2050) (Figure 4.6).

These policy shifts will help mitigate the impact of global net-zero policies, while diversifying the economy. As noted in Section 4.2.1, if Azerbaijan adopts a BAU approach, real GDP is expected to decline sharply by 6.5 percent by 2060 compared to the BAU in a global net-zero world. If Azerbaijan implements its NDCs efficiently ('Global net zero – Azerbaijan NDC'), real GDP will decline by 4.3 percent against the BAU (as opposed to 6.5 percent). Thus, implementing the NDCs is estimated to dampen the negative impact of global net-zero policies (Figure 4.7), particularly if additional revenues from energy subsidy reform and carbon pricing are used to reduce taxes on production factors, such as labor and capital. This can help boost production in non-fossil fuel sectors, particularly in services, and partially compensate for the loss in fossil fuel output (Figure 4.8).

Achieving the NDC+ targets will yield economic gains even under a higher-than-expected level of fossil fuel prices. Azerbaijan can benefit from first mover advantages by speeding up domestic decarbonization, regardless of the pace of global decarbonization efforts. Real GDP is estimated to increase by 2.3 percent by 2060 against the BAU (Figure 4.9) if the world does not implement mitigation efforts but Azerbaijan implements its NDCs ('Global BAU – Azerbaijan NDC'). The mechanism driving this result is also highlighted in the energy deep dive in Chapter 3. In a scenario of higher global energy demand and prices, Azerbaijan can benefit from domestic decarbonization by reducing fossil fuel (particularly gas) consumption and increasing energy exports.

[74] If all leading economies adopt a version of the CBAM, exports are expected to decline by 0.5 percent of GDP by 2060 compared to no CBAMs in the same year. This is driven by a 0.4-percent GDP reduction in fossil fuel exports and 0.2-percent GDP reduction in energy-intensive manufacturing exports, offsetting a 0.1-percent GDP increase in services exports.

[75] Azerbaijan Country Private Sector Diagnostic (CPSD, forthcoming).

[76] These include (a) only using carbon prices with revenue recycled to households; (b) using a combination of fossil fuel subsidy removal and carbon pricing with revenues recycled to households; and (c) using a combination of fossil fuel subsidy removal and carbon pricing, with revenues recycled through a reduction in factor (capital, labor, land) taxes.

Figure 4.6: A combination of energy subsidy reform and carbon prices will help achieve NDCs...

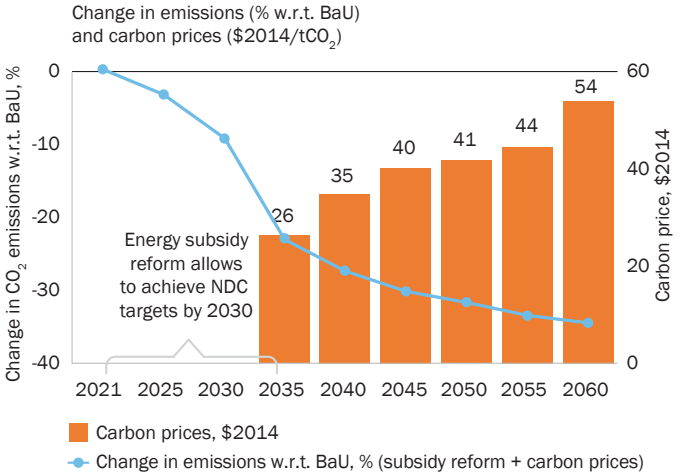


Figure 4.7: ...and dampen the domestic impact of global net-zero policies

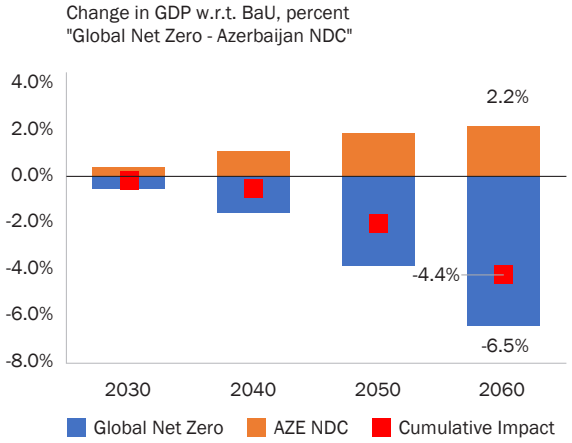


Figure 4.8: These policies can also help change the output structure of the economy

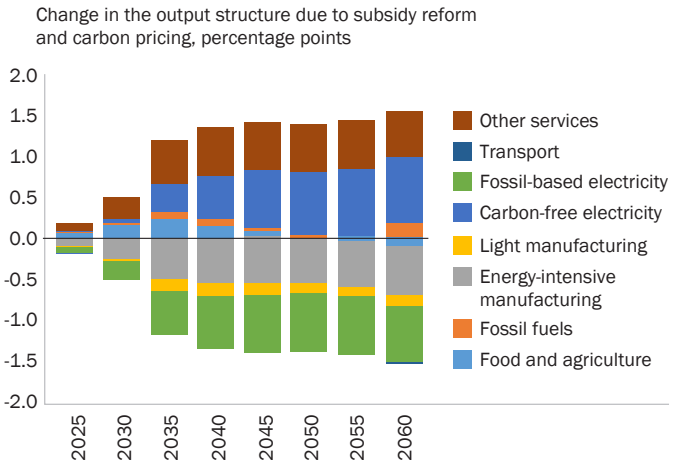
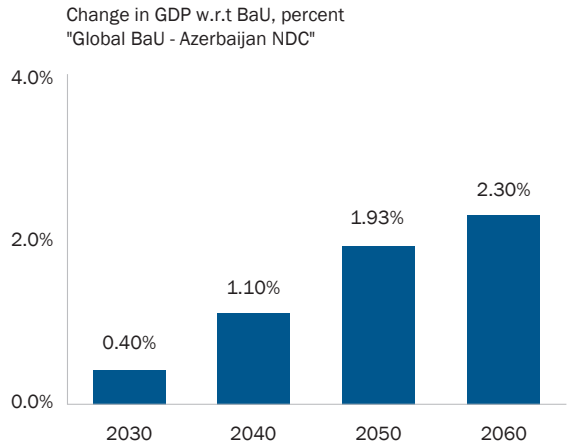


Figure 4.9: Implementing NDCs is in Azerbaijan's interest even if the world does not act



Source: World Bank, Center for Global Trade Analysis at Purdue University based on Envisage Modeling.

4.2.3. The additional economic costs of moving to net zero are likely to be offset by important co-benefits

Aligning with a global net zero by 2060 pathway is likely to generate additional economic costs for Azerbaijan. In a global net-zero world, real GDP could decline by 7.5 percent by 2060 compared to the BAU if Azerbaijan also fully decarbonizes ('Global net zero – Azerbaijan net zero'; Figure 4.12). This implies a 0.1 percent per year reduction in the growth rate compared to the BAU (before accounting for larger adverse impacts of climate change under BAU). Around 50 percent of this decline is driven by global factors—declining global demand for fossil fuels and energy-intensive commodities—while the remaining 50 percent is driven by more ambitious domestic mitigation efforts, which increase the domestic cost of production and impacts on prices and consumption.[77] Economic costs rise significantly over time, which reflects (a) an increase in the intensity of mitigation efforts as highlighted through the more ambitious emission trajectory for net zero (Figure 4.10) and rising carbon prices (Figure 4.11) and (b) the assumption that cheaper mitigation options are deployed earlier.

[77] The modeled net-zero scenario for Azerbaijan envisages a significant reduction in emissions, as compared to NDC scenario, with estimates derived from the energy system model (Chapter 3) with some modifications. The current scenario does not take into account of CCS and land-based mitigation options for Azerbaijan. This scenario is implemented using a combination of subsidy reform (full elimination by 2030), a nearly ten-fold increase in carbon price compared to the NDC scenario – which proxies the gamut of pricing, regulatory and investment policies simulated in the energy modeling and a reduction in factor taxes made possible by revenue recycling. This scenario does not yet take into consider the application of CBAM measures, which could influence the opportunity cost of Azerbaijan freeriding (i.e., limit the additional costs of full domestic decarbonization).

Figure 4.10: Index of CO_2 emissions in Azerbaijan across scenarios, 2021 = 1, excluding LULUCF and CCS

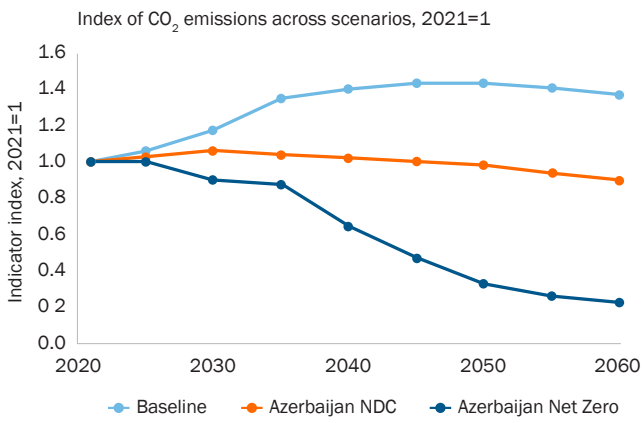
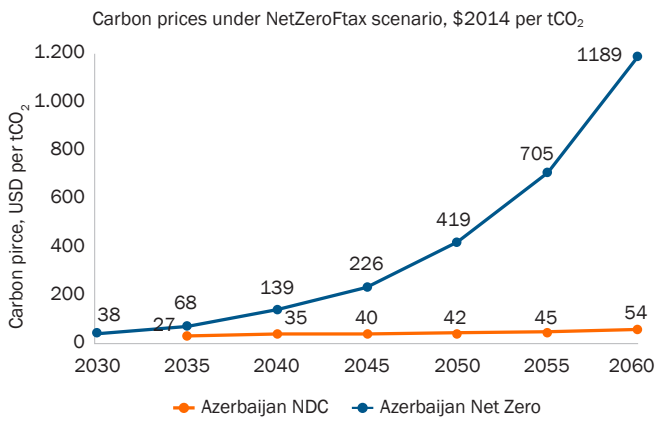


