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COUNTRY CLIMATE AND DEVELOPMENT REPORT

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Acronyms

AAC	Annual Allowable Cut
AAL	Average Annual Loss
AFOLU	Agriculture, Forestry, and Other Land Use
AMA	Accra Metropolitan Assembly
ANS	Adjusted Net Savings
APC	Annual Performance Contract
ASP	Adaptive Social Protection
BAU	Business as Usual
BESS	Battery Energy Storage System
BoG	Bank of Ghana
BRT	Bus Rapid Transit
CBAM	Carbon Border Adjustment Mechanism
CBT	Climate Budget Tagging
CCDR	Country Climate and Development Report
CCS	Carbon Capture and Storage
CGE	Computable General Equilibrium
CMMP	Capital Markets Master Plan
COP	Conference of Parties
CPAT	Carbon Pricing Assessment Tool
CPEIR	Climate Public Expenditure and Institutional Review
CRLCD	Climate Resilient and Low-Carbon Development
CREMA	Community Resource Management Area
CSA	Climate-Smart Agriculture
CSAIP	Climate-Smart Agriculture Investment Plan
CSIR	Council for Scientific and Industrial Research
CSO	Civil Society Organization
DMO	Debt Management Office
DRM	Disaster Risk Management
EC	Energy Commission
EDGE	Excellence in Design for Greater Efficiencies
EPA	Environment Protection Agency
ESRP	Energy Sector Recovery Program
ESIA	Environmental and Social Impact Assessment

EU	European Union
EWS	Early Warning System
FC	Forestry Commission
FCV	Fragility, Conflict, and Violence
FDI	Foreign Direct Investment
FIP	Forest Investment Program
FMIS	Forest Management Information System
G-CARP	Ghana Climate Ambitious Reporting Program
GAR	Greater Accra Region
GCAM	Global Change Analysis Model
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIFMIS	Ghana Integrated Financial Management Information System
GMet	Ghana Meteorological Agency
GNI	Gross National Income
GPP	Green Public Procurement
GPS	Global Positioning System
GWCL	Ghana Water Company Limited
HSD	Hydrological Services Department
ICZM	Integrated Coastal Zone Management
IT	Information Technology
IWRM	Integrated Water Resource Management
KPI	Key Performance Indicator
LEAF	Lowering Emissions by Accelerating Forest Finance
LEAP	Livelihood Empowerment Against Poverty
LED	Light-Emitting Diode
LIPW	Labor-Intensive Public Works
LPG	Liquified Petroleum Gas
LUCF	Land Use Change and Forestry
LTS	Long-Term Strategy
LMI	Lower Middle Income
MAAP-ITR	Mitigation Action Assessment Protocol
MAI	Mean Annual Increment
MDAs	Municipal and District Assemblies
MESTI	Ministry of Environment Science, Technology, and Innovation
MLNR	Ministry of Lands and Natural Resources

MMDAs	Metropolitan, Municipal, and District Assemblies
MOF	Ministry of Finance
MSME	Micro, Small, and Medium Enterprise
MTEF	Medium-Term Expenditure Framework
MTS	Modified Taungya System
MRV	Monitoring, Reporting, and Verification
MSW	Municipal Solid Waste
NADMO	National Disaster Management Organization
NbS	Nature-based Solutions
NCCC	National Climate Change Committee
NCCP	National Climate Change Policy
NDC	Nationally Determined Contribution
NDPC	National Electrification Scheme
NENRC	National Environmental and Natural Resources Council
NES	National Electrification Scheme
NGFS	Network for Greening the Financial System
NGO	Non-Governmental Organization
NMVOCs	Non-Methane Volatile Organic Compounds
NPA	National Petroleum Authority
NPL	Non-Performing Loan
NPV	Net Present Value
NRECCU	Natural Resources, Environment, and Climate Change Unit
O&M	Operations and Maintenance
ODA	Overseas Development Assistance
PES	Payment for Ecosystem Services
PFM	Public Financial Management
PIM	Public Investment Management
PIPWC	Public Investment Program Working Committee
PM	Particulate Matter
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PV	Photovoltaic
RCP	Representative Concentration Pathway
R&D	Research and Development
REDD	Reducing Emissions from Deforestation and forest Degradation[1]

[1] REDD+ refers to Reducing Emissions from Deforestation and forest Degradation and fostering conservation, sustainable management of forests, and enhancement of forest carbon stocks.

ROI	Return on Investment
SBPs	Sustainable Banking Principles
SDG	Sustainable Development Goal
SEC	Securities and Exchange Commission
SIGA	State Interests and Governance Authority
SME	Small and Medium Enterprise
SOE	State-Owned Enterprises
SOP	Standard Operating Procedure
SOR	State Ownership Report
STEM	Science, Technology, Engineering, and Mathematics
SSI	Social Sustainability and Inclusion
SWAT	Soil and Water Assessment Tool
TA	Technical Assistance
TOD	Transit-Oriented Development
TVET	Technical and Vocational Education and Training
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VRE	Variable Renewable Energy
WAPP	West African Power Pool
WASH	Water, Sanitation, and Hygiene
WBG	World Bank Group
WRC	Water Resources Commission

Bierd's-eye view of Kwame Nkrumah Circle area and Interchange. Photo: © World Bank

Executive Summary

Executive Summary

Ghana has achieved major development gains over the past three decades, but progress has slowed and there are causes for concern going forward. The economy has become more reliant on natural resource extraction and poverty reduction and job creation have slowed.[2] Ghana has not fully managed to convert its natural wealth into sufficient infrastructure, human, and institutional capital to continue to grow at a fast rate and it has been depleting its renewable natural capital.

Ghana sought to fuel its development by leveraging markets, but debt sustainability is a concern, compounded by crises. The COVID-19 pandemic triggered a sharp growth deceleration and major fiscal stress, but it also revealed significant structural weakness, reflected in the economy's limited diversification and high vulnerability to commodity cycles. Debt vulnerabilities and financing constraints have risen significantly.

Ghana's economic and human development is also vulnerable to climate change and climate-related shocks. Since 1960, Ghana's average annual mean temperature has increased by around 1 degree Celsius. Rainfall has also become more erratic. Sea level rise and changing hydrodynamics along the West African coast have resulted in increased coastal erosion. As a result, weather and climate extremes have increased in frequency and magnitude, triggering floods, droughts, and heat waves that, associated with increased exposure, cause human losses, damages to public and private assets, and disruption of economic activities. Without prompt global and local climate actions, higher temperatures and heat stress will affect crop and labor productivity. More erratic rainfall patterns will damage infrastructure and buildings. Local air pollution and congestion will hamper human capital and productivity in cities. Modeling these damages in a macroeconomic framework suggests they could increase poverty rates by at least 1 to 2 percentage points by 2050 (or up to around 1 million people), when compared to a scenario with no climate change. These are conservative estimates, as they do not consider deep uncertainties regarding future climate impacts, risks of catastrophic outcomes due to tipping points, and the costs of biodiversity loss that affect the welfare of individuals.

While climate change cannot be solved by any single country, local actions can help manage physical and transition risks as well as bring large opportunities. Early movers can leapfrog to cutting-edge technologies, develop more efficient systems while reducing externalities such as air pollution, and expand access to financial resources. For example, solar PV (photovoltaics) has become the cheapest source of energy and can be deployed at large scale to boost energy security at affordable prices, including to remote communities. Modern mass transit systems can reduce congestion and pollution while improving access to jobs. Climate and weather information are becoming more accurate and globally available to inform famers' climate-smart decisions. The circular economy can bring value out of waste and reduce local pollution and emissions. Climate finance is expanding, with innovative tools being developed and piloted around the world.

This report explores the ways in which Ghana can pursue its development objectives while considering the challenges of climate change and the opportunities from the transition. It sets the stage in chapter 1 by documenting the various ways in which climate and development interact in Ghana, emphasizing that climate action can support development. Chapter 2 reviews Ghana's climate commitments and institutional readiness to carry them out. Chapter 3 lays out concrete actions that Ghana can consider to boost its resilience and productivity in key sectors while reducing its emissions and associated externalities. Chapter 4 models some of these investments and policies to assess their overall economic and social effects and explores financing options as well as ways to crowd in the private sector. Chapter 5 concludes by laying out priorities for the government to consider that are achievable and can yield development and climate payoffs simultaneously.

[2] Ghana Rising – Country Economic Memorandum. The World Bank, 2021.World Bank. 2021. Ghana Rising: Accelerating Economic Transformation and Creating Jobs.

This report develops and explores the implications of a Climate Resilient and Low Carbon Development (CRLCD) pathway that will foster more green, resilient, and inclusive growth in Ghana. It focuses on six priority areas and three cross-cutting enablers (Table 1). For each of them, it identifies associated challenges and proposes key recommended actions, including potential policy reforms and investments. The effects on growth and poverty of the CRLCD scenario are compared to a no-action scenario, and recommendations are provided with a sequenced approach based on urgency, affordability, impact, and developmental trade-offs.

Table 1. Development pathways, priority areas, and recommended actions for a more green, resilient, and inclusive development

Pathway	Priority areas	Recommended actions		
Climate-resilient and low-carbon development	Adopt an integrated approach to agriculture and the environment	Foster integrated landscape and water management	Promote climate-smart agriculture	Support adaptation of coastal communities
	Build sustainable cities and resilient infrastructure systems	Improve urban development and resilient infrastructure	Enhance resilient mobility infrastructure and services	Better waste management
	Boost disaster risk preparedness	Enhance early warning systems	Improve national financial preparedness against climate shocks	Advance adaptive health and social protection systems
	Realize new opportunities for carbon sinks	Operationalize the ambition for zero deforestation	Enable participation to global carbon markets	Reduce use of biomass with clean cooking
	Promote a clean energy transition	Increase access to clean and efficient energy	Scale up the share of renewable energy sources	Strengthen regional energy markets
	Modernize transport	Develop public transport systems	Improve vehicle standards	Electrify mobility
Cross-cutting enablers	Enhance the enabling environment	Strengthen institutional capacity and legal framework	Unlock finance for climate action and sustainable development	Manage distributional impacts to ensure a just transition

The findings demonstrate that Ghana can simultaneously pursue development and climate objectives. Since climate change and local emissions and pollution impose significant costs on people and firms, there are significant gains to be derived from adaptation and mitigation initiatives. The key is to identify policies that maximize synergies between climate and development and to sequence interventions optimally with respect to the projected timing of climate impacts and macroeconomic constraints. Therefore, this CCDR recommends actions to be taken (i) in the immediate term, considering binding financing constraints, (ii) in the short to medium term, when larger investments can be made in building climate resilience in the economy and society, and (iii) over the longer term, where it may become more feasible to pursue more aggressive decarbonization.

In the immediate term, given current financing constraints and the time lag before which climate impacts will become critical, Ghana should prioritize: (i) investing in 'no regret' actions that deliver economic benefits, while (ii) laying the ground for important policies and investments that may only be feasible over the medium- to long-run, by adopting and implementing low-cost regulatory and institutional measures. In particular, recommended actions have been identified for the following priorities:

- **Improve macro-fiscal fundamentals, including debt sustainability and creditworthiness:** (i) Strengthen revenue mobilization, focusing on broadening the tax base and reducing tax expenditures; (ii) Rationalize spending (including by implementing the ESRP) and addressing major contingent liability risks from SOEs, and (iii) adopting clear and realistic fiscal and debt anchors.

- **Strengthen institutional capacity for climate action and the legal framework:** Anchor in law NDC climate policy priorities, establish a legal framework for participation in global carbon markets, develop a long-term strategy (LTS), and integrate climate in planning and budgeting.

- **Begin to unlock private climate finance:** Improve the business environment for private investment in green technologies and prepare bankable projects for international finance.

- **Integrate agriculture development, forest, and water management:** Promote climate-smart agriculture (CSA) and integrated water management, reduce deforestation, strengthen tree tenure and rights of landholders, and enhance integrated landscape management.

- **Create the conditions for resilient cities and infrastructure:** Integrate risk data into land use and city-wide infrastructure plans, reduce urban sprawl, introduce zoning in flood risk areas, and implement climate-informed design criteria for urban and new residential infrastructure.

- **Boost disaster risk preparedness:** Develop early warning systems in priority areas, strengthen emergency response capacity, and pilot options for disaster risk financing.

- **Set the foundations for low-carbon development in energy and transport:** Increase solar PV generation and clean cooking with LPG, improve vehicle regulations and fuel standards, and improve traffic management, including for walkways and bus/bike-only lanes.

- **Foster a just transition:** Modernize the TVET and Higher Education system and explore opportunities for adaptive social protection systems.

As financing constraints are relaxed and initial actions pay off, before 2030, the Ghana should consider boosting climate resilience through sectoral interventions, deepening financial and preparedness to mechanisms to shocks, and setting the foundation for a low-carbon transition in energy and transport. Sectoral interventions should be prioritized in agriculture, forestry, water, costal management, urban development, mobility, and waste, while mechanisms that require strengthening should focus on disaster risk management and financing, social protection, and climate-proofing the health and financial sectors. Finally, early action on mitigation in energy and transport will create conditions to leverage opportunities from technology, innovation, and financing, avoiding stranded assets and reducing externalities. In particular, the following specific priority actions are recommended:

- **Continue unlocking finance and fiscal space for climate action and development:** continue rebuilding fiscal and financial buffers to enable public investment and external resource mobilization, consider carbon taxes, revise private sector incentive schemes to mobilize private finance, scale-up green financing to MSMEs, develop a national green taxonomy and support mandatory disclosure of climate-related factors by banks and corporates, and create the conditions for trading in upcoming carbon markets.

- **Strengthen national-level institutional capacity and the legal framework:** Standardize monitoring, reporting, and verification (MRV) procedures and mainstream climate change in public financial management (PFM), public investment management (PIM), green public procurement (GPP), and state-owned enterprises (SOEs).

- **Strengthen integrated agriculture, forest, and water management:** Deploy landscape management plans at the district level, scale-up community-level natural resource management, reform land and tree tenure, and strengthen charcoal regulation.

- **Increase investments in CSA:** De-risk CSA adoption, develop bankable proposals and business models that can be self-sustained, train farmers on CSA, and expand irrigation.

- **Improve coastal management:** Strengthen integrated coastal zone management (ICZM) and improve environmental and social risk management regulations and enforcement capacities, particularly around protected coastal ecosystems..

- **Build more sustainable cities and resilient infrastructure systems:** Establish an institutional mechanism for metropolitan scale planning, build local capacity, expand water supply and wastewater treatment to underserved areas, invest in walking/biking and public transport infrastructure, invest in public mass transit systems, expand waste segregation and sanitary disposal capacity, mainstream climate risk in the design of new infrastructure and climate-proof existing infrastructure, improve operations and maintenance (O&M), and expand use of nature-based solutions (NbS).

- **Boost disaster risk preparedness:** Expand early warning systems, strengthen emergency response capacity, implement options for disaster risk financing such as insurance and contingency financing, and deploy adaptive safety nets, social support, and health systems.

- **Realize new opportunities for carbon sinks in the forestry sector:** Achieve and maintain the zero-deforestation commitment, enable participation in global carbon markets, and expand coverage of cooking LPG to 50 percent and scale-up the use of efficient cookstoves.

- **Promote a clean energy transition:** Scale-up solar PV, achieve universal access to electricity, maintain hydropower plant capacity and exploit remaining potential, integrate in the West Africa Power Pool (WAPP), increase energy efficiency, and reduce network losses.

- **Modernize transport:** Scale rail and inland waterway freight, create an end-of-life program to limit the use of the oldest vehicles, electrify 30 percent of two- and three-wheelers, and enforce the regulation and certification of vehicle sales, imports, and emissions standards.

- **Foster a just transition:** Invest in STEM, implement a hub-and-spoke model through regional collaborations; and build green skills into education curricula.

This CCDR also considers how actions in the medium-term may set Ghana up for longer-term resilience and competitiveness. The short-term payoffs of averting climate damages may be modest, but early climate actions will bring substantial benefits, as damages are expected to become much larger post-2050, if/when tipping points materialize. In addition, they position Ghana to uphold competitiveness as technology prices and global demand shift. For example, land use zoning and climate sensitive infrastructure planning can prevent development in locations that will be exposed to natural hazards in the future and avoid the creation of additional risk. It can also encourage urban density and land use efficiency that can support multi-modal and mass transit and electric vehicles, as technology and affordability allow. Similarly, when possible, decommissioning more polluting electricity assets can allow Ghana to take advantage of falling renewables costs and maintain global competitiveness as trading partners increasingly go green.

While the CRLCD pathway requires large additional investments of around US$2 billion per year (in present term value[3]), they are feasible for an economy like Ghana (2 to 3 percent of cumulative GDP). Moreover, most of the climate actions have clear economic benefits that more than compensate for their costs.[4] Nonetheless, financing them from the national budget will be challenging, even over the medium- to longer-term. As such, there is a clear role for both development assistance and private finance to fill the gap. Ghana can encourage private sector-led green growth by promoting a sustainable investment climate and creating opportunities in selected sectors for private investments such as

[3] Using a 6 percent discount rate.

[4] Additional investment costs are estimated at around US$14 billion in 2022-2030 and US$58 billion in 2022-2050 (present value using 6% discount rate). These costs do not include large retrofitting adaptation investments on existing infrastructure systems. A non-comprehensive analysis suggests that economic benefits amount to US$18 billion in 2022-2030 and US$124 billion in 2022-2050.

energy efficiency improvements, CSA technologies, and electric vehicles. The role of the financial sector will also be key to leverage opportunities for green and blue bonds, insurance, and other financial protection mechanisms that can help address climate and disaster risks. Meanwhile, international climate finance and overseas development assistance (ODA) will be critical to support measures that have high costs without comparable benefits for the local economy, such as a net zero energy transition and widespread electric vehicle infrastructure.

Flexibility will be key, given the high uncertainty about costs, benefits, and affordability of climate actions. Costs and benefits estimated today are highly sensitive to future exchange rates, commodity prices, technology prices, and the evolution of global climate change. Therefore, Ghana should revisit its climate strategy regularly (e.g. every five years) to take stock of how developments and outcomes from interim climate actions have impacted the feasibility and attractiveness of future actions.

The most effective option for Ghana to tackle the climate crisis is to grow sustainably and reduce poverty, and climate actions can support these dual goals. All other things equal, fast-growing and prosperous countries will be much better placed to protect themselves from the most harmful effects of climate change. Therefore, sound macroeconomic management, a conducive business environment, and broad and nimble safety nets are key for building resilience and laying foundations for the low-carbon transition. This report demonstrates that climate action is not only compatible with development goals, but highly complementary and beneficial to keep Ghana on track to meet its ambitions for growth and build resilience, while flagging risks of costly lock-ins into obsolete and high risk development directions, and opportunities to leapfrog to more green, inclusive, and resilient pathways.

1.

A view of Jamestown Fishing Village in Accra, Ghana. Photo: © Dominic Chavez/World Bank

Climate risks and opportunities for development

1. Climate risks and opportunities for development

1.1. Ghana's development model delivered significant gains, but the future is increasingly uncertain

Ghana has made major progress over the past three decades and the country's leadership has high ambitions for the future. GDP per capita more than doubled over the past fifteen years and poverty rates more than halved between 1998 and 2016. Going forward, the country's leadership has laid out a development vision centered around three key priorities: (i) fast growth and employment creation, underpinned by industrialization, economic diversification, and leveraging trade and global integration, (ii) universal access to essential services, and (iii) digital development to support innovation, productivity growth, and service delivery.

However, the trajectory going forward is increasingly uncertain. The authorities expect that Ghana will reach upper-middle income status by 2037-2040 and graduate to high-income status by 2057, but the past decade suggests progress may be increasingly difficult. First, Ghana's economy has become more, not less, reliant on natural resources extraction. The direct share of mining (including oil) in GPD rose from 3 percent in 2010 to 10 percent in 2021.[5] Second, poverty reduction and job creation have slowed[6] and 70 percent of jobs are still informal.

Despite initiatives to boost access to key infrastructure, such as electricity and communications, and public services, particularly education, Ghana has not fully managed to convert its natural wealth into sufficient infrastructure, human, and institutional capital. For example, Ghana scores second to last in the quality of roads infrastructure index when compared with the performance of ten other West Africa countries. Institutions, infrastructure, and services are also not keeping up with fast urbanization. As a result, around 40 percent of the urban population live in informal settlements, without access to basic services such as housing, mobility, and sanitation.[7] As the built environment continues to expand in mostly unplanned fashion, retrofitting it to more efficient and productive systems will be impossible or prohibitively costly.

Ghana has been depleting its renewable natural capital, which is a key source of livelihoods. Ghana lags its lower-middle income (LMI) peers on most indicators related to the sustainable use of resources and environmental health (Table 2). Deforestation is high and spatially concentrated in areas of high poverty, with land use change from forest to agriculture causing about 92 percent of deforestation. Low levels of renewable water per capita are compounded by poor capacity to treat wastewater, which, together with illegal mining, cause severe levels of pollution, making the resource available more scarce. Air pollution, caused by outdated vehicles, waste-burning, and indoor woodfire cooking, is a major cause of fatalities and disabilities, hampering human capital development. Due to unregulated overfishing, the stock has been decreasing steadily. Since 1997, the ecological footprint per person has been increasing and exceeding the biocapacity, causing a steady rise of the ecological deficit.[8] In 2017, the cost of environmental degradation was estimated at US$6.3 billion.[9] Looking forward, Ghana's high population growth and increased demand for natural resources makes this an increasingly pressing concern, since a shrinking natural capital stock will need to be shared with larger future generations, hampering the capacity of remining ecosystems to deliver their services.

[5] Ghana Statistical Service. 2013-2021 Annual GDP.
[6] World Bank. 2021. *Ghana Rising: Accelerating Economic Transformation and Creating Jobs.*
[7] Average access to improved sanitation is 20 percent of the total population.
[8] A national ecological deficit means that the nation is importing biocapacity through trade, liquidating national ecological assets or emitting carbon dioxide waste into the atmosphere. An ecological reserve exists when the biocapacity of a region exceeds its population's Ecological Footprint. Available at https://data.footprintnetwork.org/#/??_ga=2.62257452.1458264304.1643820273-838498602.1623245973.
[9] World Bank. 2020. Ghana Country Environmental Analysis.

Table 2. Ghana lags on most indicators of sustainable use of natural resources and environmental health

Indicator Name, year	Ghana	LMI mean
Forest loss, short term (% of forest loss), 2001-2019	16.9	8.7
Forest loss, long term (% of forest loss), 1900- 2010	66.0	40.5
Renewable internal freshwater resources per capita, 2017	1,113	4,002
Wastewater treatment capacity (% of wastewater produced), 2020	0.0	4.5
Fisheries sustainability index, 2020,	9.0	12.1
Mortality rate attributable to air pollution (per 100,000), 2016	203.8	132.1
Renewable energy consumption (% of total energy consumption), 2017	40.0	42.5
Change in GHG emissions per capita (% change), 2008-2017	35.1	11.8

Ghana sought to fuel its development by leveraging markets, but debt sustainability is a concern, compounded by crises. The COVID-19 pandemic triggered a sharp growth deceleration and major fiscal stress and revealed significant structural weakness, reflected in the economy's limited diversification and high vulnerability to commodity cycles. Debt vulnerabilities and financing constraints have risen, with the ratio of debt-to-GDP increasing from 63 to 83 percent between 2019 and 2021 and sovereign spreads on Ghana's sovereign debt on international markets have widened to the point that Eurobond issuances are no longer available to the country.

Climate change is already showing its effects and compounding the challenge. Since 1960, average annual mean temperature has increased by around 1 degree Celsius. The average number of 'hot' days has increased by 13 percent, while the number of hot nights per year increased by 20 percent.[10] This is highly significant for a country with a tropical climate, an average annual temperature of 28 degree Celsius (2020), and relative humidity between 77 and 85 percent. Rainfall has also become more erratic. Sea level rise and changing hydrodynamics along the West Africa coast have led to increased coastal erosion. As a result, weather and climate extremes have increased in frequency and magnitude, triggering floods, droughts, and heat waves that cause human losses, damages to public and private assets, and disruption of economic activities.

Climate change cannot be solved by any single country, but local actions can help manage physical and transition risks as well as bring large opportunities for early starters to leapfrog to cutting-edge technologies, develop more efficient systems, and expand access to financial resources. For example, solar PV has become the cheapest source of energy and can be deployed at large scale to boost energy security at affordability, including to remote communities. Climate and weather information are becoming more accurate and globally available to inform famers' climate-smart decisions. The circular economy can bring value out of waste and reduce local pollution and emissions. Climate finance is expanding, with innovative tools being developed and piloted around the world – for example, the debt for climate adaptation swap in the Seychelles in 2015. Over 2017-2018, Africa mobilized US$6 billion in dedicated finance for adaptation[11] and the potential is much greater.

The most effective option for Ghana to tackle the climate crisis is to grow and reduce poverty, and climate action can be part of the solution. All other things equal, fast-growing and prosperous countries will be much better placed to protect themselves from the most harmful effects of climate change. Therefore, sound macroeconomic management, a conducive business environment, and broad and nimble safety nets are key foundations for adaptation. Climate action is not only compatible with development goals, but highly complementary. This report identifies local actions that benefit Ghana's development, build resilience, and set foundations for future decarbonization, while flagging risks to avoid, such as costly lock-ins into obsolete development directions, and opportunities to seize, such as leapfrogging to more green, inclusive, and resilient development pathways.

[10] World Bank Group. 2021. *Climate Risk Profile: Ghana.*
[11] GCA and CPI. 2021. *Financial Innovation for Climate Adaptation in Africa.*

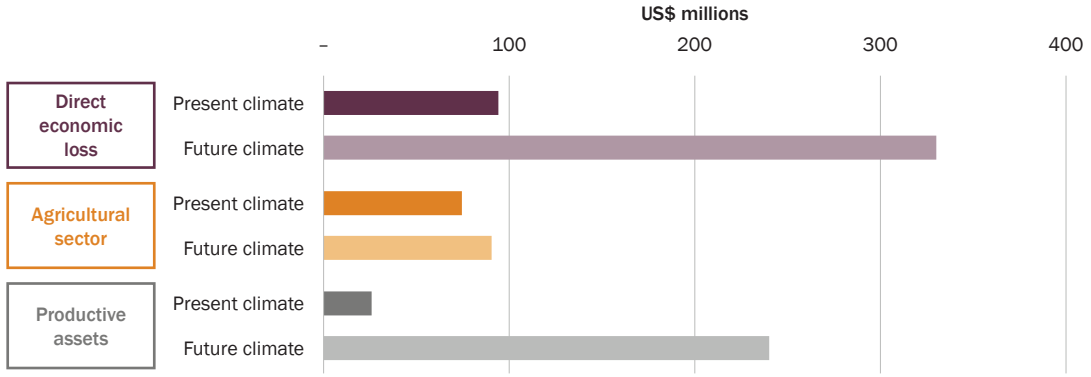
1.2. Climate risks weigh on economic and development outcomes

Ghana's economic and human development is vulnerable to climate change and climate-related shocks. Without prompt global and local climate actions, higher temperatures and heat stress will affect crop, livestock, and labor productivity. More erratic rainfall patterns will damage infrastructure and buildings. Local air pollution and congestion will hamper human capital and productivity in cities.

Significant damage to human, physical, and natural capital is already materializing. Ghana's growing population faces high risks from floods and droughts, deforestation and land degradation, poor air and water quality, rising heat stress, and depletion of natural resources.[12] Between 1968 and 2021, 32 major natural disasters were reported, mostly in the past two decades and mostly on account of floods, followed by droughts.[13] [14] On average, flooding affects around 45,000 Ghanaians every year and half of Ghana's 550 kilometer coastline is vulnerable to erosion and flooding as a result of sea-level rise.[15] [16] Meanwhile, droughts and dry periods have caused significant agricultural losses over the past decade, resulting in food insecurity or famines and lost working days and livelihoods. Under present climate conditions, 13 percent of the population is estimated to be affected by drought, particularly in the Northern belt. Landslide risk is present in about 3.5 percent of Ghana's territory,[17] with the northern part of the Volta Region, the Bono, and the Ashanti regions most affected. Despite being less frequent, storm surges, tidal events, and earthquakes also contributed to disaster tolls.[18]

Looking forward, rising heat, more frequent and extreme natural disasters, and more variable weather patterns will increasingly impact Ghana's economy. This includes both direct impacts such as losses of assets, lives, and livelihoods as a result of weather-related events as well as indirect impacts from higher heat and water scarcity on labor and land productivity. While future precipitation patterns are uncertain, pessimistic models predict that total annual rainfall could decline by 12 percent by 2050. If so, average annual losses (AALs) from droughts[19] are expected to increase significantly, from US$95 million in 2020 to more than US$325 million, per year by 2050 (Figure 1).[20]

Figure 1. Direct economic losses from droughts are projected to increase substantially for current and future (2050) climate conditions (BAU – RCP8.5)



Note: 'Productive Assets' considers only reductions in hydropower potential due to water levels.
Source: UNDRR and CIMA. 2019.