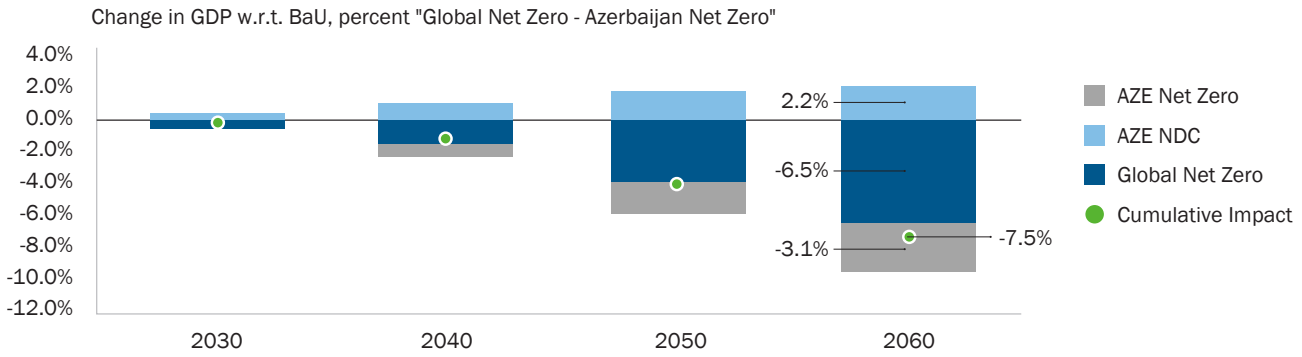
Figure 4.11: Carbon prices across NDC and net-zero scenarios in Azerbaijan



Source: World Bank, Center for Global Trade Analysis at Purdue University based on Envisage Modeling.
Note: LULUCF = Land use, land use change, and forestry. Carbon prices greater than US$1,100 as shown in Figure 4.11 may never occur as real-world mitigation cost at the end of the abatement cost curve could be lower than modeled.

Ambitious fiscal policies can attenuate these economic costs. Once carbon price revenue is recycled to reduce factor taxes, the direct economic cost of the net-zero transition is lowered by up to 40 percent. Increased formalization of the economy will further enhance the effectiveness of revenue recycling through reduced factor taxes by ensuring that more of the gains from reduced labor and capital taxes can be reaped by firms and households.

Figure 4.12: Economic costs of the net-zero transition relative to the NDC scenario



Source: World Bank, Center for Global Trade Analysis at Purdue University based on Envisage Modeling.

Substantial economic co-benefits can further offset the costs of full decarbonization. Azerbaijan's transformation will also generate indirect, but substantial, co-benefits starting in the near term, including reduced air-pollution-driven morbidity and mortality, reduced water and soil pollution, improved biodiversity, and improved land productivity. Air pollution from $PM_{2.5}$ alone causes damage of 3–12 percent of GDP annually in Azerbaijan today when accounting for health impacts. Approximately 22 percent of $PM_{2.5}$ levels today are caused by fossil fuel combustion in industry and transport and another 8 percent from residential burning of coal and biofuels (Chapter 1.1). Model results suggest the net-zero transition could generate co-benefits from reduced air pollution of 1.4 percent of GDP annually, not yet accounting for reduced air pollution from windblown dust, for example, achieved through land regeneration.[78]

[78] To provide an assessment of such co-benefits, we rely on the link between ENVISAGE and the environmental Benefits Mapping and Analysis Program – Community Edition (BenMAP-CE) air quality model (U.S. EPA 2019). We further value the risks to life following a conventional approach that estimates the willingness-to-pay (WTP) to secure the health risk reduction associated with a specific policy or measure (for example, OECD 2017).

4.3. Financial sector's opportunities and exposure to physical and transition risks

4.3.1. Financial sector readiness for green financing

A vibrant financial sector will be needed to mobilize financing toward Azerbaijan's ambitious climate goals. As highlighted in Table ES.1, the discounted investments needed for mitigation and adaptation could be at least US$1.35 billion on average per year (or about 4 percent of discounted GDP). Overall, the financial sector is not currently geared toward meeting these financing needs, as it is small and bank centric and offers a limited range of long-term financing instruments.[79] In 2022, the domestic financial sector offered only US$1.3 billion in new loans with a small share of these loans financing long-term sustainability-oriented investments. Corporates raised roughly US$600 million through the capital markets. Key barriers to developing longer-term green financing include low awareness driven partly by the lack of policies, limited capacity of financial institutions to identify green assets and manage climate-related risks, absence of criteria for green projects, and lack of long-term and blended finance instruments.

The Central Bank of Azerbaijan (CBA) has taken a leading role in promoting sustainable finance in the country. In February 2023, the CBA approved its first Sustainable Finance Roadmap 2023–2026, with the goals of ensuring the resilience of financial institutions to climate-related risks; incorporating environmental, social, and governance (ESG) factors into its regulatory and supervisory frameworks; and realizing opportunities associated with the green transition. Authorities need to build on these efforts to promote a broader strategy on climate finance and establish a national green finance force.

A key step toward mobilizing green financing is the issuance of debt instruments (bonds or loans) labeled as green, social, or sustainable (GSS) bonds. As part of the roadmap, the CBA is leading the development of a green bond framework and has recently submitted a proposal (which is pending approval) for introducing the concept of green bonds into relevant legislation. Given the relatively shallow domestic capital markets, international bonds may be the preferred option to finance climate investments at an initial stage.[80] The issuance of sustainable bonds based on the use of proceeds would likely be the appropriate instrument to use.[81] Issuances of GSS bonds domestically are also promising and could be considered alongside substantial efforts to deepen and diversify the domestic capital markets more broadly.[82]

Transparency, awareness raising, and capacity building are cornerstones for mobilizing green finance. Initial actions include addressing gaps in climate-related data, introducing disclosure requirements, and developing a green finance taxonomy to foster transparency. Additionally, raising awareness and building capacity of the industry are critical, as currently only a few financial institutions are taking steps to incorporate ESG factors into their decision-making. Regulations outlining verification and certification measures for sustainable projects also provide needed incentives for GSS bond issuances. Unlocking private capital for climate adaptation will require specific efforts, including identification of tangible investments in vulnerable sectors, development of a pipeline of bankable projects, and support for project preparation/structuring, which provide basis for the development of blended finance instruments.

Authorities could also explore the role of existing state support mechanisms in mobilizing private financing for the green transition. Roughly 40 percent of agricultural loans and more than 80 percent of mortgage lending are supported by state programs, which can be leveraged to promote the development of new green finance instruments. Existing credit guarantee mechanisms, if designed properly, can be effective de-risking instruments.[83] The government could explore options for increasing and mainstreaming green finance within the operations of state funds to reallocate domestic public finance to bridge the financing gap for Azerbaijan's climate objectives.

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[79] There are sources of climate finance outside the financial sector, such as carbon pricing initiatives, carbon taxes, and bilateral/multilateral sources.

[80] Azerbaijan is well positioned to issue Eurobonds as it is already rated by international credit rating agencies and has already three outstanding issuances.

[81] In these cases, the proceeds of the bond are earmarked for investments in mitigation or adaptation projects.

[82] An extension of the domestic yield curve through longer-dated sovereign issuances would be a necessary step. In addition, efforts to address gaps in the enabling environment and expand the investor base are needed.

[83] Concessional lending from the Entrepreneurship Development Fund (in the process of becoming Business Development Fund), the Agrarian Credit and Development Agency, and the Azerbaijan Mortgage and Credit Guarantee Fund (AMCGF). Roughly 10 percent of business loans were financed by state funds through financial institutions. The AMCGF also provides credit guarantee to entrepreneurs in non-oil sectors.

4.3.2. Climate risks to the financial sector

Climate change poses potentially significant impacts on the stability of the financial sector. Representing roughly 95 percent of financial sector assets, the banking sector is exposed to both physical and transition risks. Physical risks stem from both the gradual and abrupt impacts of climate change and natural disasters on the value of real assets and their underlying financial instruments. Transition risks originate from efforts to mitigate climate change and improve environmental conditions by greening the economy, which may create economic adjustment costs in a broad range of sectors. These costs can create financial risks for firms and investors that did not anticipate the transition and can ultimately jeopardize the functioning and stability of the financial system.[84]

The negative effects of physical risks[85] on real estate and agriculture sectors represent significant transmission channels for the financial sector. Residential and commercial real estate loans constitute 23 percent of total loans in the banking sector. These loans may be affected through two main channels: (a) potential changes in energy prices and, consequently, in energy consumption and financial capability of borrowers[86] due to the vulnerability of hydroelectric plants to expected reduction in precipitation and increase in flash flooding and (b) physical and social effects of acute natural hazards, such as flooding affecting vulnerable housing and building, which can also feed through to the banking and insurance sectors. In addition, agriculture finance, which accounts for 7 percent of total loans, is a major exposure of climate-related financial risk in banks. The direct impact of climate change on the economic capacity of farmers as well as spillovers in the food supply chain (food processing, packaging, processing equipment) from rising costs of production are potential micro-transmission channels to the financial sector.[87] From a macroeconomic perspective, physical risks may limit energy and agriculture supply chains, which may in turn translate into higher prices, unemployment, and lower income for households, farmers, and other sectors. All these factors could translate into increased credit losses to financial institutions.