[12] RISE Diagnostics for Ghana, 2021, unpublished.
[13] EM-DAT, CRED / UCLouvain, Brussels, Belgium. www.emdat.be.
[14] Of all recorded events, floods represented 84 percent of the total, followed by droughts (10 percent), and storms and wildfires (3 percent each)
[15] Rentschler, Jun, and Melda Salhab. 2020. *People in Harm's Way: Flood Exposure and Poverty in 189 Countries.* World Bank, Washington, DC.
[16] Rozenberg, Julie,,and Marianne Fay. 2019. *Beyond the Gap: How countries can afford the infrastructure they need while protecting the planet.* World Bank, Washington, DC.
[17] Adshead, D., Thacker, S., Fuldauer, L.I., Gall, S.S., Chow, N., Pant, R., Russell, T., Bajpai, A., Morgan, G., Bhikhoo, N., Boroto, D., Palmer, R., Cançado, D., Jain, N., Klöttschen, V., Lawal, H., Dery, P., Twum, E., Mohammed, G., Hall, J.W., and Agbesi, L. 2022. Ghana: Roadmap for resilient infrastructure in a changing climate. Ministry of Environment, Science, Technology & Innovation, Accra, Ghana.
[18] UNDRR. 2018. DesInventar Sendai – Ghana Profile.
[19] Defined as more than three months of drought conditions based on the Standardized Precipitation-Evapotranspiration Index (SPEI)
[20] UNDRR and CIMA. 2019. *Ghana Disaster Risk Profile.*

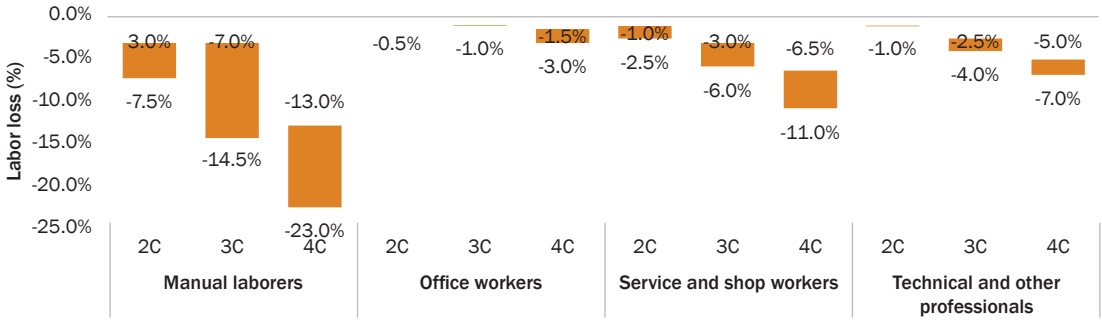
On the other hand, extreme precipitation events will become more frequent and of increased magnitude, contributing to increased flood risk.[21] The AAL due to floods is currently estimated at US$100 million. Under an RCP8.5/SSP 5 scenario, this is expected to double to US$200 million by 2050 (0.18 percent of expected 2050 GDP), with direct losses expected to fall mostly on infrastructure (34 percent), residential buildings (28 percent), and agriculture (16 percent). The full economic costs of flooding are likely to be much higher, as, for example destroyed bridges cut off access to markets, floods destroy regional health centers, urban flooding compromises sanitation, risk aversion to floods deters productive investments, and the 'spikiness' of disaster spending undermines the stability of public finances. While most floods remain circumscribed, an estimated 4.3 million people, are already at high risk to a 100-year return period event. Flood risks in Ghana are expected to grow due to both *hazards* (climate change) and *exposure* (rising asset values, population size, and land use change).

As urban areas continue to expand mostly unplanned, flood risk increases. Exposure is the main driver of future flood risks and costs for Ghana – accounting for around 60 percent of the risk increment by 2050, compared to around 40 percent for climatic changes.[22]

Rising temperatures will reduce yields for most of Ghana's crops, affecting producer incomes, raising costs of living, and harming cash crop exports. With more pessimistic (RCP8.5[23]) temperature increases of 1.12 degrees Celsius by 2050, yields are expected to fall by 1 to 21 percent, with most crops in the 2 to 6 percent range. This is expected to translate to average price increases of around 13 percent, compared to a no climate change scenario.[24] Yields of Ghana's leading cash crop, cocoa, are expected to fall 5.5 percent by 2050 under RCP8.5 warming, which will impact export revenues. Higher prices for subsistence crops are expected to raise costs of living, potentially with second-order effects for wage competitiveness. The poor devote a higher share of their budgets to food purchases, and higher food prices can push more people into poverty and make many households poorer. Among farming households, the increase in food prices implies a boost to nominal incomes, but the limited landholdings of the poor mean higher nominal incomes may not be enough to offset consumption cost increases.

Rising temperatures will also depress labor productivity through heat stress, particularly for outdoor workers doing manual labor such as agricultural and construction workers. Heat stress and heat-related diseases could reduce agricultural labor productivity by 8.5 percent by 2050 under RCP8.5,[25] with more moderate impacts for manufacturing (-2.6 percent) and services (-0.3 percent). A 3-degree Celsius warming from 1990 levels could reduce labor capacity by 11 percent for manual laborers, but less than one percent for office workers, compared to a no heat stress scenario (Figure 2).

Figure 2. Average labor capacity in Ghana is expected to reduce under 2-4 Celsius degrees warming



Source: Saeed, Hertel, Kong, and Huber. Forthcoming. Heat Stress in Human Labor and Poverty: The Case of Ghana.

[21] IPCC, 2022. "Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." Cambridge University Press. In Press.
[22] By 2050, the exposure multiplier is estimated at around 2 under SSP5/RCP8.5, compared to a hazard multiplier of 1.2-1.3 in the same scenario.
[23] RCP8.5 represents a high-emissions scenario in which unabated GHG emissions continue, leading to an average warming of almost 5 degrees Celsius by 2100. While long-term GHG emissions in RCP8.5 are widely considered overly pessimistic, the CMIP5 scenarios with RCP8.5 provide plausible high-warming scenarios, consistent with continued GHG emissions and high climate change sensitivity or a positive feedback from the carbon cycle.
[24] Background note. Heat Stress in Human Labor and Poverty: The Case of Ghana. Saeed, Hertel, Kong & Huber, 2022
[25] Roson and Sartori. 2016. Estimation of climate change damage functions for 140 regions in the GTAP 9 database. Journal of Global Economic Analysis, 1(2), 78–115.

Moreover, Ghana faces high costs from local pollution and congestion. With urbanization and income growth, outdoor air pollution is expected to quadruple by 2050 and transport congestion to rise substantially. Polluted air reduces workers' energy and cognitive function, resulting in measurably reduced labor productivity on days with higher air pollution; these effects are compounded by mortality and morbidity directly caused by pollution.[26] Congestion undermines agglomeration economies, productivity, and competitiveness of the urban economy.[27] The elasticity of labor productivity to air pollution is under-studied, but early estimates suggest that from 2020-2050, urban air pollution may be more detrimental to Ghana's labor productivity than heat stress caused by climate change, and may cause similar GDP impacts.[28] This underscores the domestic importance of emission mitigation actions, even in countries with minor contributions to global climate change.

Ghana is in a region that is increasingly unstable, with waves of conflict in the Sahel over the last two decades anticipated to worsen, partly as a result of climate change. As the region becomes less suitable for human life as temperatures rise,[29] communal tensions may increase between cultivators and pastoralists and between competing pastoralist groups. The emergence of climate in- and out-migration hotspots as early as 2030 reflects movement due to water stress, crop and ecosystem productivity losses, and sea level rise and storm surges in coastal areas. By 2050, there could be 7.3 to 27.3 million internal climate migrants across West Africa (1 to 2 percent of the population).[30] Some estimates project a 1-degree Celsius increase in temperature will lead to a 54 percent increase in conflict probability in mixed areas populated by farmers and herders.[31] Women and other vulnerable groups are most affected, as they often do not have equal economic opportunities.

The impact of climate change damages and pollution on Ghana's economy and poverty will depend on firms' and households' vulnerability and capacity to adapt. Ghana's vulnerability to many at-risk sectors (including agriculture, extractives, and informal manual work) will reduce with structural transformation, growth, and diversification of the economy. With strong information, skills, capital, and institutions, including well-functioning markets and property rights, firms and households can better anticipate and adapt to climate shocks, protecting themselves from the worst effects through 'private adaptation'. For example, farmers can substitute from the worst-affected crops (e.g. maize) to less affected crops (e.g. yams), invest in irrigation, or transition towards services or industrial sectors less exposed to climate risks; firms and households can avoid building in flood-risk zones, and/or invest in defenses and insurance; firms and workers can reduce exposure to heat stress by moving to cooler regions or focusing more on indoor, or less physically demanding, work; transport providers can plan around flood risks. However, when firms and households lack information about risks and opportunities, skills for alternative work and livelihoods, capital to finance the transition, or access to well-functioning markets and supportive institutions, they remain vulnerable to even smaller shocks.

Analyses that use a Computerized General Equilibrium (CGE) framework capture and help quantify the importance of building adaptative capacity to mediate the income and poverty effects of climate change. It is estimated that the heat stress attendant on 2-4 degrees warming would result in average income losses of 18-24 percent if households have no capacity to adapt and Ghana's economic structure is fixed at that of 2017.[32] (Figure 3). By contrast, allowing strong endogenous adaptation under a (GTAP) CGE framework results in more modest GDP losses of 3.3 to 5.4 percent under

[26] Global estimates suggest an elasticity of outdoor labor productivity to PM2.5 concentration of 0.1-0.25. Neidell. 2017. "Air pollution and labor productivity".

[27] No data is available to project forward congestion trends. In 2013, congestion in Kumasi was estimated to cost the equivalent of 9 percent of daily working hours – almost one hour, compared to 9.5 working hours. Takyi et al. 2013. "An Assessment of Traffic Congestion and Its Effect on Productivity in Urban Ghana." *International Journal of Business and Social Science Vol. 4 No. 3.*

[28] Assuming a 5 percent urban labor productivity elasticity to PM2.5, and air pollution increasing by 350 percent by 2050, suggests (urban) labor productivity damages of -17.5 percent in 2050 due to air pollution, compared -0.3 to -2.6 percent for urban service and manufacturing workers respectively due to heat stress. Given the limited evidence base and high resulting damages, 17.5 percent should not be interpreted as a precise estimate, but rather indicative that local air pollution impacts may indeed rival those of heat stress and other climate damages.

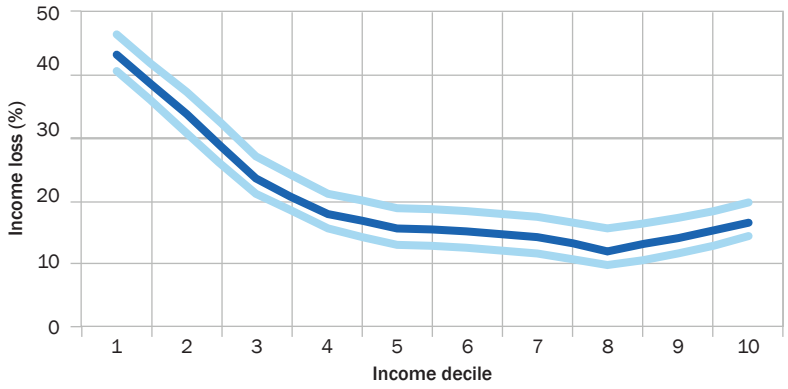
[29] Xu, Chi, et al. 2020. *Future of the human climate niche.*

[30] World Bank. 2021. *Groundswell Part 2: Acting on Internal Climate Migration.*

[31] Eberle et al. 2020. *Heat and hate: climate security and farmer-herder conflicts in Africa.*

[32] Walsh. Forthcoming. *Macroeconomics and Climate Change.*

Figure 3. Income loss (%) from labor capacity losses under 2-4 degrees warming, with no adaptation



Sources: Walsh. Forthcoming. Macroeconomic and Climate Change.
Saeed, Hertel, Kong,and Huber. Forthcoming. Heat Stress in Human Labor and Poverty: The Case of Ghana

3 degrees warming,[33] and real cost of living increases for near-poor households (US$1.90/person/day income) of a more modest 3.2 percent. A second ('MANAGE') CGE analysis, incorporating a wider range of climate damages for Ghana (Box 1), and allowing not only strong private adaptation[34] but also structural transformation over time under a CGE framework, predicts that GDP would be approximately 7 percent lower by 2050 under a high-emission scenario (RCP8.5), or 5 percent lower under a middle-emission scenario (RCP4.5) – implying less than 0.2 percent reductions in annual GDP growth.[35] This illustrates that high *direct* impacts on temperatures, yields, and labor productivity in affected sectors may have more modest impacts on final outcomes like GDP and poverty, if people and firms are endowed with strong information and ability to adapt.

[33] Compared to a reference scenario with no climate change. There is no date for this estimate: it reflects expected impacts at whatever time Ghana reaches 3 degrees warming since 1990 levels.
[34] Actors are assumed to adapt instantaneously after a shock, and unconstrainted by location-specific advantages or constraints other than a binary rural-urban distinction. Adaptation in the MANAGE CGE remains subject to certain constraints, such as households' or firms' education profiles, location in rural versus urban areas, and access to incomes and capital. The MANAGE model also allow firms and households to respond to damages only after they occur, removing a role for forward-looking information and expectations that may allow pre-emptive adaptation to avoid losses.
[35] Exact impacts of climate scenarios sensitive to a range of assumptions and parameters; magnitudes are indicative (see Box 1).

Box 1. Simulating climate damages in the MANAGE CGE model for Ghana

The MANAGE CGE model was used to analyze the impact of climate change damages and climate-related policies on macroeconomic and emissions outcomes, with strong private adaptation.[36] The three scenarios used were: (i) a reference scenario, with no climate damages, (ii) a medium (RCP4.5) scenario, and (iii) a high (RCP8.5) global emissions and climate change scenario. They use damage functions for: (a) crop productivity;[37] (b) heat-related impacts of a 1-degree Celsius temperature rise in Ghana on labor productivity, tourism, and energy;[38] (c) flooding; and (d) air pollution.[39]

Figure 4. Impact of climate damages on GDP (RCP4.5 and RCP8.5), 2030–2050

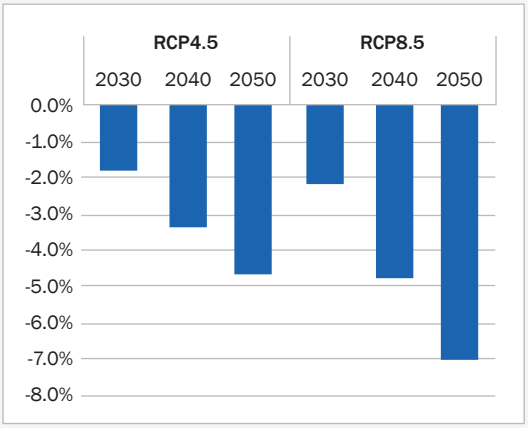
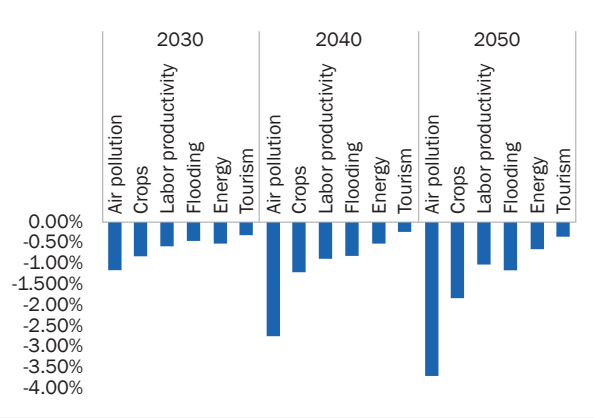


Figure 5. Impact of climate damages on GDP (RCP8.5), 2030–2050 per damage function



Source: Walsh. Forthcoming. Macroeconomic and Climate Change.

For the most vulnerable populations, high risks remain even after factoring in some capacity to adapt. Translating the MANAGE CGE results (which assume strong private adaptation) to a microsimulation model suggests that the share of the population projected to be living in poverty (3.20 USD 2011ppp) by 2050 would be 1.7pp higher under a high global emission scenario (RCP 8.5) and 0.8pp higher under a middle emission scenario (RCP 4.5), compared to a scenario with no climate change damages where poverty is projected to be 11.3 percent. This could mean anywhere between 400 thousand and 900 thousand additional Ghanaians in poverty due to climate change by 2050. Aggregate results also mask important heterogeneity: the less well-off will be most affected, due to their higher concentration in agricultural and outdoor manual work, and lower capacity to adapt; flood damages that are low as a share of GDP may have large impacts on local communities affected, such as the urban poor living in informal urban areas; Ghana's forest regions will have higher vulnerability to increasing rainfall, while the savanna will face increasing aridity.[40]

Climate-related damages are also anticipated to rise substantially after 2050.[41] By 2050, Ghana's average temperature is projected to rise by 1 to 3 degrees Celsius compared to pre-industrial levels, exposing over 20 million Ghanaians (roughly 67 percent of the population) to extreme heat every five

[36] The model includes dynamic interactions between 42 activities and 38 commodities, eight labor types (four levels of education, plus rural and urban), 15 household types (rural farm, rural non-farm, urban; separated into income quintiles), four tax types (sales, direct, import, export), and several carbon pricing options. Poverty and distributional impacts are obtained through micro-simulations, which distribute macroeconomic shocks among the population, based on population and household heterogeneity (reported in household surveys) in sector employment, wages, age, and education.
[37] Weather-related damages to crops (under RCP4.5 or RCP8.5) were taken from the IMPACT analysis conducted for Ghana's CSA Plan.
[38] Roson and Sartori. 2016.
[39] Increases in urban air pollution from unmanaged urban transport were estimated (Chapter 3) and linked to worker productivity.
[40] Environmental Protection Agency of Ghana 2020.
[41] The BAU only considers the medium-term (2020-2050) and does not consider flood damages resulting from more extreme events. Moreover, the most acute temperature changes for Ghana are projected to occur after 2050, at which point damages would be substantially higher. The temperature projections also take linear averages of multiple climate models and do not account for possible negative climate 'tipping points' that could accelerate timelines. Finally, wider economic impacts from flood damages (e.g. temporarily reduced access to work and services) are not captured in the model.

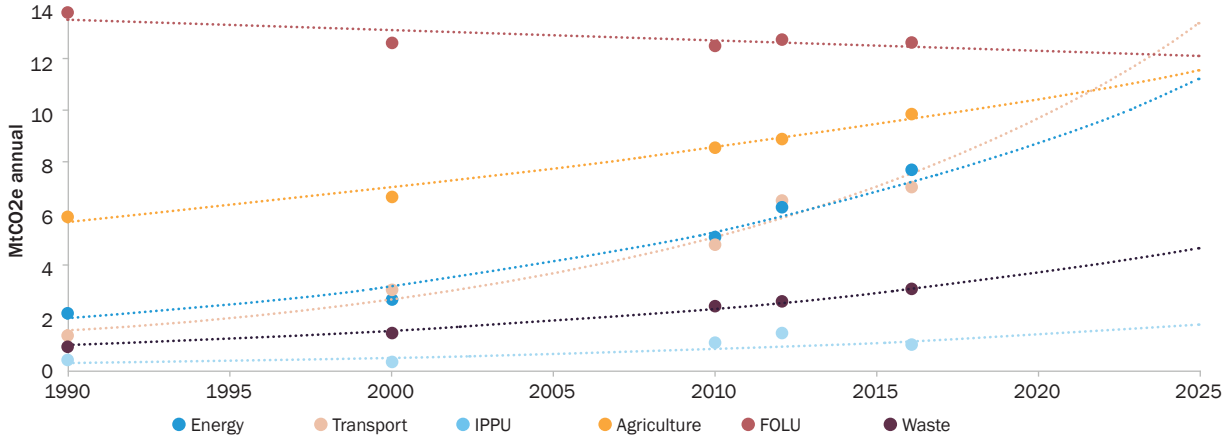
years. Beyond 2050, severe heatwave events will become more frequent and affect almost the entire population, while some parts of Ghana will experience near-unlivable conditions.[42] Direct losses from flooding may reach US$400 million annually (driven up by both higher asset values, and worse climate conditions) unless strong adaptation measures are taken locally and mitigation measures taken globally. These are conservative estimates that don't consider climate tipping points, wider economic impacts of disruptions, or increases in fragility.

1.3. Emissions will increase sharply with significant externalities

Ghana's GHG emissions are modest, but they are projected to increase in absolute and per capita terms. Ghana is responsible for only 0.04 percent of global CO2 emissions today and its cumulative emissions since 1750 amount to 0.02 percent of the world's total. Emissions are also low on a per capita basis—at approximately 1.57tCO2e/capita, they represent around 24 percent of the global average.[43] However, emissions have increased steeply—from 35.2MtCO2e in 2010 to an estimated 48.8 MtCO2e in 2019 as a result of growth and population increase. Looking forward, if emissions grow in line with projected GDP, they will rise by 62 percent before 2035.

In Ghana, more than 90 percent of total emissions come from two sectors—agriculture, land-use change, and forestry (AFOLU) and energy, including transport (Figure 6). Historically, AFOLU has been the largest source, accounting for 54.4 percent of emissions in 2016, driven primarily by agriculture expansion, wood-fuel harvesting, and illegal logging and mining. FOLU contributed to 30.5 percent of emissions and agriculture to 23.8 percent. In 2016, the energy sector accounted for 35.6 percent of emissions (18.6 percent for electricity and 17 percent for transport). With economic and urban growth, it could become the main source of emissions before 2025, as vehicle ownership and demand for electricity expand. Already, electricity production has become more carbon intensive as grid electricity has transitioned from 100 percent hydro in 1992 to 57 percent thermal by 2016. Renewables have played a limited role to date, despite plummeting market costs for solar and wind, mainly due to over-capacity in thermal power generation and high prices of negotiated Power Purchase Agreements (PPAs) for solar and wind projects. Emissions from the waste sector, including wastewater treatment and solid waste, which amount to 7.5 percent, are also anticipated to grow.

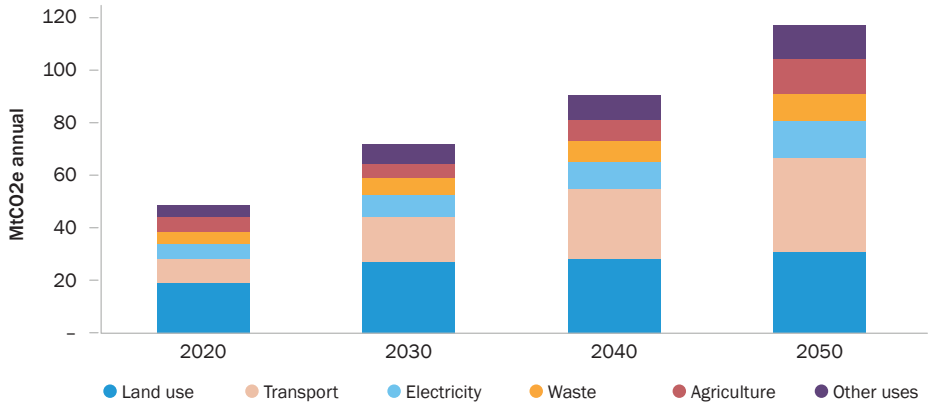
Figure 6. Ghana's Net Emissions by Sector (1990-2030)



Source: Calculated using emissions data (1990, 2000, 2010, and 2016) from EPA (2019), 'Ghana's Fourth National Greenhouse Gas Inventory Report'. Trend lines are projections, assuming exponential growth trends.

[42] Xu, Chi, et al. 2020. *Future of the human climate niche.*
[43] Own per capita estimations using MANAGE model figures. Latest equivalent global figure from CAIT/Our World in Data at 6.45tCO2e/capita (2019).

Figure 7. Projected emissions by sector under a "do nothing" scenario in Ghana as calculated in the MANAGE model (see chapter 4), 2020-2050



Source: Background paper on Macroeconomics and Climate Change

Beyond their direct emissions contribution, emissions from transport, cooking with wood-fuel, and open waste burning also release toxic pollutants that have significant negative human health impacts. Ghana's annual mean PM2.5 concentration levels are up to six times higher than the WHO guideline and an important cause of disability and mortality, with 11,739 premature deaths every year.[44] In addition, increased precipitation extremes and flooding driven climate change cause more hazardous waste, such as unintentional persistent organic pollutants and electronic and mining waste, to leak into rivers, lagoons, and the sea, putting the population at greater risk of exposure.

Shifting demand patterns from global decarbonization will also have implications for Ghana. Three-quarters of its exports are concentrated in oil, gold, and cocoa, all of which will be affected by global decarbonization efforts, particularly oil. While manufacturing plays a small role in the economy, Ghana's ambition to industrialize and integrate in global value chains will require adequate attention is given early on to avoid costly lock-ins and investments in soon-to-be stranded assets.

1.4. Climate actions can support the transition to a more green, resilient, and inclusive development pathway

To achieve and sustain its long-term development goals, Ghana must seek to turn climate challenges into opportunities. The following chapters will explore these opportunities in greater depth, focusing on six priority areas and three cross-cutting enablers. The effects on growth and poverty of the CRLCD scenario are compared to a no-action scenario, and recommendations are provided with a sequenced approach based on urgency, affordability, impact, and development trade-offs. By transitioning to a CRLCD pathway, Ghana can simultaneously soften the impacts of climate change and set the foundations for more sustainable growth, underpinned by new technologies and innovation, as well as support the achievement of Ghana's Beyond Aid vision and its NDC.

While Ghana has time until the most severe damages set in, it is critical to act now to fully leverage climate-development synergies. Implicit in various findings is that not just climate policies, but also broader economic and human development, will be critical for building Ghana's climate resilience. Skills, knowledge, capital, and incomes improve households' and firms' ability to adapt to climate risks and recover after setbacks. Faster structural transformation can also reduce the concentration of jobs and production in at-risk sectors and occupations and create new high-quality jobs.

[44] WHO conservatively estimated the annual health impacts of ambient air pollution in Ghana to be 11,739 premature deaths, 419,049 years of life lost (YLL) and 425, 931 disability-adjusted life years (DALYs) (WHO, 2016). In 2016 the mortality rate attributed to household and ambient air pollution for Ghana was estimated by WHO to equal 101 per 100,000.

2.

Smallholder farm irrigation from White Volta in Northern East Region, Ghana. Photo: © Lorenzo Carrera

Country climate enabling environment

2. Country climate enabling environment

2.1. Ghana has made ambitious climate commitments

Ghana ratified the Paris Agreement in 2016 and, in its updated NDC submitted to the UNFCCC in 2021, it committed to substantially reduce its emissions by 2030 and enhance adaptation. To achieve this, the government laid out 13 programs of action on adaptation and 34 on mitigation. Ghana plans to generate absolute GHG emissions reductions of 64 MtCO2e between 2020 and 2030, compared to the cumulative emissions in a baseline scenario over the same period. Nine unconditional programs of action would result in a 24.6 MtCO2e reduction in emissions and 25 conditional programs of action would achieve a further reduction of 39.4 MtCO2e. While the unconditional programs would be funded out of budgetary resources, the conditional programs would require financial support from the international community and private sector investments. According to the NDC, the actions will generate nearly one million jobs and benefit 31.5 million people through reduced climate risks by 2030.

The proposed NDC mitigation actions focus on energy, forestry, and waste management. Emissions reductions from sustainable forest management and urban solid waste management each account for approximately one-third of the NDC emissions reduction target. An additional 20 percent is anticipated to come from a range of energy-related actions, including low-carbon electricity generation, clean cooking solutions and sustainable charcoal consumption, and energy efficiency.

The proposed NDC adaptation actions focus on resilient infrastructure, urban planning, and agriculture landscapes and food systems. This will require investments in enhanced early warning and disaster risk management as well as integrated water resource management. To foster social inclusion, Ghana has also prioritized enhancing the climate resilience of women and vulnerable groups, including for health-related climate risks.

To implement these 47 actions, Ghana has prepared an NDC Implementation Plan, which will require between US$9.3 and US$15.5 billion of investment. The Implementation Plan provides guidance for sectoral ministries on how to translate NDC commitments into costed priority actions, outlines the roles of state and nonstate actors, and recommends how to monitor progress towards NDC targets. Investments of US$3.9 billion would be provided from budgetary sources to implement the 16 unconditional programs of action, while the US$5.4 billion would be mobilized from public, international, and private sector sources, including carbon markets, for the 31 conditional programs of action. Ghana will need an additional US$3 million biennially to support coordination and regular international reporting. The NDC Implementation Plan is divided into three phases: (1) Readiness (2018-2020) support for technical capacity, resource mobilization, preparation, and socialization; (2) Compliance (2020-2025) support for institutional capabilities and implementation of priority actions; and (3) Stocktaking (2025 and 2030+) support for evaluation of NDC implementation and progress.

In addition, at COP26, the government signed the declaration on forests and land use and on accelerating the transition to zero emission vehicles, becoming one of the first five countries and the only African country to join the Lowering Emissions by Accelerating Forest Finance (LEAF) Coalition. Together, these global commitments aim to collectively halt and reverse forest loss and land degradation by 2030 and rapidly accelerate the transition towards all sales of new cars and vans being zero emission globally by 2040 or earlier, with leading markets reaching 100 percent by 2035.

2.2. Legal reforms are needed to strengthen the climate change enabling environment

Ghana's has a patchwork of policies and development plans, grounded in its National Climate Change Policy (NCCP), rather than a solid framework of binding and enforceable climate change laws and regulations. The 2013 NCCP is Ghana's main climate policy. Although it does not have the force of law, it aims "to ensure a climate-resilient and climate-compatible economy while achieving sustainable development and equitable low-carbon economic growth." It acknowledges that economic modernization will increase emissions but argues that the new development path will reduce emissions against the baseline. It outlines five priority areas: agriculture and food security, disaster preparedness and response, natural resource management, equitable social development, and energy, industrial, and infrastructural development. Ghana does not have a framework law dedicated to climate change, but various legal provisions. These provisions are found in the 1992 Constitution, structural statutes such as the Environmental Protection Act of 1994 and Public Financial Management Act of 2016, and sector-specific statutes and regulations such as the Renewable Energy Act of 2011, Energy Efficiency Regulations of 2008, Water Use Regulations of 2001, Concessions Act of 1962, Forest Protection Act of 1974 as amended in 2002, and Ghana Railways Act of 2008.

Ghana's climate change enabling environment does not provide sufficient coherence, comprehensiveness, and enforceability. Unlike policies, statutory provisions are generally legally binding, enforceable, and their certainty can be decisive for attracting public and private sector capital in support of Ghana's climate and development goals. In addition, the current patchwork of policies and sectoral laws and regulations leaves out some important elements, such as a law on carbon and green taxation, a definition of "carbon" and rights to manage or transact carbon, and a requirement that environmental and social impact assessments (ESIAs) for new projects consider climate change. This patchwork also introduces some policy incoherence and a lack of resources and coordination across agencies. In other areas, laws are not sufficient or not sufficiently implemented and enforced. Revisions to legislation in relevant sectors, combined with the enactment of dedicated climate change framework legislation, could comprehensively detail adaptation and mitigation requirements and signal Ghana's commitment to the policy aspirations detailed in the NCCP and related policies. The 2021 Climate Action Tracker Climate Governance report also concludes that policy inconsistencies need to be addressed, giving a "poor" readiness score for policy processes.[45]

Therefore, Ghana should focus on a few short- to medium-term legislative reforms. These include:

i) Anchoring in law NDC policy priorities by amending sector laws and, in the longer term, anchoring in law climate policies through framework climate legislation or new sector laws.

ii) Explicitly integrating climate considerations in the ESIA process and all relevant sectors and processes, such as through regulatory and legislative amendments.

iii) Establishing a legal framework for participation in international carbon markets.

iv) Strengthening parliamentary law-making and oversight on climate change.

v) Bolstering the enforcement and compliance capacity of agencies to develop and implement climate policies, laws, and regulations.