Insurance firms will also have to incorporate these risks into their business models, as customers might seek compensation for property losses incurred from extreme climate-related events.[88] Accounting for less than 3 percent of financial sector assets, the insurance sector is underdeveloped and coverage in the country is low. However, according to the 2011 Compulsory Insurance Law, real properties and state-owned assets must be insured, including against losses arising from natural disasters.[89] As such, insurance companies will need to continuously increase their capacity for assessing and managing these risks.

Mirroring the country's economic structure, the exposure of the banking sector to climate policy relevant sectors (CPRS) suggests high vulnerability to transition-related risks.[90] In 2022, 55.4 percent of total loans were exposed to CPRS. Exposures are highest in the housing/real estate sector (23 percent of total loans), followed by energy intensive sectors[91] (13 percent), agriculture (7 percent), transport (3 percent), and fossil fuels (2 percent). The exposure also includes commercial loans (18 percent) in related sectors, such as construction materials, plumbing, food, and beverage manufacturing. A breakdown of nonperforming loans (NPLs) also illustrates that credit risks associated with key CPRS are already higher compared to non-CPRS. These credit risks are set to increase as the effects from climate change materialize.[92]

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[84] World Bank 2022c.

[85] In Azerbaijan, key physical risks include (a) stress on water resources and (b) increased frequency and severity of acute natural hazards, such as draughts and flooding in certain regions. Earthquakes, although not climate related, represent the most significant catastrophic hazard.

[86] (13 percent), agriculture (7 percent), transport (3 percent), and fossil fuels (2 percent). The exposure also includes commercial loans (18 percent) in related sectors, such as construction materials, plumbing, food, and beverage manufacturing. A breakdown of nonperforming loans (NPLs) also illustrate that credit risks associated with key CPRS are already higher compared to non-CPRS. These credit risks are set to increase as the effects from climate change materialize.

[87] It is important to note that climate physical risks are determined by the location of hazard occurrences, especially since these events are not uniformly distributed across the country. The current loan data availability does not allow for a detailed analysis of the geographical distribution of agricultural and real estate loans. At the aggregated level, roughly 19 percent of total loans were in the Shirvan-Salyan, which is province at greatest risk of floods, both in absolute and relative terms of impact to GDP, including vulnerable cities such as Shirvan, Neftetchala, and Salyany. However, the sectoral distribution of these loans is not available. The Central Aran region, which accounted for roughly 19 percent of loans as well, also had cities highly vulnerable to flooding, such as Kurdamir, Saatly, and Zardab (GFDRR 2017).

[88] More granular data are required to assess the level of exposure of the insurance sector to physical risks, particularly through several nonlife insurance classes that could be affected by physical risks, such as floods and earthquakes (motor and casualty and collision insurance, accident, and so on).

[89] Flash flooding in rural areas of Azerbaijan has resulted in the government paying out small individual sums to uninsured households in the past.

[90] The CPRS is a classification of economic activities to assess climate transition risk, first developed in the article by Battiston et al. (2017). It has been used to help assess banks' exposure to potentially vulnerable assets to transition risks. In addition, agriculture was also mentioned as one CPRS due to the relevance of the sector in Azerbaijani's GDP and lack of sectoral productivity, which might affect technology shift toward water and energy-smart processes.

[91] Manufacturing of basic iron, steel and of ferroalloy, metal structures, electronic equipment, and so on.

[92] The insurance sector is small and conservative, with limited vulnerabilities to transition risks.

At the macro level, the banking sector is highly exposed to increased fluctuations in energy markets, which can be mitigated through diversification. As highlighted in Section 4.2, Azerbaijan is at risk of losing significant oil and gas rents, translating into lower fiscal and export revenues, in light of declining production and global decarbonization efforts. With all else held constant, falling export revenues are likely to put devaluation pressure on the exchange rate. The sharp manat devaluations in 2014–2015 illustrates how Azerbaijan's currency dependence on oil prices translates into financial vulnerabilities in the banking sector, depressing economic growth. Diversifying away from fossil fuels, to ensure that export revenues are resilient to energy transition risks, will be key to mitigating this macro risk to the financial system.

To help combat climate-related risks, the CBA can accelerate efforts to promote policy coordination and awareness raising, build internal capacity, and integrate these risks into its supervisory frameworks. Key steps to be taken include the following: (a) increase CBA's engagement in government policies and plans for the climate transition, providing guidance to line ministries and overall public-private dialogues;[93] (b) strengthen data collection for more granular sectoral lending and underwriting data; (c) conduct a first climate risk assessment of Azerbaijan's financial sector; (d) coordinate with public and private actors to strengthen assessments of climate risks and identifying solutions, including potential mitigation mechanisms through state agencies, such as the Agrarian Insurance Fund and the Azerbaijan Mortgage and Credit Guarantee Fund; (e) contribute to policy dialogue on a comprehensive disaster risk financing (DRF) strategy; (f) incorporate climate risk management into its supervisory practice, including monitoring and supervisory tools as well as clarifying its expectations — either through guidelines or regulations — on climate risk management by financial institutions, using a phased approach;[94] and (g) increase knowledge and capacity in relation to climate risks, including through a mapping of knowledge gaps, participation in international networks, and knowledge-sharing events.[95]

Authorities could also explore available solutions to address these risks and leverage insurance sector contribution, to ensure a prompt recovery following a natural disaster or climate-related event. Agriculture insurance is at early stages of development, with the government taking important steps to increase coverage. Established in 2019 as a public-private initiative, the Agricultural Insurance Fund[96] provides standardized agriculture insurance to farmers, covering a wide range of crops, animals, and aquaculture against natural disasters. This mechanism should be periodically reviewed to ensure its effectiveness and continuously monitor opportunities for addressing other risks. In addition, the development of a broader DRF strategy could contribute to improvements in the protection against climate-related events.[97]

4.4. A just and inclusive transition for households and workers

The low-carbon transition will involve economic restructuring and have significant distributional implications. The transition will entail costs for firms, new skills required by workers, and economic and social adjustment costs on households. The impacts of climate change will be felt unevenly, varying by region, by sector of economic activity, and, at the micro level, by household income.

However, assessing the distributional impacts in Azerbaijan is made challenging by significant data constraints. This includes lack of access to micro data such as the labor force survey, precluding deeper analysis of transition impact on workers; the household budget survey, preventing a full analysis of equity and distributional impacts of proposed policy measures; and the firm survey, preventing a granular analysis at the firm level of the risks posed by climate change and the readiness of firms to benefit from the low-carbon transition.

This section focuses on two select distributional issues that could be examined, given existing data constraints: the labor market risks and opportunities provided by the low-carbon transition and the potential impacts of domestic decarbonization on poverty. The spatial and sectoral impacts of climate damages have been discussed in Section 4.1.

[93] Currently, the CBA is not part of the State Commission on Climate Change.

[94] The CBA is currently working on broader amendments to corporate governance regulations for the financial sector. The integration of ESG factors is among the proposed amendments.

[95] The CBA became a member of the Sustainable Banking and Finance Network (SBFN) in January 2022.

[96] Under the fund, an insurance mutual company was established by seven insurance companies operating in Azerbaijan. The capital is AZN 2.1 million (US$1.3 million). Farmers receive partial subsidies to pay for premiums, while insurance companies issue policies and transfer risks to the AIF.

[97] The strategy could consider different instruments, such as catastrophe bonds, catastrophe insurance risk pools, contingent financing, and weather-related parametric insurance.

4.4.1. Labor market implications of the low-carbon transition

Azerbaijan's economy has generated stronger employment growth over the last decade, but the oil, gas, and mineral mining sectors have not been a major source of employment. Other than a small dip during COVID-19, employment grew at a consistent rate over the last 20 years (Figure 4.13) and, since 2011, has kept pace with the growth of the working age population. The overall sectoral structure of employment has remained relatively static over two decades, with the agriculture share of employment falling only 3 percentage points (from 39 percent to 36 percent) between 2001 and 2021. However, there were significant shifts in employment in other parts of the economy. While the construction sector boom—fueled by oil and gas revenues—created substantial employment during 2001–2011, it has since slowed down sharply in the last decade. The manufacturing and services sectors both experienced strong growth in the last decade, to absorb the additional labor (Figure 4.14). Throughout this period, the oil, gas, and mineral mining sectors, which dominate economic output, have played a marginal direct role in terms of job creation, accounting for less than 1 percent of total employment. These sectors have in fact been shedding jobs in the last decade (Figure 4.14).

Although the direct impact of the low-carbon transition on Azerbaijan's formal labor market is expected to be minor, its indirect impacts may be significant. The indirect impacts of the transition are likely to be significant, given that rents from the oil and gas sector indirectly support economic activity in other economic sectors, such as trade, construction, finance, and the public sector, which have been driving employment growth (Figure 4.14).