2.3. Stronger institutional coordination and effective implementation of existing systems could facilitate climate action

While there are multiple national, subnational, and sectoral strategies addressing climate change, they are not well aligned, and coordination is limited. Roles and responsibilities are fragmented across ministries and agencies, which dilutes responsibility and accountability. The Ministry of Environment Science, Technology, and Innovation (MESTI) is responsible for climate change issues and houses the

[45] Climate Action Tracker. 2021. *Climate Governance in Ghana.*

National Climate Change Committee (NCC), which consists of Municipal and District Assemblies (MDAs,) development partners, the Parliament, Civil Society Organizations (CSOs), and the private sector, while the National Environmental and Natural Resources Council (NENRC), chaired by the Vice President, has an oversight role. The Environment Protection Agency (EPA), which has a broad mandate to protect the environment, provides technical support. In addition, several MDAs have established climate change units, indicators, and plans that overlap. Within the Ministry of Finance (MoF), the Natural Resources, Environment, and Climate Change Unit (NRECCU) oversees, coordinates, and manages financing of and support for climate-related activities. With regards to Ghana's NDC, MESTI coordinates the NDC process and advocates for resources at cabinet and parliamentary levels, while the EPA is responsible for monitoring and reporting on NDC implementation, including the Biennial Update Report,[46] the NDPC is responsible for mainstreaming NDC targets into sectoral and MMDA plans, and the MoF is responsible for monitoring funding to implement NDCs and mobilizing climate finance. The coordination structures, while clear, are not fully operational and there are limited feedback loops to allow for real-time adjustments.

Public climate finance resource identification and mobilization is operationalized through Ghana's Climate Budget Tagging system (Box 2) and associated annual budget processes, but the NCCP does not outline an explicit climate finance strategy. The 2022 Budget Policy Statement included references to climate change and climate finance. Budget guidelines require public institutions at national and subnational levels to identify climate relevant spending. In addition, climate change has been integrated into the three-year rolling budget and medium-term expenditure framework (MTEF). With support from United Nations Development Programme (UNDP), the MoF developed Standard Operating Procedures (SOPs) for tracking climate change expenditures. A climate tracking dashboard is expected to disaggregate that information at MDA and sector levels. The combination of the dashboard, MoF annual reporting, and MMDA annual reporting to EPA will strengthen government reporting on climate change budget funds, including co-financing through the budget system. The budget is also linked to SDG targets, which allows for tracking climate-related spending. In addition, to facilitate financing to the subnational levels, the NDPC has supported incorporation of the NDC in many national and subnational plans.[47] The new Public Financial Management (PFM) Strategy (2022-2026) supports both adaptation and mitigation through a number of activities, including: (i) tax exemptions to incentivize climate-smart investments by the private sector, (ii) disclosure of information on climate-smart investments by the public sector and SOEs, (iii) the introduction of climate change into performance scorecards of MDAs' budget committees, and (iv) automation of public services for reducing GHG emissions from transport.

[46] The EPA seeks funding to develop Ghana's long-term strategy based on the lower emissions reduction target in its updated NDC.
[47] SAI noted there are no timelines and targets; and asked whether the Government had baseline information on carbon footprint.

Box 2. Climate Budget Tagging in Ghana

Ghana's Climate Budget Tagging system ('CLIMFINTRACK') and methodology, which was developed by MoF in collaboration with MESTI, has been in place since 2016, although this report could not confirm its implementation. Climate budget tagging (CBT) follows from the first Climate Public Expenditure and Institutional Review (CPEIR) undertaken with support from UNDP. The CBT aims to track all on-budget climate-related expenditure from key line ministries and provide data to compare projected and actual spending. It is integrated in the Ghana Integrated Financial Management Information System (GIFMIS) and budget management system.

The use of CBT has helped ensure greater budget transparency and accountability, but precisely estimating the share of climate-relevant expenditures remains challenging. In Ghana, relevance weights based on Rio markers are used to estimate the share of climate-relevant expenditures at program and project levels by MDAs and MoF. Actions with a clear focus on climate adaptation or mitigation are classified as highly relevant and weighted at 100 percent, actions that have links to climate change objectives are considered of medium relevance and weighted at 50 percent (which can be split between adaptation and mitigation at 25 percent each), and actions related to medium relevant expenditures but not directly linked to climate change are considered low relevance and weighted at 20 percent (which may be split between adaptation and mitigation at 10 percent each). However, despite the clear methodology, this report could not confirm the functioning of the tool.

However, several opportunities remain to strengthen public climate finance, including enhancing public investment management. Ghana is a signatory to the Helsinki principles adopted by the Coalition of Finance Ministers for Climate Action, which includes mainstreaming climate-informed Public Investment Management (PIM). Climate considerations are embedded in project selection, with the EPA as a member of the Public Investment Program Working Committee (PIPWC), which reviews all medium and large projects, including externally funded projects. To enhance this assessment, the MoF is developing guidance and a methodology to appraise public investment projects that integrates climate considerations, including at the project concept note screening stage. The government is also considering including a climate-smart appraisal guideline. A separate PPP act is currently in draft and will include PPP impacts on climate mitigation and adaptation.

Green public procurement (GPP) is another potential lever for climate action. The government has taken steps to include environmental considerations in public procurement but is yet to develop GPP practices. Amendment to the 2003 Public Procurement Act includes evaluation criteria for environmental and green issues only if and when needed but stops short of mandating GPP practices. Moreover, the primary focus on cost-minimization considerations undermines the inclusion of pro-climate requirements that usually result in higher costs, particularly for public spending on infrastructure. Institutional capacity for GPP is also insufficient at the level of MDAs and bidders are not required to comply with environmental regulations to be eligible for contract awards.

Subnational governments are partially responsible for implementing Ghana's climate policies, but have insufficient funds and limited capacity. MMDAs develop medium-term development plans and budgets that must conform to the national plan. However, there is a sizeable gap between the plan and actual funds received and executed. There are no climate-related expenditure mandates or climate-specific transfers aside from development partner funds and climate change is not integrated into PFM at the subnational level.

Finally, the economic importance of SOEs and their influence in key climate-relevant sectors, such as energy and mining, is crucial. In this context, integration of climate action plans into the APCs signed between SOEs and their supervisory agency, the State Interests and Governance Authority (SIGA), could provide a useful lever. A next step could be to analyze contingent climate risks and possible impacts

on the financial viability and operational performance of SOEs. In addition, climate-related actions and climate-smart investments could be included in State Ownership Reports (SORs) to enhance transparency and accountability.

Finally, while there are no laws or regulations dedicated specifically to the monitoring, reporting, and verification (MRV) of GHG emissions and sinks, mitigation, adaptation, or climate finance, agencies can rely on existing authority to complete these functions. MESTI and the EPA developed a multi-sector MRV system—the Ghana Climate Ambitious Reporting Program (G-CARP), and several institutions have the legal authority to obtain information from public institutions and private entities in the NDC sectors, which they can use to compile and report on the data platforms they manage. However, there are multiple data generation platforms managed by different institutions that are not well interconnected, roles and responsibilities are fragmented, and funding is insufficient to ensure a working centralized national data and MRV system. While the MoF has prepared a climate finance tracking tool and guidance on MRV of climate funds, a dedicated national MRV regulation or strategic plan is needed to help avoid duplication, reduce institutional delays in reporting, and address gaps, including the inability of the system to effectively aggregate the cumulative effects of individual mitigation and policy measures.

Against this background, Ghana should focus on few short- to medium-term policy actions, including:

i) Developing a long-term low-emission development strategy (LT-LEDS) under the umbrella of Ghana@100, consolidating analysis and information in the various national documents.

ii) Integrating climate change considerations, with concrete goals, into other policies and planning instruments.

iii) Mainstreaming climate change in PIM, including the introduction of GPP.

iv) Mainstreaming climate change in SOEs, including introducing climate-related KPIs in APCs.

In the longer-term, Ghana should also focus on:

i) Amending existing or enacting new dedicated regulations to enshrine into law a framework for standardized MRV procedures.

ii) Supporting institutional arrangements for climate actions, including the proper functionality of G-CARP.

2.4. Enhance readiness for participation in international carbon markets

Ghana is one of early movers in voluntary cooperation under Article 6 of the Paris Agreement. The Government of Ghana has signed bilateral cooperation agreements with the Government of Switzerland and the Swedish Energy Agency to develop projects under Article 6 and has been preparing institutional arrangements and country processes for transacting Article 6 units (or "mitigation outcomes") to benefit from the opportunities presented by international carbon markets. It also prepared a draft policy framework for Article 6.2, which is under consultation by the Government of Ghana, to provide clarity to potential market participants (investors, project developers, buyers) on how to outline eligible activities that can transfer mitigation outcomes internationally and obtain government authorization and account for such transfers.

In this context, the World Bank initiated the International Transfer Readiness module of the Mitigation Action Assessment Protocol (MAAP-ITR) to identify policy, institutional, and infrastructure areas in which Ghana requires support to enhance its readiness for international carbon markets. The analysis recommended that the government consider:

i) Expanding the coverage from Article 6.2 transactions more broadly to all international carbon markets, including voluntary carbon market transactions.

ii) Preparing an overarching crediting strategy that lays out its plan to minimize overselling risks.

iii) Establishing a pricing strategy for mitigation outcomes to be transferred internationally.

iv) Strengthening the institutional framework and streamline the process for registering and authorizing international transactions.

v) Reviewing the design of the Ghana Carbon Registry under development to ensure it has the necessary systems in place to communicate and establish connection with other registries to prevent double counting.

vi) Establishing a legal framework or regulatory instruments (e.g. Climate Change Law or Act) to provide a legal basis for participation in international carbon markets. While a legal framework is not necessary, it can help maintain continuity of climate strategies despite political changes and provide confidence to market participants.

3.

Pineapple production at Ekumfi Fruits and Juices Ltd in the Central Region, Ghana. Photo: © World Bank

Pathways to climate resilient and low-carbon development

3. Pathways to climate resilient and low-carbon development

This chapter explores challenges and identifies opportunities to enable a pathway to Climate-Resilient and Low-Carbon Development (CRLCD) in priority areas (Table 3). Climate-resilient priorities include mostly no-regret climate actions that will be implemented in the short to medium term. Low-carbon priorities include climate actions that might be implemented in the longer term, but also identifies policy options that will need to be implemented in the short term to build a strong foundation and leverage opportunities for the transition. Combined into the CRLCD scenario, these actions will help Ghana sustain its economic growth, incomes, and livelihoods, while preparing the ground for a more green, inclusive, and resilient future.

Table 3. Priority areas for climate resilient and low carbon development pathway

Climate-resilient and Low-carbon Development	
Adopt an integrated approach to agriculture and the environment	Realize new opportunities for carbon sinks
Build sustainable cities and resilient infrastructure systems	Promote a clean energy transition
Boost disaster risk preparedness	Modernize transport systems

3.1. Priority areas for climate-resilient development

To address multiple challenges and development priorities, in the context of high debt and fiscal constraints, Ghana should prioritize no-regret actions in the short-term (3-5 years)[48] that maximize resilience benefits at an affordable cost. This report explores priority actions across three key development areas: (1) adopting an integrated approach to agriculture and the environment, (2) building sustainable cities and infrastructure systems, and (3) boosting disaster risk preparedness. These will also build the foundations for the low-carbon development actions (see Section 3.2).

3.1.1. Adopt an integrated approach to agriculture and the environment

Addressing natural resources management through an integrated lens can benefit the environment, reduce climate-related risks to assets, and boost rural growth incomes and jobs. Agriculture, forestry, and fisheries activities are a vital part of the economy, contributing to 20 percent of GDP, as well as people's incomes and livelihoods, particularly in rural areas where it employs 71 percent of the population. The sector also supplies more than 70 percent of national food demand and is a primary source of employment for about a third of new workers who enter the labor force each year.[49] Moreover, forests provide livelihoods for more than 2.5 million people.[50] Therefore, investing in better management of natural resources is a key development priority. **Integrated agricultural and environmental management will require: (1) enhancing integrated landscape-level planning, (2) promoting climate-smart agriculture (CSA), and (3) supporting the adaptation of coastal communities.** These actions can also have a significant impact on Ghana's GHG emissions, given that the agriculture and forest sector make up 54 percent of Ghana's emissions (see Section 3.2.1).

Enhance integrated landscape level planning for forest ecosystems and food and water security

Ghana is projected to become hotter and drier and continue to experience extreme events with detrimental impacts on land, forests, and water. Droughts and floods lead to soil erosion, deforestation,

[48] "No-regret" actions are actions by households, communities, and local/national/international institutions that can be justified from economic, social, and environmental perspectives, whether natural hazard events or climate change (or other hazards) take place or not. No-regret actions build resilience. Heltberg, Siegel, Jorgensen, 2009; UNDP, 2010.
[49] World Bank, 2018. Ghana 3rd Economic Update. Agriculture as an Engine of Growth and Job Creation. Washington D.C. World Bank Group.
[50] World Bank. 2020. *Country Environmental Analysis.*

land degradation, and biodiversity loss,[51] while warmer and drier temperatures result in the loss of forest quantity and quality by increasing the risks of hazards such as fires, water shortages, pests, and diseases. Ghana's poor water management has already made it a water scarce country, in terms of per capita availability, despite having abundant total renewable water resources.[52] Ecosystem degradation and erosion due to climate change, combined with the pressures from a growing population and anthropogenic stressors such as deforestation, land use change, and urbanization will further exacerbate water scarcity. Several models, including the simulations carried out for this report using the Global Change Analysis Model (GCAM),[53] have highlighted high levels of uncertainty on water availability trends to 2050, mostly due to uncertainty in precipitation models. However, GCAM simulations confirm that the Northern part of the country will continue facing water scarcity and might suffer from increased droughts and soil erosion. The Soil and Water Assessment Tool (SWAT) analysis[54] shows that temperature, precipitation, and land use changes will impact the water balance. Specifically, under a business-as-usual (BAU) scenario, evapotranspiration and groundwater recharge could decline sharply, resulting in a water yield decrease of up to 30 percent in affected areas by 2050.[55] In parallel, soil erosion will also increase with deforestation, with sediment yield increasing by up to 2 tons per hectare. A total of 25 million tons per year of additional sediment is expected to be generated at the country level under a BAU scenario. This implies increased surface runoff with high potential for flash floods during the rainy seasons and illustrates the significant role of forest management as an early action in maintaining an optimal water balance.[56]

To promote integrated landscape management to balance competing needs for food, livelihoods, energy, water, and ecosystem services, Ghana should focus on four short- to medium-term actions:

i) Establishing integrated landscape governance strategies and plans at the district level.

ii) Reforming land and tree tenure to encourage farmers to adopt natural regeneration, plant trees, and manage trees on-farm.

iii) Scaling up community-level natural resource management.

iv) Enhancing institutional capacities for monitoring and reporting on the state of forests.