Figure 4.13: Overall employment growth trends

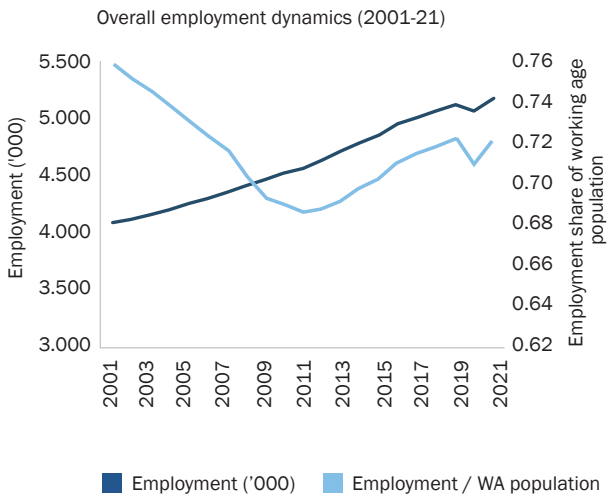
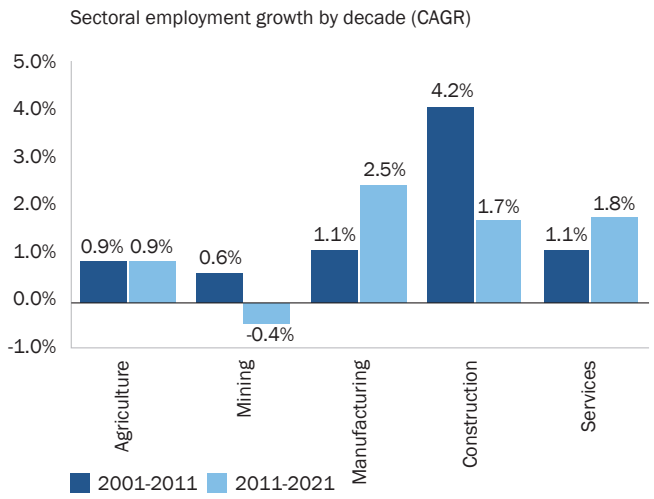


Figure 4.14: Sectoral employment growth



Source: Based on official labor statistics data.

As oil revenues decline, the resulting fiscal shortfall may put pressure on public employment levels and wages. In a global net-zero world, fiscal revenues could decline by 12 percent by 2060 compared to the BAU if Azerbaijan also fully decarbonizes ('Global net zero – Azerbaijan net zero'). This creates a challenge for public sector employment and raises overall concerns for the labor market.The public sector is accounting for more than 21.9 percent of total formal employment in 2022. Splitting by economic activity rather than property form, the combined services sector is responsible for more than 70 percent of formal employment in the same year, and government-dominated subsectors within services, including public administration, education, and health, provided an annual average of 36 percent of total formal jobs between 2015 and 2022. Counting also informal employment, the agriculture sector accounted for approximately 34 percent of employment in 2021.[98] Moreover, these sectors accounted for 32 percent of the share of compensation of employees in gross value added in the same period.

[98] Formality in this text follows the State Statistical Committee's definition of 'employment,' which describes it as persons who perform labor activity under a written contract with the employer specifying the basic conditions of employment. The opposite is understood as informality here (Website of the SSC 2023 https://www.stat.gov.az/source/labour/?lang=en).

The transition also raises risks to employment diversification. In a scenario where the world and Azerbaijan fully decarbonize ('Global net zero – Azerbaijan net zero'), the output structure of the economy is expected to shift significantly. Modeling estimates suggest that, between 2021 and 2060, labor- and emission-intensive sectors are estimated to decline in terms of real gross value added. This includes energy-intensive manufacturing such as textiles and food processing (by 23 percent) and other services such as construction (by 2.4 percent). At the same time, other sectors are estimated to expand, including carbon-free electricity (over a fivefold increase) and light manufacturing (increase by 7.7 percent).

Changing demand for skills within existing sectors will likely have a larger impact on Azerbaijan's labor market than will jobs shifts across sectors. Findings from a recent assessment of labor market impacts of the green transition in ECA[99] indicate that three times as many jobs are vulnerable to within-sector occupational shifts as are at risk from decline of 'brown' sectors. Without access to labor data in Azerbaijan, it is not possible to identify the characteristics of workers in sectors exposed to job loss or in occupations that will require upskilling. However, based on experiences from similar countries, workers in Azerbaijan's 'brown' sectors—especially oil and gas—are likely to be relatively highly skilled with transferrable skills (for example, engineering, project management) that should support a transition, especially to renewable energy and manufacturing jobs. The bigger challenge for the transition is that these sectors tend to have significant wage premiums that may not be supported in non-extractive sectors. Workers in manufacturing sectors, transport, waste management, and, especially, agriculture will likely face much larger challenges in the transition as they tend to both face larger skills gaps and have other characteristics (for example, lower income, residing in less economically dynamic regions) that will make them less resilient to the transition.

Existing labor market constraints will act as a barrier to an inclusive transition. At the higher end of the labor market, Azerbaijan faces a skills shortage that will make it difficult for firms to adjust to changing requirements from the transition, as the wage premium of the oil industry and preferences for public sector employment means that few highly educated workers seek employment beyond these sectors. At the other end of the labor market, workers face barriers to upskilling and transitioning to new opportunities. While unemployment is relatively low,[100] more than two-thirds of workers in Azerbaijan are in the informal sector,[101] mainly in low productivity jobs. Low quality of education, low tertiary enrollment, and inadequate supply of vocational training programs are main reasons for high informality and low productivity in the Azerbaijan labor market. Lack of formal employment opportunities limits workers' potential for skills development and implies that most workers in Azerbaijan (those working without formal contracts) lack access to contributory pensions and other types of social insurance that mitigate the risk of poverty at old age.[102] Rural workers, mainly involved in low-productivity agriculture are likely to face barriers related both to skills and mobility to adapt to a changing labor market resulting from climate change. Female workers, whether rural or urban, skilled or unskilled, face additional barriers due to gender gaps in activity, employment, and wages, while low levels of job creation and lack of school-to-work support services are barriers to youth participation. Recently, authorities repealed some of the job restrictions for women which is a step in the right direction in terms of addressing some of the above-mentioned gender gaps. While there are no precise data on coverage of employment and intermediation services (including training programs), it is estimated that less than 10 percent of the registered unemployed benefit from such services.

Apart from risks, the low-carbon transition may also provide opportunities for green jobs, likely to be greater at the intensive than the extensive margin. The domestic energy transition will create significant opportunities for growth of renewable energy jobs, also leveraging certain skills of Azerbaijan's oil and gas workers that could be transferable. For instance, offshore petroleum engineering skills are relevant for offshore wind development, CCS, and hydrogen. Meanwhile, thermal power plant operators and construction workers can apply their skills to clean energy power plants as well as upgrade technologies to use hydrogen, electric vehicles, and other innovative clean fuels in the future. The results in Figure 4.15 show that labor intensity of renewable energy is several times higher compared to fossil fuel energy production and substantially higher than that of the oil and gas sector. However, the scale of direct employment creation from renewable energy will remain relatively limited. Moreover, the findings from the GTN analysis suggest that Azerbaijan will face significant challenges to develop a comparative advantage in green value chains. On the other hand, transformation of

[99] World Bank 2022c.

[100] Unemployment was 4.8 percent in 2019 and rose to 6.5 percent in 2020 during the pandemic.

[101] Employment in informal sector was calculated as a share of employees with labor contracts in total employment based on Statistical Committee data.

[102] World Bank 2022a.

key natural resource sectors could offer potential to raise productivity in existing labor-intensive sectors. Crops and livestock production alone accounted for more than one in three jobs in Azerbaijan in 2021, while the fisheries sector has the highest jobs multiplier in the economy.[103] The introduction of CSA and environmentally sustainable practices in the fisheries sector could raise earnings while also safeguarding livelihoods from the impacts of climate change.

Accelerating human development plans in the near and medium term supported by social investments could facilitate labor shifts and avoid workers being left behind by the green transition. Flexible labor markets and flexible skill mixes are important to alleviate the negative impacts of the transition. Programs for motivating workers for self-learning to absorb social skills integrated with technology for the future would mitigate transition shocks. Adaptive skills and socio-emotional skills are important to smooth the transition and equip workers with new skill sets for the green sectors. In addition, it is essential to strengthen public-private partnerships to guide vocational and tertiary education with needs of the private sector, building on the efforts already under way. Targeted active labor market programs (ALMPs) (hiring incentives to firms and financial incentives for self-employment, additional cash benefits for mobility or child-care or going back to work) can be used for promotion of women's employment, transition to formal and more productive employment, upskilling and transitioning of redundant workers to alternative occupations, and employment of skilled and unskilled youth. Indeed, while targeting existing employees in upskilling/reskilling interventions, there is a significant opportunity to target inactive youth (NEET).

In addition to preparing people for new jobs through ALMPs, during the transition period, the vulnerable should be protected by social assistance and targeted services. Azerbaijan can build on a strong foundation, given recent increases in spending on social protection policies and programs, and well-developed tools for social protection, consisting of both contributory and non-contributory benefit programs. ALMPs can be used, in the short term, for on-the-job training programs focusing on target groups and, in the longer term, to strengthen links between service providers and the private sector, establish a dynamic skills inventory system for labor market developments, and disseminate skills and occupations in demand regularly. In this regard, the self-employment program that is being implemented by the government in the past several years could be utilized. Building on existing programs and systems (particularly integrated information systems), coverage of the social safety nets can be expanded to include populations who are at risk from the transition, with a clear focus on targeting safety nets to women while leveraging the leadership role they can play in local public works programs. While recent reforms in the Targeted Social Assistance have improved adequacy and decreased application processing times, relatively weak outreach at the local level, restrictive targeting/eligibility determination methodology, and application-based benefits are potential constraints against increasing coverage of the poor population. Therefore, to support and provide guidance to people during the transition period, it is necessary to improve case management tools to strengthen coordination among social protection institutions and support the creation of a single social registry system. A single social registry would allow the government to respond to the shocks and alleviate the impacts of the transition period on workers. This could be complemented by measures to strengthen social dialogue.