Investing in landscape level plans and governance structures can strengthen the integration of agriculture, forestry, and water resource management. This can help tackle issues such as conversion of land from forest to agriculture or mining and address inconsistencies in sectoral policies to reinforce common objectives of landscape management. Such landscape governance structures are already being established in hotspot intervention areas under Ghana's Emission Reduction Program. Building on this, sectoral ministries such as the Ministry of Lands and Natural Resources (MLNR), Forestry Commission (FC), EPA, and Water Resources Commission (WRC) also need coordination platforms and upgraded institutional structures that address overlapping roles and responsibilities. In addition, integrated water resource management (IWRM) will need to be enhanced, including investments in water harvesting and storage infrastructure, measures to increase groundwater recharge and improve dam safety, and the rehabilitation and development of new irrigation areas, both at large and small scales. Water resource management institutions such as the Volta Basin Authority could also be strengthened to coordinate multi-dam systems in anticipation of water-related transboundary conflicts with neighboring countries. Finally, support for fire management interventions driven by local leadership will need to increase. In most parts of Ghana, wildfires occur frequently and up to 90 percent of the total area of the dry northern savanna zone is prone to annual bushfires. While all fires are not bad for ecosystem health, the main cause in Ghana is slash-and-burn agriculture. Improved mapping of the causes, frequency, and

[51] Ghana Strategic Investment Framework (2021-2025)

[52] In 2020, Ghana's IRWR was 975 cubic meters (m^3) per person, about 40 percent less than the amount in 2000 and below FAO's water scarcity threshold of 1000 m3 per person.

[53] GCAM is an integrated tool for exploring the dynamics of the human-Earth system and its response to global changes. http://jgcri.github.io/gcam-doc/.

[54] Arnold, J. G., Kiniry, J. R., Srinivasan, R., Williams, J. R., Haney, E. B., & Neitsch, S. L. (2012). Soil and Water Assessment Tool: Input/output Documentation - Version 2012. Texas Water Resources Institute, TR-439.

[55] Own estimates based on flow duration curve for baseline and land use change scenario with deforestation to 2050 at the outlet grid of the Tano River in Western and Ashanti regions in Ghana.

[56] World Bank. Forthcoming. "Modelling the impacts of forest cover and deforestation on water quality and surface water recharge in Ghana."

severity of fires is needed to better understand fire patterns and impacts to inform design of appropriate interventions.

Strengthening tree tenure reform and the rights for landholders could encourage farmers to adopt natural regeneration, plant trees, and manage trees on-farm. At present, farmers have limited incentives to invest in good management practices that are costlier or to retain trees on land given they lack rights to the trees. In Ghana, naturally occurring trees are, by default, considered to be in the possession of the state and planted trees must be registered with the FC or risk being considered government property. However, the envisaged establishment of a national tree registry could be costly and complicated.[57] Therefore, the government has initiated some reforms, but further action is needed on land and tree tenure security with buy-in from traditional leaders, landowners, and farmers. Land rights for landholders include the right to access, hold, use, and control land within a land tenure system. The recognition of land rights can enhance land tenure security for landholders and can be a key incentive for implementation of CSA practices that enhance the adaptive capacity of crops and ecosystem services. Clear and recognized tenure rights are especially important for women who face discriminatory land rights and for receiving performance-based payments from many carbon financing instruments.[58] The operationalization and strengthening of Customary Land Secretariats as mandated by the Ghana Land Act (2020) and registration of land are key policy options.

Community-based natural resource management can also build adaptive capacity to climate shocks and diversify local livelihoods. Ghana can build on existing interventions and incentive mechanisms, such as the co-management of reforestation in the Modified Taungya System that recognizes farmers as co-owners of forest plantations and the Community Resource Management Areas (CREMA) that enables community-driven land use planning. In exchange for sustainable management, communities are granted rights to economic benefits derived from the areas and receive support for agriculture inputs, agroforestry, and additional livelihoods. In addition, Ghana should pass supporting legislation, including the Wildlife Resource Management Bill to add momentum to scaling-up of CREMAs, and strengthen the enforcement of existing regulations, such as those related to charcoal production to ensure the sustainable harvesting of trees by communities (see Section 3.2.1).

Over the medium term, the government could also consider further efforts to enhance technical and institutional capacity for monitoring and consistent reporting on the state of forests. Currently, there is significant variance in hectares of deforestation and degradation numbers reported to various international and national fora. Addressing the inconsistency together with a complete inventory of the national forest resources and a Forest Management Information System is needed for effective management. An up-to-date forest inventory and use of advance remote sensing technologies for real time forest change detection will also help Ghana to leverage support from international partners. In addition, a review of the Forestry Commission to enhance its capacity for coordination and synergistic policy interventions with other sectors such as agriculture, mining, and COCOBOD, is highly desirable.

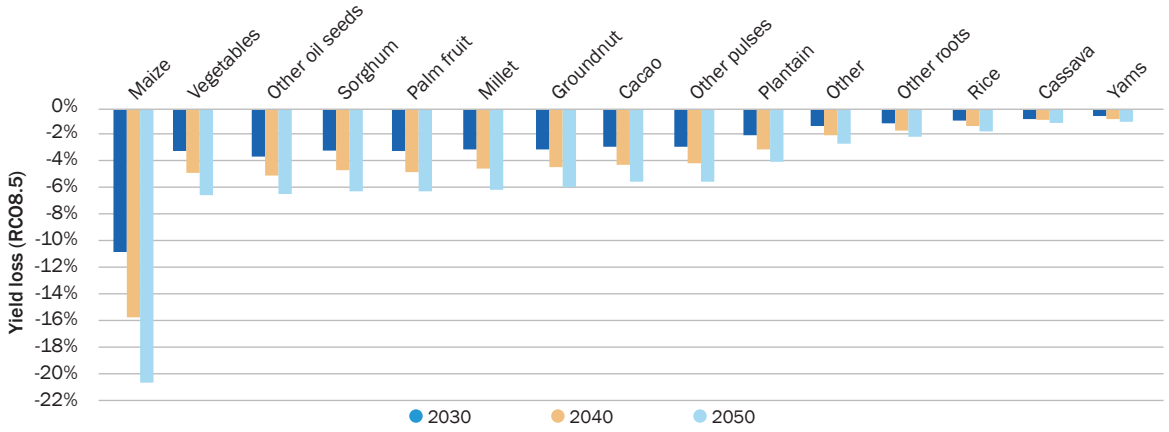
Promote climate-smart agriculture

To reduce the vulnerability of food and cocoa production to climate change and increase agricultural incomes, Ghana should transition to CSA. It is estimated that climate change could cause yield losses to most rainfed cereals, especially maize, up to 16 to 21 percent in 2050, compared to a baseline without climate change, and increase the share of livestock affected by droughts from 13 to 39 percent.[59] Yields could also decrease for other crops like cassava, yam, plantain, and groundnut (Figure 8). Cocoa yields could also decline 3 percent by 2030 and 5-7 percent by 2050. This, in addition to other challenges like the Cocoa swollen shoot disease (CSSD) could cause Ghana to lose global trade comparative advantage. This will not only have major impacts on the 30 percent of the economically

[57] Meridia. Viability of a cost recovery model for farm-level tenure documentation and tree tenure registration: Experiences from the Asankrangwa Stool. (2020). Washington, DC: USAID.
[58] Bolin, A., Lawrence, L. & Leggett, M. (2013). Land tenure and fast-tracking REDD+: time to reframe the debate?; Global Canopy Program; Forest Carbon Partnership Facility (FCPF) (2016). Carbon Fund – Methodological Framework.
[59] Adzitey F. 2013. *Animal and meat production in Ghana*. J World's Poultry Res 3(1):01–04. UNDRR and CIMA. 2019. *Ghana Disaster Risk Profile.*

active population[60] employed by the agriculture sector, but on all Ghanaians, given that the agriculture sector supplies more than 70 percent of national food demand and contributes 20 percent of GDP.[61] The poor, in particular, will be severely affected, with 88 percent of the household heads of the poorest wealth quintile being self-employed in agriculture.[62]

Figure 8. Yield losses by crop under a high emission scenario RCP8.5 (2030-2050)



Source: IMPACT analysis in the Climate-Smart Agriculture Investment Plan for Ghana (World Bank, 2020)[63]

To promote and scale-up CSA, Ghana will need to develop enabling policies and incentive packages as well as increase investments over the short- to medium-term, focused on three key actions:

i) Expanding irrigation infrastructure and services.

ii) Training farmers on CSA practices and digital skills.

iii) Rebalancing public spending and de-risk CSA adoption by appropriate planning.

CSA technologies and practices for improving water resource management, including increasing areas under irrigation and introducing water harvesting technologies, will also be critical. At present, only two percent of agricultural land is irrigated.[64] As a result, the sector is characterized by variable production and low productivity. Expanding large- and small-scale irrigation would enable multiple cropping, stabilize yields during droughts, and potentially deliver higher yields. Improved water use efficiency should also be promoted by modernizing and rehabilitating irrigation and drainage infrastructure and achieving water savings. Saved water resources can be reused to irrigate additional agricultural land or for other sectors. In this context, implementation of Ghana's Climate-Smart Agriculture Investment Plan CSAIP will be critical, along with further investments to secure adequate water for food production. Although the need is national, the Northern and Upper West regions present the most potential to increase productivity and small farmer income. The potential is also high to ramp up rice production to meet growing domestic demand and substitute costly imports.

Training on various CSA technologies and practices, such as intercropping and cocoa agroforestry, is also needed to offset the impact of climate change on yields. Identified options from CSAIP could increase cereal-legume and cocoa productivity by at least 40 and 32 percent, respectively, thereby increasing food availability and export earnings. However, while such CSA investments can reduce emissions from agriculture by improving productivity per hectare, greater intensification also leads to more GHG emissions from increased energy and agrochemical use. Therefore, it will be important to promote the

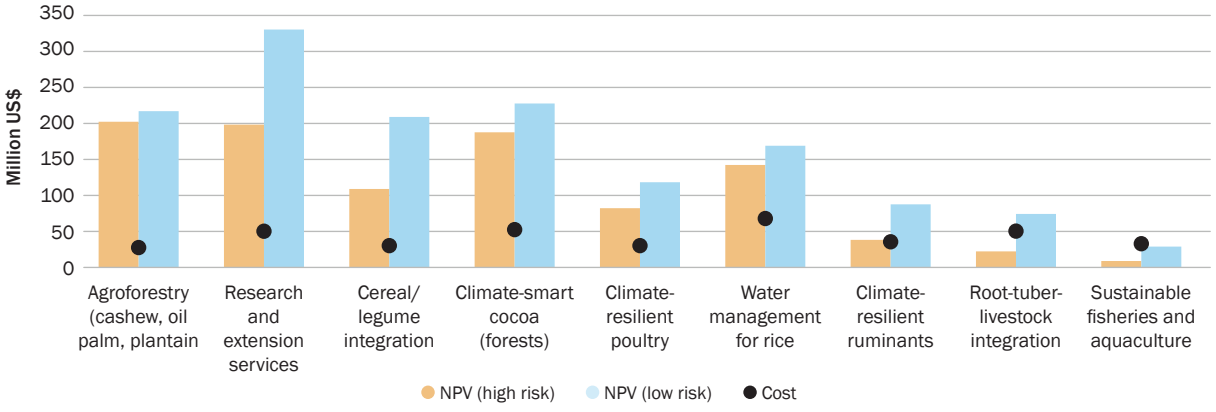
[60] World Bank. 2022. Employment in agriculture (% of total employment) (modeled ILO estimate) - Ghana. Data accessed on May 19, 2022. https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=GH
[61] World Bank. 2020. Climate-Smart Agriculture Investment Plan for Ghana.
[62] World Bank 2020. Ghana Poverty Assessment. Poverty and Equity Global Practice, Africa Region.
[63] World Bank. 2020. Climate-Smart Agriculture Investment Plan for Ghana.
[64] Ghana Ministry of Food and Agriculture. 2020. "Agriculture in Ghana: Facts and Figures (2019)" Statistics, Research, and Information Directorate.

use of less fertilizer without sacrificing crop yields through Integrated soil fertility management, the application of the 4R technique (right source, placement, quantity, and time) for synthetic fertilizer, and the integration of crop-livestock production systems. Specifically, the CSAIP recommends two national investments focused on providing capacity building, information, infrastructure, and national services to enable CSA, along with seven subnational investments focused on introducing CSA practices such as improving soil fertility and management and planting heat-tolerant and disease-resistant crop varieties in certain parts of the county. All these investments are predicted to provide significant benefits for Ghanaian farmers and have positive returns on investment (ROIs), reaching as high as nine times for tree crops.

CSA implementation will require training for farmers and digital solutions. Priority training topics include the management of pests and diseases, crops, trees, soil, and water. Higher-level digital skills on big data and remote sensing will also be necessary for the development of smartphone-based financial and information services, precision farming, digitizing records, barcode product tracking, and GPS-equipped transportation services. In addition, the use of blockchain can help build climate resilience once technology systems are in place. In addition, developing and maintaining climate information services, digitizing farm records, early warning pest and disease management systems, and soil information services will require software development and business skills.

Implementing these CSA interventions will also require a mix of financing options, including rebalancing public spending and de-risking CSA adoption, but are projected to generate strong ROI. While an estimated US$389.54 million over four years is required for CSAIP investments, which aim to reach about 1.7 million beneficiaries, they could generate an NPV of US$1.2 billion (Figure 9). This investment could come from redirecting public spending in agriculture towards CSA and complementary areas such as infrastructure, research and development, and extension services. Given that financing needs are larger than available public resources, mobilizing new funds, including from the private sector, will be crucial. However, this will require improving the capacity of policymakers to develop bankable proposals that can be self-sustained in the medium- to long-run.[65] In addition, to reduce upfront costs and risks associated with CSA adoption by farmers,[66] incentive instruments such as feebate schemes,[67] payment for ecosystem services (PES), and weather-based insurance can be used.

Figure 9. CSA measures are estimated to generate strong ROI (represented by NPV)



Source: World Bank. 2020. Climate-Smart Agriculture Investment Plan for Ghana.

[65] Djido, A., et al. 2021. "Implementation, usage, and effectiveness of Ghana climate change policies: An assessment of the national CSA Action Plan and CSA Investment Framework." CCAFS Info Note.
[66] Murken, L. and Gornott, C. 2019. "Climate risk analysis for identifying and weighing adaptation strategies in Ghana's agricultural sector." Potsdam Institute of Climate Impact Research.
[67] A feebate combines an increase in taxes on unsustainably produced commodities with a decrease in taxes on sustainable products.

Support the adaptation of coastal communities

Approximately 80 percent of Ghana's 550-kilometer shoreline is at high risk of coastal flooding and erosion. Ghana is amongst the most exposed countries in Sub-Saharan Africa (SS) to coastal risk, with more than 5.5 million people and 550 km^2 of built-up area within less than one kilometer from the shoreline. After Nigeria and South Africa, Ghana is the third most exposed country in SSA to a 10-year coastal flood event. In Accra, flood risk to assets exceeds US$20 million per year (AAL in 2015),[68] which is among the highest in SSA. Ghana's coast is eroding at rates averaging 4 to 12 meters per year, and even more in areas downstream of port infrastructure, reaching 20 meters per year in some places. This challenge will be exacerbated, as ten new or expanded ports are under construction or planned, without integrated studies of their impact on coastal erosion, accretion, sediment balances, and sea level rise. Projections indicate that sea levels will rise by 16.5 cm and 34.5 cm by 2050 and 2080, respectively, and the share of populations affected will increase. Sea level rise is projected to exacerbate shoreline recession, inundating low-lying coastal areas, and increase the salinity of estuaries and aquifers, negatively impacting Ghana's remaining mangrove forests. Projected flooding increases in low and coastal areas could severely impact marine ecosystems, biodiversity, and coastal livelihoods, especially in areas inhabited predominantly by fishermen and farmers.

Overfishing is causing significant declines in coastal fisheries stocks,[69] while climate change is deteriorating the conditions that are necessary for sustainability and overall fisheries health, jointly and negatively affecting fish production.[70]

In the near term, recommended policy actions to foster resilient coastal communities include:

i) Developing a blue economy framework.

ii) Adopting an integrated coastal zone management (ICZM) approach, which includes improved spatial planning and enforcement capacities for protecting and managing coastal ecosystems.

A blue economy framework could help Ghana to sustainably enhance socioeconomic benefits from its coastal and marine resources. The framework should guide relevant sectors, including fisheries, maritime trade and transport, extractives, and tourism, to enhance their institutional capacities and investments. It should address institutional fragmentation around coastal zone management and develop relevant and enforceable blue economy policies and regulations, while aligning with regional policies such as Agenda 2063, which calls for the development of the blue economy.

Building on this, Ghana should consider adopting an ICZM approach, centered around ecosystem protection, as a low-cost, high yield strategy that can have widespread benefits. Blue carbon ecosystems, such as mangroves, wetlands, lagoons, and seagrasses, increase the resilience of coastal communities by naturally mitigating the impacts of flooding, shoreline erosion, and storm surges.[71] Ecosystem protection and restoration, including prevention of further encroachment through improved urban planning and enforcement of protected areas, can yield significant development benefits while contributing to climate mitigation. A key benefit is a more sustainable fisheries sector, which provides jobs and incomes for 10 percent of the population and accounts for 60 percent of animal protein consumption. Since ICZM is a multidisciplinary and iterative process, it will require coordinated action and clear delineation of responsibilities across relevant line ministries, along with improved environmental and social risk management, especially around ports and coastal protection infrastructure, to ensure that coastal development does not pose risks to communities or ecosystems. An ecosystem-based ICZM approach is a low-cost action that could enhance the areas critical for fish spawning and breeding, expand suitable habitat while improving biodiversity, and strengthen the

[68] World Bank, 2022. Living on water's edge. Flood risk and resilience of coastal cities in Sub-Saharan Africa

[69] Lazar, N., et al. "Status of the small pelagic stocks in Ghana and recommendations to achieve sustainable fishing 2017." Scientific and Technical Working Group. USAID/Ghana Sustainable Fisheries Management Project (SFMP). Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island. GH2014_SCI042_CRC (2018).

[70] World Bank. 2020. *Ghana Country Environmental Analysis.*

[71] IPCC. 2021. Climate Change: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the IPCC. MassonDelmotte, V., et al.. Cambridge University Press. In Press

resilience of coastal communities most at risk from climate change. The Volta Delta is a potential hotspot for the adoption of ecosystem based ICZM approach.[72]

In the longer term, a blue economy approach should catalyze transformational changes in relevant sectors. This includes moving from carbon-intensive offshore oil and gas towards renewable marine-based energy and shifting from infrastructure-based approaches for resilience towards nature-based solutions (NbS). This will also require policy reforms, capacity development for enforcement, and increased mobilization of finance for a multisectoral blue economy approach that addresses trade-offs while maximizing sustainability and economic benefits. Innovative financial mechanisms such as blue bonds and carbon markets can be implemented to increase funds for the transition.

3.1.2. Build sustainable cities and resilient infrastructure systems

Ghana's cities continue to face major challenges with delivering inclusive and resilient growth, in the face of increasing populations and climate risks. Its urban population more than tripled since 1990, from under 4 million to nearly 17 million people (57 percent of the total population) and is expected to reach 37.5 million (73 percent of the projected total population of 51.2 million) by 2050.[73] While urbanization has coincided with economic expansion, improved human capital, and declines in poverty, it has also been accompanied by unplanned and low-density expansion, a proliferation of informal settlements (now home to 40 percent of the urban population), and inefficiencies and inequalities in the delivery of basic services.[74] In addition, infrastructure development in most cities has not kept pace with urbanization and exposure to high temperatures, droughts, and floods poses major threats to its housing, transport, water, sanitation, and energy assets. Urban floods have become more frequent and of higher intensity because of several factors, including fast growing occupation of flood risk areas, inadequate and unmaintained drainage systems, heavy siltation and waste accumulation along waterways, increased impervious surfaces with lower water infiltration capacity and faster run-off, and increased extreme precipitation events. Urban floods have major impacts on people and infrastructure, with 2015 flood events affecting 53,000 people in Accra, causing around US$55 million in damages, and requiring US$105 million for reconstruction.

Increasing surface temperatures and loss of vegetation in urbanizing areas have also resulted in urban heat island effects. For example, it is estimated that the urban heat island effect in Greater Accra is 4.86 degrees Celsius compared to surrounding areas.[75] In Kumasi, green space per capita is just 4.7 square meters, well below the WHO's recommendation of 9 square meters and far below that of Johannesburg (60.0) and Nairobi (37.3), and Addis Ababa (36.5). This increases energy requirements for air conditioning, air pollution levels, and heat-related illness and mortality. If current sprawling expansion trends persist, Ghana could double its built-up area by 2050.[76]

Urban density is expected to remain low compared to other large cities in the region[77]), exacerbating the cost of supplying basic services and the potential exposure of public infrastructure to flooding. As cities expands with low density, the costs of O&M of flood management infrastructure increase. This presents a major challenge for new expansions in Accra and secondary cities.

As urbanization continues, there is a narrow window of opportunity to make cities more livable, productive, and resilient. This will require changes to Ghana's urbanization patterns and strategies for cities, including ramping up climate-resilient investments that avoid locking in unsustainable low-density growth patterns that will be increasingly vulnerable to climate impacts. Accra has prepared a

[72] World Bank. 2022. Compendium: Coastal Management Practices in West Africa - Existing and Potential Solutions to Control Coastal Erosion, Prevent Flooding and Mitigate Damage to Society. Washington, DC: World Bank.
[73] UNDESA, Population Division. 2018. *World Urbanization Prospects*.
[74] World Bank Group. 2015. Rising through Cities in Ghana: Ghana Urbanization Review Overview Report. World Bank, Washington, DC.
[75] Wemegah, Cosmos S. Edmund I. Yamba, Jeffrey N.A. Aryee, Fredrick Sam, Leonard K. Amekudzi. 2020. Assessment of Urban Heat Island Warming in the Greater Accra Region. Scientific African, Volume 8, 2020. ISSN 2468-2276.
[76] Adapted from Fafchamps and Shilpi (2020) projections.
[77] Increasing from 2,900 people per square kilometer in 2020 to 3,100 by 2050

Resilience Strategy (2019) and Climate Action Plan (2020), but is the only city in Ghana to do so and its implementation is lagging. **To build more sustainable cities and resilient infrastructure systems, Ghana should prioritize: (1) taking an integrated approach to urban development, (2) investing in high-quality infrastructure for walking and biking and improving public transit services, (3) expanding rural-urban connectivity with resilient infrastructure, and (4) developing the circular economy.**

Taking an integrated approach to urban development

Integrated approaches to urban planning and development can help Ghana to build climate resilience while enhancing the quality of life for urban residents and improving urban economies. Although the Land Use and Spatial Planning Act (2016) provides for sustainable land development through a decentralized system of planning, with regulations for spatial planning across all tiers of government, and a multi-district planning committee to tackle cross-district issues, the preparation and enforcement of urban plans have been weak. Most of Ghana's 261 municipalities do not have spatial plans to guide and coordinate infrastructure investments across transport, water, sanitation, and housing and a structured plan for the Greater Accra Metropolitan Area is still under preparation.

Implementing climate-informed, integrated urban plans across Ghana should involve a wide range of short- and longer-term priority investments, including in:

i) Preparing urban plans, mainstreaming climate change, and assuring enforcement.

ii) Promoting NbS, such as multifunctional urban green spaces.

iii) Enhancing climate-resilient water supply and sanitation services and infrastructure.

iv) Expanding green buildings for new construction and retrofitting, including in informal areas.

v) Exploiting digital technologies for smart city development.

In the short-term, no-regret actions include incorporating city-specific climate risk analyses into urban infrastructure planning, integrating climate risk data into land use plans and building codes, building climate-proof infrastructure, and improving the enforcement of urban development regulations. A potential anchor for more integrated urban planning could be transit-oriented development (TOD), which is prioritized in the Accra Climate Action Plan. TOD can reverse the trend of low-density expansion by creating compact, walkable urban spaces that include a mix of commercial and residential buildings around public transit nodes, as detailed below.

While this may involve some grey infrastructure such as seawalls and bridges, the use of NbS will be key to improving the livability of Ghana's cities and their attractiveness for business. For example, multifunctional urban green spaces can provide recreational areas while absorbing stormwater runoff and reducing the urban heat island effect or afforestation along riverbanks and catchment areas can help protect flood-prone areas, reduce sedimentation, and safeguard exposed roads. Such planning should extend to informal settlements and be adaptive to their context.

Investments are also needed in resilient water supply and sanitation services, which have not kept pace with urban growth and are highly affected by climate change. Only 60 percent of the urban population has access to a safely managed water supply and just 12 percent have access to safely managed wastewater treatment services.[78] Open defecation remains prevalent, at 22 percent nationwide and as high as 67 percent in the Upper East region.[79] Wastewater treatment systems only serve 5 percent of the country and have poor O&M, leading to the overflow of sewage into drains, impacting health and polluting water. As a result, more than 50 percent of human excreta produced in cities ends up untreated in the environment. Poor wastewater management also contributes to an estimated 14 percent of GHG emissions in Accra. To provide universal access to safely managed water supply and basic sanitation

[78] JMP 2021 report

[79] Multi-Indicator Cluster Survey (2017/2018)

services in cities by 2030, Ghana needs to invest US$11.3 billion.[80]

Extreme events like flooding could destroy WASH infrastructure, causing service disruptions, pollution of the potable water supply and the environment, and corresponding health risks. Additionally, since several wastewater treatment plants in Accra, Tema, and Sekondi-Takoradi are located close to the coast, sea-level rise may impact their operation. Drought is another major risk, particularly for the Densu and Volta sources that serve the western and eastern parts of Accra. During the extreme dry period, the Ghana Water Company (GWCL) has had to ration water supply in most of its operational areas. To address these risks, it is necessary to: (i) build climate-resilient and climate proof existing water supply infrastructure, including reservoirs, drains, and boreholes for cities and communities, and (ii) train communities on the management of water resources and water infrastructure.

Likewise, demand for housing has outstripped supply and resulted in a deficit of 1.8 million homes, creating opportunities to ensure new buildings are more resilient and greener. The deficit has manifested in overcrowding and poor housing conditions, including reliance on non-durable construction materials and lack of access to water and sanitation, which increase families' vulnerability to climate risks and shocks such as the COVID-19 pandemic. If unaddressed, the deficit could reach 4.8 million housing units by 2050. Ensuring that new housing in cities integrates green and resilient design measures, including site-specific risk assessments, is a no-regret action that will promote safe and healthy shelter for residents. Upgrading slum areas, including the installation of basic services and drainage, should be implemented in parallel to the construction of new housing.

Box 3. Green Buildings — Excellence in Design for Greater Efficiencies (EDGE) program

Since 26 percent of Accra's GHG emissions in 2015 came from energy, mainly residential buildings, increasing the construction of green buildings can reduce demand-side pressure on the consumption of energy and water, lower operating expenses, and reduce GHG emissions. To support the expansion of the green building market, the Excellence in Design for Greater Efficiencies (EDGE) program could be scaled up. Launched in 2015, EDGE laid the foundations for green building in Ghana by improving the legal environment, building capacity, and raising awareness of the industry and green finance, and promoting the use of voluntary certifications. As a result, the volume of green certification has grown from one project with a floor area of 17,000 sqm in 2015 (less than 0.1 percent of total new build) to 202,000sqm (7.8 percent) in 2021. Notably, in 2021, the first affordable housing project in Ghana to achieve the EDGE certification was completed. The 1,700-unit Knightsbridge community features efficient lighting, natural ventilation, low-flow faucets, and dual-flush toilets, reducing electricity and water use by a third. Moreover, the community was built from materials that require 50 percent less energy to manufacture, transport, and install compared to other buildings in Accra.

Efforts to promote more compact urban growth with integrated service delivery are also projected to help curb GHG emissions. In 2015, 51 percent of Ghana's CO2 emissions were emitted in urban areas.[81] [82] As rapid urbanization continues, so will emissions. Under a BAU scenario, GHG emissions from urban areas would almost quadruple by 2050. However, the Accra Climate Action Plan shows that emissions could be reduced by 27 percent by 2030 and 73 percent by 2050 (Box 4).

[80] Using a discount rate of 6 percent. Source: WASH Sector Development Programme (2021-2030).
[81] Urban centers, suburban and peri-urban areas, and dense and semi-dense settlement clusters.
[82] Crippa et al., 2021. "Global Anthropogenic Emissions in Urban Areas: Patterns, Trends, and Challenges." Environmental Research Letters 16 (7): 074033. Country-level data accessed through EC's EDGAR database (https://edgar.jrc.ec.europa.eu/)

Box 4. Accra's Resilience Strategy and Climate Action Plan

Accra's Resilience Strategy (2019) offers a roadmap and its Climate Action Plan (2020) identifies emissions reduction opportunities with targets for 2030 and 2050. In 2015, Accra generated 1.2 tCO2e per capita, comparable with other capital cities in Africa, such as Lagos (1.4 tCO2e) and Addis Ababa (1.6 tCO2e). Most of Accra's emissions are generated due to solid waste and wastewater treatment (44 percent), followed by transportation (30 percent), and energy (26 percent). If no climate actions are taken, Accra's emissions will triple by 2050. However, Accra aims to reduce emissions by 73 percent by 2050 through specific actions such as 100 percent residential LED, 60 percent shift of passengers to mass transit, 60 percent of new households in TOD areas, 100 percent treatment of wastewater, and 90 percent capture of landfill gas. Among these actions, encouraging the use of public transit, walking, and biking achieve the greatest reductions. These are urgent, "no-regret" actions that will deliver large development benefits related to traffic, air quality, road safety, and spatial inclusion.

Finally, to support integrated urban planning and service delivery, Ghana is well-positioned to leverage digital technologies. Given that Ghana's mobile phone adoption stands at 55 percent, the highest in West Africa, and has one of the highest ratios of mobile-to-internet penetration in Africa,[83] its cities can leverage mobile technologies and services for improved early warning systems, coordinated planning, and the efficient delivery of climate-informed infrastructure and services. However, major challenges need to be addressed, including the scarce use of data-based solutions in urban planning, the absence of a cross-cutting digital strategy, and limited collaboration among different levels of government. A roadmap toward smart city development in Ghana is currently under preparation and includes quick-start actions such as outlining a governance framework that clarifies cross-tier roles, identifying common solutions that groups of cities can adopt, and building capacities. These actions would ultimately support the development of a pipeline of investor-ready solutions.