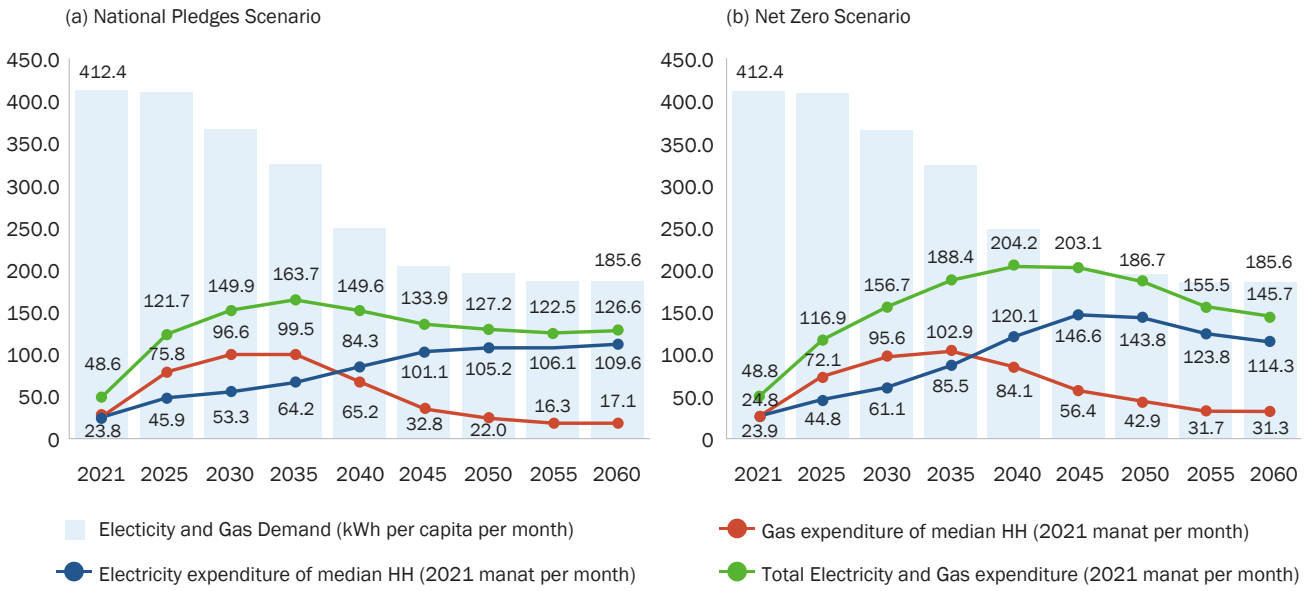
4.4.2. Implications of domestic decarbonization on poverty

In both the NDC and net-zero scenarios, energy would be more expensive for the median household despite the efficiencies brought about by the transition. While comprehensive distributional analysis is not feasible due to limited access to micro-level data, rough estimates suggest that higher prices would significantly lower gas consumption (while electricity use would increase). On aggregate, that would mean that households could use 55 percent less energy coming from electricity and gas in 2060 than in 2021 (see Figure 4.15). However, changes in prices for these commodities would mean that the household expenditure for electricity and gas is estimated to increase by 2.6 times (in the case of the NDC+/NPS) and nearly 3 times (in the case of the net-zero scenario) in 2060 compared to actual levels in 2021. A near tripling of energy costs could imply that, for a median household, given the relative difficulty of substituting energy in the consumption mix, household spending on energy could account for more than 20 percent of income by 2060 compared to 8 percent in 2021.[104]

[103] Based on data from GTAP, every US$1 million in increased demand in the fisheries sector is associated with nearly 40 direct and indirect jobs.

[104] These estimates would need to be validated through a detailed breakdown of household budget expenditures which is not currently available.

Figure 4.15: Electricity and gas consumption and expenditures for the median household by scenario

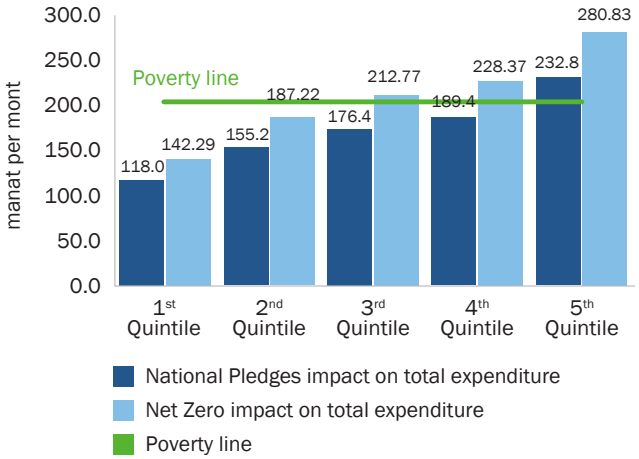


Source: Based on energy modeling.

Note: Electricity demand in kWh per capita per month is shown as bars and energy expenditures in manat per month as lines.

Some households will be at risk of falling into poverty due to greater energy costs (Figure 4.16). Although a full detailed poverty and social impact analysis is challenging due to microdata unavailability, estimations using aggregates show that both the national pledges and the net-zero scenarios would result in greater total consumption expenditures of 11–20 percent per month, depending on quintile, by 2060 relative to 2021 levels. In Azerbaijan, estimates show that the share of households' budget spent on 'water, electricity, gas, and other fuels' is progressive—meaning that the share is larger among the better-off households. However, the impact on expenditure could be AZN 118.0 and AZN 142.3 per household per month for the households in the first quintile for the national pledges and net-zero scenario, respectively. For the second quintile, national pledges would result in an impact of AZN 155.2 more per month, while net zero would result in an additional AZN 187.22 per month spent on energy. Considering that the poverty line is AZN 204.7 per month in 2021, these numbers could push some of the households in the lower quintiles into poverty. The potential impacts on poverty underscore the need for improved targeting of social protection.

Figure 4.16: Impact on total expenditure by scenario, based on greater energy costs per quintile (manat per month)



Source: Based on Envisage Energy Modeling.

Chapter 5

From Assessment to Action

Photo credit: Deniza 40x / Shutterstock.com

5.1. Aligning climate action with Azerbaijan's development objectives

This report has shown that climate action is aligned with Azerbaijan's development objectives, starting with the critical need to broaden and diversify the asset base away from the hydrocarbon sector. Policies encouraging diversification are likely to reduce the carbon intensity of the economy and, in themselves, shield the country from trade-related shocks induced by global decarbonization policies. Conversely, the introduction of domestic mitigation policies is conducive to achieving Azerbaijan's development objectives, both by capturing the opportunities of the current global decarbonization trajectory and by supporting the diversification needs. The phaseout of energy subsidies will remove distortions hindering the growth of the non-hydrocarbon economy, while the introduction of specific carbon pricing measures will further accelerate structural change away from fossil fuels. At the same time, without adaptation investments, the diversification potential of sectors such as agriculture will likely remain constrained.

Navigating the transition will entail due attention to prioritizing interventions. The recommendations below are prioritized in terms of impact and urgency. In addition to their decarbonization and resilience impact, the prioritization considers their potential to reduce macroeconomic and social risks and/or strengthen human capital. In terms of urgency, short-term actions (including no-regret measures leading to aggregate economic gains and those that cannot be postponed despite their additional costs, because, for instance, of the need to avoid lock-in or stranded assets) are prioritized over long-term interventions which can be delayed at limited to no cost, for instance, because of the expected decline in technology costs. Policy recommendations are also screened in terms of institutional readiness for implementation, providing an indication of whether the current policy and institutional frameworks, human capital stocks, fiscal capacities, and enabling private investment environment are considered currently adequate to support implementation or whether actions are needed to strengthen these. Table 5.1 summarizes the prioritization criteria.

Table 5.1: Criteria for Prioritizing and Sequencing of Recommended Policy Actions

	Dimension	Description
Development impact	Human Capital	• Impact on poverty reduction • Potential for employment generation
	Economic Growth	• Relevance to growth as measured by contribution to GDP
	Natural Capital	• Conservation and restoration impact
Climate impact	Mitigation	• Impact on emission reduction • Potential for lock-in into assets that may become stranded assets
	Resilience	• Reduced vulnerability to climate risks • Enhanced adaptive capacity
Implementation readiness	Enabling Architecture	• Adequacy of policy framework • Adequacy of institutional framework • Technology availability
	Financing	• Impact on fiscal burden • Attractiveness to private sector

Source: World Bank.

Table 5.2 summarizes policy recommendations and their underpinning policy actions, which are then elaborated further in Sections 5.1.1–5.1.3. For each recommendation, shaded circles depict the priority and readiness level of the policy package against the sub-criteria detailed in Table 5,2 (green indicates large impact/readiness). Policy sequencing is indicated through (a) short-term policy actions envisaged to be initiated and/or implemented within the next two years leading up to 2025/2026 and (b) medium-term policy actions be initiated and/or implemented within the subsequent five years, or up to 2029/2030. Where applicable, the table indicates to which priority action in the 2022–2026 SEDS the recommendation is aligned.

Table 5.2: Summary of CCDR policy recommendations

Recommendation	Priority policy actions	Prioritization and readiness	
Policy Package A: Aligning Institutions, Policies, Incentives, and Financing to Scale Up Climate Actions			
Strengthen institutions for economywide decarbonization and resilience planning	*Short-term:* • Mainstream a climate perspective into the overall strategic and planning direction of the country's development • Empower the State Commission on Climate Change to ensure the results of such planning informs the next generation of strategic documents • Build on the CCDR modeling to develop robust integrated assessments of Azerbaijan's resilience and decarbonization pathway • Further build capacity within key institutions including CBA and Ministry of Finance (MOF) • Support financial sector readiness for green financing • Foster support for the transition among the private sector and the public • Strengthen the fiscal policy framework to ensure that temporary short-term windfalls resulting from higher global energy prices are saved for later periods *Medium-term* • Implement structural reforms to ease private sector constraints, including improving access to skills, enhancing access to finance, promoting competition and competitive neutrality between SOEs and the private sector, and improving the investment climate	●●● **Development**	●●○ **Human Capital** ●●● **Growth** ●●● **Natural Capital**
		●●● **Climate**	●●● **Mitigation** ●●● **Resilience**
		●●○ **Readiness**	●●○ **Enabling Architecture** ●●○ **Financing**
Policy Package B: Accelerating the Clean Energy Transition in Energy, Transport, and Digital Infrastructure			
Implement energy pricing reforms and establish well-functioning energy markets, while providing targeted protection to the vulnerable	*Short-term:* • Adopt cost-reflective pricing of electricity and natural gas (aligned with SEDS Activity 5.2.1) by ensuring targeted social protection • Initiate gradual liberalization of electricity market (SEDS Activity 5.2.1) • Strengthen regulatory institutions (SEDS Activity 5.2.1) • Increase fuel levies and other environmental taxes to EU levels *Medium-term:* • Initiate gradual liberalization of natural gas market (SEDS Activity 5.2.1) • Gradually but steadily phase out implicit fossil fuel subsidies by raising prices for petroleum, natural gas, and electricity to export parity, by ensuring the social acceptability of reforms • Pursue targeted social protection measures in parallel to price reforms, in combination with broader strengthening of the social protection system (including data, capacity, targeting, and so on) (SEDS Activity 2.2.1) • Pilot carbon taxation, with revenue recycling to help vulnerable and low-income groups	●●● **Development**	●○○ **Human Capital** ●●● **Growth** ●●● **Natural Capital**
		●●● **Climate**	●●● **Mitigation** ●○○ **Resilience**
		●○○ **Readiness**	●○○ **Enabling Architecture** ●●○ **Financing**

Table 5.2

Recommendation	Priority policy actions	Prioritization and readiness	
Invest in publicly funded enabling infrastructure and strengthen policy frameworks for private clean energy, transport, and digital infrastructure investment	*Short-term:* • Update the mapping of solar and onshore wind resource potential, also taking into account the potential impact of climate change • Strengthen planning capacity for renewable energy development and grid integration (aligned with SEDS Activity 5.2.3) • Demonstrate bankability of investment frameworks for renewable energy investments and gradually refine policies and regulations • Develop a roadmap to leverage clean energy potential in Azerbaijan to attract investment in Green Data Infrastructure *Medium-term:* • Transition from bilateral agreements for renewable energy investments to competitive selection and price discovery (SEDS Activity 5.2.3) • Develop and implement a national transmission grid modernization program to enable the grid to evacuate, integrate, and eventually export renewable electricity (SEDS Activity 5.2.3) • Roll out charging infrastructure for electric mobility (SEDS Activity 5.2.5) • Expand and modernize the rail network (SEDS Activity 1.1.17)	●●● **Development**	●●● **Human Capital** ●●● **Growth** ●●○ **Natural Capital**
		●●● **Climate**	●●● **Mitigation** ●●○ **Resilience**
		●●● **Readiness**	●●○ **Enabling Architecture** ●●● **Financing**
Develop programs to scale up energy efficiency and electrification in the industry, building, transport, and digital sectors	*Short-term:* • Scale up recently approved EE fund (aligned with SEDS Activity 5.2.6) • Set up national program for public building energy efficiency (SEDS Activity 5.2.6) • Enhance EE standards for buildings and industry (SEDS Activity 5.2.6) • Raise fuel efficiency standards for vehicles (SEDS Activity 5.2.5) • Provide incentives for the replacement of old vehicles (SEDS Activity 5.2.5) • Support improvements in the efficiency of freight transport operations (SEDS Activity 1.1.11) • Leverage public procurement for the electrification of the government vehicle fleet, with adequate charging infrastructure (SEDS Activity 5.2.5) • Incentivize upgrade of digital connectivity infrastructure from copper-based networks to low energy consuming modern fiber-optic-based connectivity networks (SEDS Activity 1.1.8) *Medium-term:* • Provide incentives for private sector building energy efficiency including electrification of heating through heat pumps (SEDS Activity 5.2.6) • Provide incentives for electric or fuel-cell vehicles (SEDS Activity 5.2.5)	●●● **Development**	●●● **Human Capital** ●●○ **Growth** ●●● **Natural Capital**
		●●● **Climate**	●●● **Mitigation** ●●○ **Resilience**
		●●○ **Readiness**	●●○ **Enabling Architecture** ●●○ **Financing**

Table 5.2

Recommendation	Priority policy actions	Prioritization and readiness	
Upgrade natural gas infrastructure to reduce methane emissions and enable the blending with clean gas and hydrogen	*Short-term:* • Reform natural gas grid tariffs to allow for sufficient cost recovery of investments in grid modernization (SEDS Activity 5.2.1) • Reduce methane emissions in the natural gas grid, especially in gas distribution (SEDS Activity 5.2.2) • Develop an MRV system and reduce fugitive emissions from the oil and gas industry *Medium-term:* • Upgrade the gas grid to accommodate high-blend shares of clean gas and hydrogen	**Development**	**Human Capital** **Growth** **Natural Capital**
		Climate	**Mitigation** **Resilience**
		Readiness	**Enabling Architecture** **Financing**
Pilot programs for clean gas and green hydrogen (power-to-X) for use in hard-to-abate applications in power generation, industry, and transport	*Short-term:* • Assess resources (including renewable energy and CCS potential) and evaluate infrastructure needs under different development scenarios (SEDS Activity 5.2.5) • Build in-country human resources and technological capacity, in conjunction with the private sector *Medium-term:* • Initiate selected pilot investments, starting with smaller-scale pilot projects by the end of the decade followed by larger-scale pilot projects in the 2030s (SEDS Activity 5.2.5)	**Development**	**Human Capital** **Growth** **Natural Capital**
		Climate	**Mitigation** **Resilience**
		Readiness	**Enabling Architecture** **Financing**
Policy Package C: Future-Proofing the Agriculture-Food-Water Nexus			
Reform agricultural subsidies and mainstream CSA practices	*Short-term:* • Support knowledge transfers and extension systems to be upgraded rapidly (in terms of skills and reach) • Enhance access to finance particularly for SMEs and small producers towards the adoption of climate smart agriculture practices *Medium-term:* • Adopt soil and land planning management practices to protect soil health • Strengthen agro-climatic forecast systems and research and development (R&D) for climate resilient technologies	**Development**	**Human Capital** **Growth** **Natural Capital**
		Climate	**Mitigation** **Resilience**
		Readiness	**Enabling Architecture** **Financing**
Invest in energy-efficient, water-efficient and low-carbon solutions for agriculture and livestock	*Short term:* • Develop incentive packages towards resilience and mitigation measures (for example, solar power pumping, biogas production, water efficiency measures, improved feeds) • Pilot farms and best-practice sharing	**Development**	**Human Capital** **Growth** **Natural Capital**
		Climate	**Mitigation** **Resilience**
		Readiness	**Enabling Architecture** **Financing**

Table 5.2

Recommendation	Priority policy actions	Prioritization and readiness	
Increase the adaptation and resilience capabilities to face climate and geophysical risks through the implementation of DRF instruments and insurance provision	*Short-term* • Develop a comprehensive DRF strategy • Establish a reserve fund to finance emergency response costs and reconstruction efforts, • Strengthen public asset insurance to reduce the government's liabilities in the event of a catastrophe • Expand Agricultural Insurance Fund to cover climate risks • Encourage uninsured low-income households to insure assets against key risks	●●● **Development**	●●● **Human Capital** ●●● **Growth** ●●○ **Natural Capital**
		●●● **Climate**	●●○ **Mitigation** ●●● **Resilience**
		●●○ **Readiness**	●●○ **Enabling Architecture** ●●○ **Financing**
Rehabilitate and modernize hydraulic infrastructure	Short-term: • Invest to improve efficiency and reduce water losses (lining of conveyance canals, improvement of drainage) • Invest to improve the spatial and hydrological distribution of storage, (construction and/or rehabilitation of medium and small reservoirs) • Build capacity for planning, delivering, and operating the investments Medium-term: • Introduce a spatial hydro-economic simulation model • Deploy decentralized smart water and irrigation management information systems (MISs) • Establish a regulatory system based on mutual accountability between the Amelioration Agency and WUAs	●●● **Development**	●●○ **Human Capital** ●●○ **Growth** ●●● **Natural Capital**
		Climate ●●●	●●○ **Mitigation** ●●● **Resilience**
		Readiness ●○○	●●○ **Enabling Architecture** ●○○ **Financing**
Intensify regional coordination on transboundary catchments	*Short-term:* • Establish protocols of information exchange with neighboring countries *Medium-term:* • Establish common monitoring of transboundary water resources, shared projections of expected impacts on transboundary water flows	●●● **Development**	●●○ **Human Capital** ●●● **Growth** ●●● **Natural Capital**
		●●○ **Climate**	●○○ **Mitigation** ●●● **Resilience**
		●●○ **Readiness**	●●○ **Enabling Architecture** ●●○ **Financing**

Source: World Bank.
Note: Where applicable, brackets behind a recommendation refer to the related activity planned in Azerbaijan's SEDS for 2022–2026.

5.1.1. Aligning institutions, policies, and financing to scale up climate actions

Recommendation 1: Strengthen institutions for economywide decarbonization and resilience planning. Azerbaijan's recent strategic documents do not account for the full scale of the decarbonization and adaptation challenges facing the country. A first no-regret step is to build on the CCDR modeling to strengthen economywide planning and develop robust integrated assessments of Azerbaijan's economy. Such planning exercises take time and should be started as soon as possible to provide a solid foundation for future targets and policies across all sectors of the economy. This includes setting fiscal targets and strengthening the existing institutions for fiscal management to ensure that any temporary short-term windfalls resulting from higher global energy prices are saved and invested for later periods. Mainstreaming a climate perspective within the overall strategic and planning direction of the country's development will allow the country to better minimize economic and social risks and capture the opportunities for decarbonization and resilience. Capacity exists within key institutions such as the CBA and MOF, although tools and skills need to be upgraded to increase capacities. The State

Commission on Climate Change should be empowered to ensure the results of such planning will need to inform the next generation of strategic documents. In the medium term, to enable a vibrant private sector in the non-oil and gas sectors, Azerbaijan should continue to implement a structural reform agenda, focused on improving access to finance, ensuring that skills supply is meeting the evolving demand of the private sector, promoting competition, and leveling the playing field for SOEs and the private sector.

5.1.2. Accelerating the clean energy transition in energy and transport

Recommendation 2: Implement energy pricing reforms and initiate the transition to competitive energy markets, while providing targeted protection to the vulnerable. Electricity and natural gas tariffs are currently well below their economic costs, due to the presence of significant implicit fiscal subsidies. Considering the current energy sector revenues windfall, Azerbaijan is well placed to move forward with the subsidy phaseout, as international experience shows that successful pricing reforms are implemented when fiscal pressures are low. A gradual but steady fossil fuel subsidy phaseout by 2030, followed by the introduction of economywide carbon pricing of at least US$25 per tCO_2 by 2035 (to be increased in the following decades) is the economically most efficient path to remove existing economic distortions and incentivize clean energy generation, energy efficiency, and the adoption of cleaner technologies in end use sectors. This entails the gradual deregulation of natural gas, electricity, and fuel prices and the strengthening of regulators and market mechanisms in price setting. The wholesale electricity market reform roadmap currently under development is a critical first step and can serve as role model for other parts of the energy sector. In transport, gradually aligning fuel prices closer to international benchmarks and adjusting fuel levies and other environmental taxes to EU levels provide first steps. However, due to their distributional impacts and social inclusion risks, fuel pricing reforms will need to be implemented in conjunction with targeted social protection measures. While recent social assistance reforms have achieved efficiencies, institutional bottlenecks still prevent adequate targeting, including the lack of adequate data. The creation of a single social registry would allow an accurate response to shocks and the alleviation of transition impacts on households and workers, contributing to achieving the targets set under Activity 2.2.1 (Developing additional social protection opportunities for low-income and vulnerable groups) of the 2022–2026 SEDS. Revenue recycling measures aimed at alleviating the tax burden on production factors, including labor, are central to pricing reforms, by providing direct benefits through additional employment and indirect benefits through improved access to social assistance benefits. The pace and sequencing of reforms, as well as a comprehensive understanding of impacted stakeholders and segments, are central to their success. Moreover, effective communications that galvanize behavioral change can make unpopular reforms more palatable, particularly at times of widespread government mistrust and legitimacy deficits. These recommendations are aligned with the actions outlined under Activity 5.2.1 (Improving regulation and liberalizing the energy sector as needed) of the 2022–2026 SEDS.

Recommendation 3: Invest in publicly funded enabling infrastructure and strengthen policy frameworks for private clean energy, transport, and digital infrastructure investment. Exploiting Azerbaijan's abundant renewable energy resources at scale (in line with the goals of Activity 5.2.3 of the 2022–2026 SEDS) will require substantial public investment in enabling electricity infrastructure and private investment in renewable generation and energy efficiency, which could also be unlocked through target use of public-private partnerships. To support variable renewable energy integration (which will have to reach 50 percent of total generation in the NPS and more than 90 percent in the NZS by 2060), Azerbaijan will need to establish an appropriate legal and regulatory framework, clear grid connection rules and codes, dispatch priorities, and curtailment rules, as well as support investments in strengthening the power transmission grid to accommodate larger shares of renewable energy. Reskilling and upskilling programs will be critical to leverage the existing human capital stock that the country requires to achieve the transition. In the transport sector, public investments will be required to accelerate the rollout of charging infrastructure for privately financed electric vehicles and the expansion of the rail network, which are actions included respectively under Activity 5.2.5 (Expanding the use of environment-friendly transport and other green technologies for climate action) and Activity 1.1.17 (Re-vamping the road infrastructure) of the 2022–2026 SEDS. In terms of digital infrastructure, the public sector can prioritize greening its planned data infrastructure investments through the use of renewable energy and clean energy sources in their operations as well as by adopting the role of a strategic purchaser (through public procurement) of capacity from private sector developers and operators of data centers with clear policy guidelines around their energy efficiency, consumption, and sources. With regard to institutional readiness, the government's declared intention to develop a national program for power grid strengthening and a strategy to support the deployment of electric vehicle charging stations is a step in the right direction, and there is clear responsibility allocated to the line ministries for energy and transport. However, implementing these investments will require careful planning and strengthened institutional capacity in the respective departments.

Recommendation 4: Develop programs to scale up energy efficiency and electrification in the industry, building, transport, and digital sectors. As shown by the modeling, even in the NPS, more than half of the incremental GHG emission reduction to be achieved compared to the BAU scenario will have to come from energy efficiency improvements. The Government of Azerbaijan has made energy efficiency a national priority in the 2022–2026 SEDS, under Activity 5.2.6 (Ensuring energy efficiency). As a first step, a program of energy efficiency in public buildings should be implemented, to serve as a basis for the subsequent rollout to the entire buildings sector. This rollout should involve stricter efficiency and emission standards, financial support programs (for example, grants, tax incentives, subsidized lending terms), strategic communication, and awareness campaigns. In industry, the focus of government should be on getting energy prices 'right' by removing subsidies, combined with standards and mandates for efficient products and processes. In the power sector, the focus should be on upgrading the power plants that have not been rehabilitated yet to increase their efficiency and limit emissions. In terms of institutional readiness, the government has recently approved the creation of an energy efficiency fund and is planning on launching an energy efficiency program for public buildings. However, the residential energy efficiency and sustainable heating markets have been historically difficult to develop at scale, even in more advanced economies. In the transport sector, steep increases of fuel efficiency standards, incentives for the replacement of old internal combustion engine vehicles, and improvements in the efficiency of freight transport operations (for example, systems to improve fleet management and increase the load factor, provision of intermodal connections) are priorities. The government has implemented tax breaks for electric vehicles, but the large-scale adoption of clean vehicles will require additional financial incentives and tighter emission standards. These recommendations related to the transport sector are aligned with the actions outlined under Activity 5.2.5 (Expanding the use of environment-friendly transport and other green technologies for climate action) of the 2022–2026 SEDS. In the short to medium term, biofuel blending mandates can support GHG emission reductions while electrification picks up. At the initial stages, to create markets for private sector uptake, the government should consider leveraging public procurement for the electrification of the government vehicle fleet and the installation of charging stations in public buildings.

Recommendation 5: Upgrade natural gas infrastructure to reduce methane emissions and enable the blending with clean gas and hydrogen. In all modeling scenarios, natural gas, increasingly blended with clean gas and hydrogen, will continue playing a role in Azerbaijan's energy mix to supply hard-to-abate applications and balance variable renewable generation. To fulfill this role, the gas infrastructure will need to be upgraded to meet the current supply levels with lowest-possible methane emissions and, in the medium term, to accommodate high-blend shares of clean gas and hydrogen. In the NZS, in 2060 synthetic methane, biogas, and green hydrogen could account for about 80 percent of total piped gas. The modernization of the gas infrastructure is also predicated by Activity 5.2.2 (Improving the performance of the country's gas and heat supply systems and ensuring reliable supply) of the 2022–2026 SEDS. When planning for these investments over the next decade, Azerbaijan will need to carefully monitor sector trends and technological developments to avoid stranded assets. In terms of financing, current natural gas tariffs are insufficient to adequately cover investment costs for grid modernization. In recent years, Azerbaijan has implemented some institutional reforms at Azerigaz and the company now has a focused mandate (serving the domestic gas market) and, as a wholly owned subsidiary, can draw on financial and human resources from SOCAR to modernize its planning, investment management, operation, and maintenance. However, without tariff reforms, economically attractive investments will not be implemented, even when limiting this to investments that are economic at (implicitly) subsidized prices. This affects investments to reduce the still very high levels of gas leakage as well as long-term investments to prepare and eventually transition the gas grid to low-carbon energy carriers.

Recommendation 6: Pilot programs for clean gas and green hydrogen (power-to-X) for use in hard-to-abate applications in power generation, industry, and transport. Initial analyses indicate that with its large offshore wind potential, Azerbaijan can produce clean gas or green hydrogen from renewable energy. The results of the GES show that Azerbaijan could export 50 TWh of green hydrogen per year by 2060, increasing its energy exports by about 15 percent (in terms of energy content) compared to the NZS. It is hard to predict how fast the technologies for the production of synthetic methane, green hydrogen, and other low-carbon carriers will evolve over the next decades and what levels the global demand for these fuels will reach. Over the next few years, Azerbaijan should therefore continue monitoring the technological developments and market trends while laying the groundwork for the development of value chains for low-carbon energy carriers. This will include (a) identifying needs for the expansion of the existing energy infrastructure (for example, international power transmission interconnections such as the Black Sea submarine cable and gas pipelines that could absorb increasing levels of low-carbon energy carriers), (b) developing the human capital that will be required to support the clean energy transition and especially the deployment of clean gas and green hydrogen technologies (for example, engineers, specialized construction workers, and technicians); and (c) initiating selected pilot investments targeting the

most promising technologies and adopting fair risk sharing mechanisms between the public and private sectors. For example, the government has established contacts with private sector players active in renewable energy to kickstart discussions on hydrogen development in the country. However, a detailed study is recommended to assess the potential for the development of green energy exports, the role the government should play, and the prospects for a domestic hydrogen industry and hydrogen markets in electrified transport, industries, and heating. Plans to explore the hydrogen production and utilization potential and develop pilot projects are also included in the 2022–2026 SEDS, under Activity 5.2.5 (Expanding the use of environment-friendly transport and other green technologies for climate action).

5.1.3. Future-proofing the agriculture-water nexus

Recommendation 7: Reform agricultural subsidies and mainstream CSA practices. To be transformative, the uptake of CSA practices will need to go beyond large agricultural farms and reach SMEs as well as small farmers. Knowledge transfers and extension systems should be upgraded rapidly not only in terms of skills but also to extend their reach, and access to finance for SMEs and small producers toward the adoption of CSA practices should be enhanced. In addition to awareness raising and skilling of farmers, to incentivize buy-in, government subsidies to the sector (currently pegged to the size of farmed areas) could be partly earmarked for CSA inputs—at least in the first stage and with a view to also creating viable markets for CSA technologies (both equipment and other materials such as seed) and later linked to actual adoption, based on specific service performance indicators. The impact of subsidy schemes could be leveraged by introducing specific financing schemes and appropriate credit instruments in partnership with rural finance institutions. The successful rollout of CSA practices will furthermore require a strengthening of agro-climatic forecast systems and agricultural extension capacities. Developing harvest-forecasting methodologies is critical to strengthening R&D for climate-resilient technologies as well as extension systems responsible to facilitate their adoption by small farmers. Beyond new crop adoption, agricultural extension should target the on-farm deployment of modern but established technologies such as drip irrigation, satellite monitoring of agro-climatic conditions to enhance input efficiency, the introduction of high-quality breeds lowering methane output per unit, and sustainable fodder production. Improved soil and land planning management practices are required to protect soil health and avoid productivity losses from land degradation and soil erosion—for example, windbreaks around croplands help control soil erosion, improve crop quality, and enhance yields.

Recommendation 8: Invest in energy-efficient, water-efficient, and low-carbon solutions for agriculture and livestock. Solutions to lower the carbon intensity of agriculture include solar power pumping and biogas production as well as water efficiency measures which will deliver important adaptation and mitigation gains given the current energy intensity of the hydraulic system. Selected opportunities for energy efficiency investments to reduce GHG emissions can also strengthen the sector's productivity, for example, satellite monitoring to enhance input efficiency. Measures to enhance animal husbandry and livestock support services should include GHG mitigation technologies to reduce enteric fermentation through improved feeds, interventions to minimize wind-induced soil erosion (windbreaks), biogas production, and improved manure management. These measures are proven to reduce GHG emissions per unit of livestock while also enhancing productivity, yet additional incentive packages toward combined resilience and mitigation measures in the livestock sector may be needed.

Recommendation 9: Increase the adaptation and resilience capabilities to face climate and geophysical risks through the implementation of DRF instruments and insurance provision. Critical measures include the development of a comprehensive DRF strategy and the establishment of a reserve fund to finance emergency response costs and reconstruction efforts, together with the strengthening public asset insurance to reduce the government's liabilities in the event of a catastrophe. DRF instruments can help reduce 100-year return period government liabilities by up to US$200 million and can reduce the ratio of government liabilities to GDP from almost 0.5 percent to 0.25 percent. In parallel, an expansion of agricultural insurance to cover climate risks is required to protect farmers. The full operationalization of the Agricultural Insurance Fund has put in place further ex post support procedures and proactive measures aimed at introducing differentiation by types of crops and geographical location. However, neither climate change scenarios nor climate-related loss-damage projections are currently considered when determining prioritization. Beyond the agricultural sector, legislation to encourage uninsured low-income households to insure their assets, starting with their homes, against flood risk appears critical.

Recommendation 10: Launch a long-term program of rehabilitation and modernization of hydraulic infrastructure. Increasing the adaptation and resilience capacity needs investments starting from lining of conveyance canals, expansion, and improvement of drainage (to reclaim salinized areas) and extension of

sprinklers. Also, resilience investments should also focus on improving the spatial and hydrological distribution of storage including through the construction and/or rehabilitation of medium and small reservoirs through a national-level prioritization of investments. The rehabilitation and modernization of infrastructure will reduce water losses and improved efficiency at all levels and improve water distribution to crops, a key factor for agricultural productivity gains. The efficiency and effectiveness of investments in the modernization of the country's hydraulic infrastructure (reservoirs, canals, intakes) will depend on adequate capacities for planning, delivering, and operating the investments. Building the capacity of stakeholders involved in water storage, conveyance, and on-farm operation (Water Resources Agency, Amelioration, and WUAs also based on management-oriented information systems is key. Key measures include introducing a hydro-economic simulation model based on a geographic representation of the overall water infrastructure, deploying decentralized smart water and irrigation MISs, improving managerial capacities for water storage infrastructure, establishing a regulatory system based on mutual accountability between the Amelioration Agency and WUAs, and enhancing the role of women within WUAs. This is complemented by the need for private and blended finance for modernizing of urban and industrial water use infrastructure.

Recommendation 11: Intensify regional coordination on transboundary catchments. Azerbaijan has signed the 1992 United Nations Economic Commission for Europe (UNECE) Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) and actively coordinates with neighbors on transboundary water policy. Current coordination mechanisms are likely to come under strain without proactive action based on an informed understanding of expected impacts on water quality and availability and measures planned by respective countries. Establishing protocols of information exchange with neighboring countries based on common monitoring of transboundary water resources and shared projections of expected impacts on transboundary water flows would consolidate current cooperation mechanism and prepare them for future shocks.

5.2. Meeting the climate finance gap

Decarbonizing the economy beyond power generation would require significant investments across all sectors. The analysis showed that to achieve net zero by 2060, Azerbaijan would have to invest in the energy system US$7.9 billion over 2022–2030 and US$28.1 billion during 2022–2060 (discounted). In the transport sector, most of the incremental investment is in private mobility, particularly electric vehicles. Among the low-carbon electricity generation technologies, most of the investment would have to go to wind offshore and solar. The incremental investment by 2060 is equivalent to about 2.1 percent of the cumulative discounted GDP.

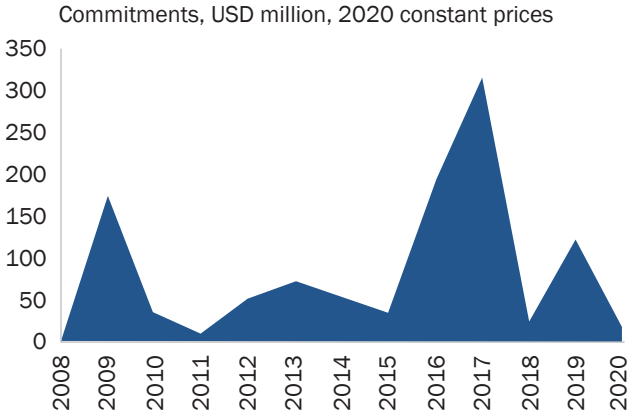
Achieving resilience in the water and agriculture sectors will also entail large investments. The total estimated cost of resilience investments until 2060 is US$16 billion (discounted), which is equivalent to about 2 percent of the cumulative discounted GDP. These estimates cover investments in maintenance, development, and redevelopment of reservoirs, canals, and deployment of other irrigation infrastructure both on-farm and off-farm. This would come alongside the sizable additional sector investments (US$2.9 billion) already foreseen to be allocated to storage infrastructure in the liberated territories.

Mobilizing this level of investment will require an ambitious economywide policy agenda to attract private sector investments. While a range of measures for both decarbonization and resilience will need to be supported by public resources (starting with energy system strengthening to enable RES penetration or consolidation and maintenance of the current hydraulic infrastructure), a larger share (renewable energy investments and CSA adoption) can and should be resourced from commercial and private sector financing. The potential private investment volumes toward decarbonization could reach as much as 70 percent of the total, while the private sector share for resilience investments is likely to remain about 10 percent of the total.

So far, clean energy projects have been financed with a combination of balance sheet equity from Azerbaijani entities and some debt raised from local state-owned banks. This was only possible due to the modest size of the projects, mostly onshore wind and solar. It is unlikely that the domestic market will be able to cover the debt required for large projects at cost-effective rates. Azerbaijan's successful track record of private investment in energy has been focused on upstream oil and gas targeting export markets, while domestic private sector participation has been marginal. As to investments in adaptation and resilience, private sector participation remains minimal. Bankable regulatory frameworks are needed for private investment to flow at scale for both domestic clean energy development and resilience. Azerbaijan is already familiar with the use of equity instruments such as public-private partnerships in the oil and gas sectors, which could be applied to clean energy projects. Complementarily, green debt instruments such as bonds and securities can be issued either by public or private actors.

Meeting the financing gap will entail developing the local sustainable finance ecosystem and leveraging additional multilateral climate finance. Azerbaijan is eligible for support from climate-focused grants and concessional facilities.[105] However, to this day, the footprint of international financial institutions (IFIs) in Azerbaijan is limited. In general, projects financed across sectors in recent years by IFIs have lacked an explicit focus on fostering decarbonization and resilience. As a result, even when factoring in support from bilateral development partners, overall levels of climate finance to the country remain well below needs. By fostering the development of a local sustainable finance ecosystem, Azerbaijan can get access to a suite of financial instruments in local currency that can complement each other on supporting both climate change mitigation and adaptation. Local financial instruments, such as green equity, green and social bonds, and green loans, can be complemented with international support in the form of concessional finance, blended finance, technical assistance, and guarantees from multilateral development banks (MDBs) and IFIs, to support projects and technologies with different levels of risk (see Section 3.1.5 for a discussion about private capital and risk).

Figure 5.1: Total climate-related development finance to Azerbaijan, 2008–2020



Source: OECD/DAC based on Rio Markers calculations.

[105] Such as the Global Environment Facility (GEF), Green Climate Fund (GCF), and Climate Investment Funds (CIFs).

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