Invest in high-quality walking and biking infrastructure and improve public transport services

Major investments are needed in public transport infrastructure and services. Although motorization is relatively low in Ghana compared with global levels—around 32 vehicles per 1000 people in 2015 compared to 182 globally, vehicle ownership continues to increase. In addition, longer travel distances in expanding urban areas have increased travel mileage by an estimated tenfold in the past 25 years. Public transport infrastructure and services—largely provided by informal tro-tros (minibuses)—have failed to keep up with demand.[84] The result is worsening accessibility, spatial exclusion, and congestion, particularly for the most vulnerable—trends that are projected to continue in a BAU scenario. It is estimated that from 2015 to 2030, the primary road length per 1,000 residents will decrease by 43 percent in Kumasi and 71 percent in Tamale, whereas the private vehicle fleet will increase by 177 percent and 192 percent, respectively.[85] In a BAU scenario, areas on the periphery of the city will be excluded from accessing jobs via public transport.

Recommended policy actions and investments to improve mobility through public transport include:

i) Enhancing the quality of public transport services and systems.

ii) Improving public transport fleet quality.

iii) Providing high-quality walking infrastructure.

[83] World Bank. 2020.
[84] Arroyo-Arroyo. 2021. *Connecting the Dots: People, Jobs, and Social Services in Urban Ghana. International Development in Focus.* Washington, DC: World Bank.
[85] Arroyo-Arroyo. 2021.

Reforms to the public transport sector can improve the coverage and quality of public transit services. This includes improving the professionalization of operations, rationalization of routes, and digitalization of payment systems. Without investment now in public transport infrastructure and services, the cost of congestion—already a major source of productivity loss in Ghana's urban areas—will counteract the productivity benefits cities can deliver, and it will be too costly or impossible to retrofit cities and their urban transport systems to become competitive, inclusive, and sustainable.

Improving public transport services should be coupled with fleet improvements. Road transport vehicles in cities are a significant contributor to GHG emissions and negative health impacts associated with air pollution from vehicles. In Ghana, the vehicle fleet is responsible for 80 percent of outdoor air pollution. In 2016, PM2.5 in Ghana averaged 54.5 micrograms per cubic meter (μg/m^3), far exceeding the WHO annual guideline of 10 μg/m^3.[86] In the same year, ambient air pollution was responsible for as many as 11,739 deaths.[87] For the future, it is estimated that the GDP impacts of urban air pollution may be comparable to the aggregated impacts of climate change. While emissions standard for passenger and freight vehicles are likely to be handled at the national level (see Section 3.2.3), cities can support fleet renewal for public transport. Renewing the fleet of old, low-quality tro-tros to meet Euro 4 emissions standards could reduce local air pollutant emissions by 76 percent in Accra and by 98 percent in Kumasi, with moderate corresponding GHG emissions reductions.[88] Electrifying public transit vehicles—a commitment in Ghana's NDC—would further reduce emissions, but at a much higher cost. Therefore, the most cost-effective gains to reduce GHG emissions and air pollution would be realized by prioritizing the expansion of the number of trips taken by public transit (over less efficient private vehicles) through improvements in service coverage and quality.

In Ghana's cities, since most trips are made by foot out of necessity, providing high-quality walking infrastructure can improve pedestrian safety, promote inclusion, and make walking a more sustainable choice. In Accra, Kumasi, and Tamale, around 60 percent of trips to schools or markets and 40 percent of trips to work are made on foot.[89] This is not by choice. Unpaved roads, particularly prevalent in informal settlements, create difficult conditions for walking and bicycling, and even more so during the rainy season. In Accra, only about 20 percent of roads have sidewalks.[90] As Ghana's cities continue to develop outward, people must walk very long distances to access economic opportunities or education and health care services. Low-income groups, women, and people with disabilities face greater barriers to mobility. They are also exposed to road traffic fatalities and serious injuries. In 2016, the WHO estimated that road crashes were responsible for 7,018 premature deaths and 105,270 serious injuries; fatalities per registered vehicle are approximately 100 times those in EU comparators. These were valued at US$4.5 billion, using the value of a statistical life (VSL) approach. And with 70 percent of road crash fatalities and injuries in the country affecting individuals in the most economically productive age groups (15-64 years), there are important indirect costs to livelihoods and welfare.[91] Thus, creating attractive, high-quality infrastructure for walking and biking is a "no regret" climate action that would deliver large economic and social benefits.

Expand rural-urban connectivity with resilient transport infrastructure

Ghana's road network is still inadequate to provide rural-urban connectivity for all people in the country and faces high exposure and vulnerability to climate change. Despite the significant expansion of Ghana's road infrastructure, some rural communities remain disconnected. Of Ghana's 137 districts, 17 have a rural accessibility index (RAI)[92] of 50 percent or lower. Most of these disconnected communities are in the Volta basin or Northern region. Many others are connected by roads that are threatened by changes in temperature, precipitation, and climate-induced natural hazards, facing increasing risk

[86] https://www.who.int/data/gho/data/indicators/indicator-details/GHO/concentrations-of-fine-particulate-matter-(pm2-5)
[87] https://www.who.int/data/gho/data/indicators/indicator-details/GHO/ambient-air-pollution-attributable-deaths
[88] Arroyo-Arroyo. 2021.
[89] Arroyo-Arroyo 2021.
[90] Accra Climate Change Action Plan
[91] https://www.roadsafetyfacility.org/country/ghana
[92] A measure of the share of people within 2 kilometers or an all-weather road

of economic and social isolation. Flooding and landslides are the most frequent and damaging for Ghana's roads, with around 117 kilometers affected by flooding each year.[93] In the period 2020-2050, floods are projected to cause US$2.05 billion in (discounted) direct damages to assets.[94] Combining the flood exposure and RAI, 41 districts (30 percent) are classified as vulnerable due to their high exposure to frequent and severe flooding and their low rural accessibility and high isolation rates, with 8 districts classified as highly or very highly vulnerable.

Key transport hubs such as airports and ports are also at high risk from floods. The three most exposed airports in Ghana—Tamale, Ho, and Takoradi—serve over 500,000 passenger trips and the five most exposed inland river ports—Makange, Yeji, Dambai, Dodolkope, and Kete Krachi—serve 1.7 million trips. Thus, millions of Ghanaians are facing increased interruptions in transport systems, affecting livelihoods (e.g., access to markets, workplace, education) and health (e.g. reaching hospitals in emergencies) as well as economic activity and trade.

To expand connectivity and strengthen the resilience of transport, recommendations include:

i) Mainstream climate risk into feasibility studies and designs.

ii) Investing in road maintenance.

iii) Building institutional capacities for disaster risk management and emergency response.

Invest in the circular economy for integrated waste management

As cities expand, waste generation will increase, presenting challenges for sustaining and scaling waste management in the face of growing climate vulnerability. Ghana generates nearly 8 million tons (MT) of solid waste per year and this is projected to grow by 250 percent by 2050, surpassing 20 MT per year. Meeting this demand for services will require cumulative capital investments and operational costs of US$4 billion (discounted) by 2050, and important policy reforms enabling private sector participation in improved service provision. The solid waste sector also plays an important role in flood risk management, as improper disposal can be a significant factor contributing to flooding in urban areas.

To strengthen waste management in Ghana, the government should focus on two key actions:

i) Improving the treatment and productive use of liquid solid waste.

ii) Eliminating burning, open dumping, and uncontrolled disposal of solid waste.

iii) Promoting the transition to a circular economy.

The treatment of liquid waste is imperative to reduce environmental pollution and the risks of waterborne and sanitation-related diseases. The production of soil conditioner and briquettes from liquid waste co-composted with organic solid waste are initiatives that have been piloted in Ghana and can be expanded. The nutrients from liquid waste, when appropriately handled, can also return nutrients to crops, while improving water quality. Efforts to reduce open defecation can also have positive impacts on child health and cognitive development as well as reduce the prevalence of under-nourishment and stunting in children (which are at 7 percent and 18 percent, respectively).[95]

To meet current and future needs for waste management, Ghana should improve waste management systems and adopt a circular economy approach. This will require investments to minimize waste generation and eliminate burning, open dumping, and uncontrolled landfilling, along with measures to improve governance. Also, since the largest share of household municipal solid waste (MSW) is organic (54 percent), increased composting and waste separation should be prioritized, along with increased

[93] UNDRR and CIMA, 2019. *Ghana Disaster Risk Profile.*

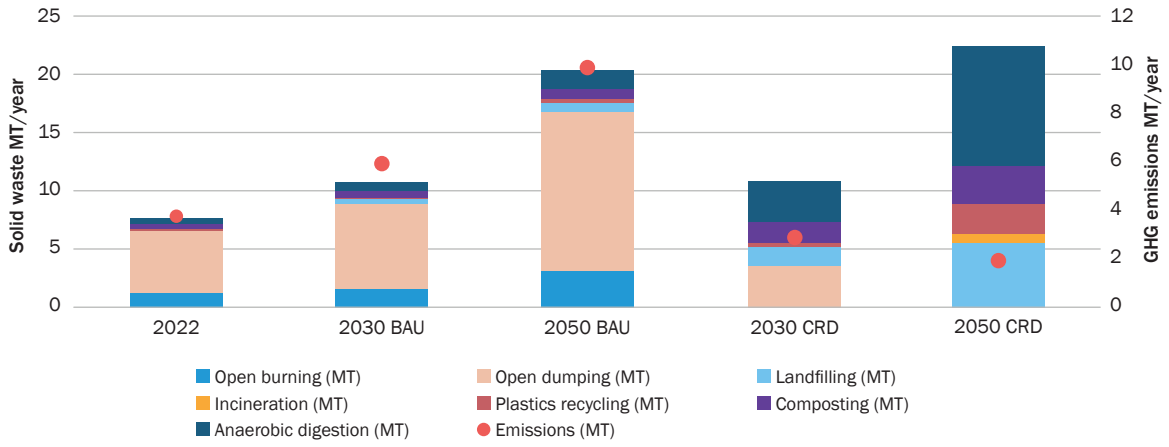
[94] Undiscounted damage estimates range from US$3.9 billion (undiscounted) in damages to road infrastructure on a national scale (Adshead, D. et al. 2022. Ghana: Roadmap for resilient infrastructure in a changing climate. Ministry of Environment, Science, Technology & Innovation, Accra, Ghana).

[95] FAOSTAT 2017

recycling, particularly since the next largest component of household MSW is plastics (16 percent). Ghana could aim to increase recycling of plastics from 15 percent in 2020 to 60 percent by 2050, increase composting from 9 to 50 percent, and increase landfill gas capture from 0 to 100 percent.

Investing in a circular economy can also have significantly reduce emissions and air pollution. Ghana's waste sector contributes to 7.5 percent of national emissions and 44 percent of emissions in Accra. These are projected to more than double, to 10 MT CO2e, by 2050, in the absence of the nearly US$ 1.5 billion (discounted) in capital investments needed (Figure 10). The eradication of open burning and universal adoption of landfill gas capture by 2050 would significantly mitigate waste-related air pollution, including 8 MTCO2e, 4,700 tonnes of black carbon, 63,000 tonnes of PM2.5, and 61,000 tonnes of NMVOCs. Improved waste management would translate to US$6 billion (discounted) savings in health expenditures in 2022-2050[96] and mitigate about 200,000 avoidable deaths per year. Achievement of a circular economy by 2050 would generate at least 50,000 direct jobs across the waste management chain, with indirect jobs reaching a factor of 8.5.[97]

Figure 10. Improved solid waste management, under the CRLCD scenario, is projected to reduce air pollution and GHG emissions in 2050 despite an increase in waste generation



Transitioning to a circular economy model will require a suite of reforms to create an enabling policy environment to catalyze planning, investments, behavior change, innovation, and good governance. First, a comprehensive financial plan for the sector is needed to enable new facilities to be brought online and existing facilities to operate according to environmental standards, to enhance the sector's long-term sustainable performance, and to increase the value-for-money of public expenditures by increasing competitiveness. In parallel, the government should develop a long-term integrated resource plan to anticipate future waste generation and develop infrastructure before critical shortages occur. Cost recovery for waste management services can be improved through a mix of measures, such as restructuring how fees are calculated based on income and ability to pay and expanding property taxes. Collection practices should also be strengthened by standardizing contracting, monitoring, and evaluation. Including key performance indicators for service providers would support the achievement of minimum performance, especially if remuneration is linked to performance. As indicated in the National Plastics Management Policy (2020), the government should introduce an extended producer responsibility scheme (EPR) for plastics and other packaging materials to cover costs of collection and processing of recoverable material streams, thereby reducing total waste volumes requiring disposal and creating incentives for growth of private sector operations. Finally, it is essential to address gaps in monitoring and evaluation and empower the national regulator to enforce standards. This includes building the capacity of local governments to manage private sector contracts for waste collection,

[96] Considering US$1 invested in SWM has 4 times public health benefits: Jonathon P. Leider, Natalia Alfonso, Beth Resnick, Eoghan Brady, J. Mac McCullough, and David Bishai (2018) "Assessing The Value Of 40 Years Of Local Public Expenditures On Health" HEALTH AFFAIRS. 37, NO. 4 (2018): 560–569, doi: 10.1377/hlthaff.2017.1171

[97] More Jobs, Less Pollution: Growing the Recycling Economy in the U.S., Tellus Institute and Sound Resource Management, 2011.

transfer, treatment, and disposal, for instance by providing national standardized contracts and monitoring and reporting.

3.1.3. Boost disaster risk preparedness

Increasing climate variability and weather extremes are already inflicting significant damage on Ghana's human, physical, and natural capital, and exacerbating poverty. Natural disasters such as drought and floods, coastal storms and erosion, and health shocks can prevent vulnerable households from escaping poverty, or even bring them back into poverty, and put a large burden on public finance. Disaster risk preparedness can effectively help the country and communities to cope with and promptly recover from these shocks. Over the last decades, Ghana has invested in disaster risk management (DRM) and has one of the most advanced systems in West Africa—the Ghana National Disaster Management Organization (NADMO), which was formed in 1996. Since then, NADMO has addressed several national emergencies, working in close collaboration with MMDAs, which are responsible for the local implementation of DRM plans. **To further improve its resilience and preparedness for responding to disaster risks, Ghana's priority actions should include: (1) enhancing early warning systems, (2) improving national financial protection against climate shocks, and (3) advancing adaptive health systems.**

Enhance early warning systems

Ghana is developing early warning systems (EWSs), but these tools and technologies are nascent in the country and not fully integrated. The Ghana Meteorological service oversees weather and climate monitoring and alerts. Information is passed to NADMO's Emergency Operation Centers, where warnings are internally distributed and, with support of MMDAs, publicly disseminated. Ghana has initiated Flood EWS in the Volta River Basin and Greater Accra Region (under development), but significant gaps remain on the quality of the warning and the geographic and sectoral coverage. Seasonal forecast and agrometeorological information are available to farmers, although these can be improved with more advanced and reliable tools. Therefore, despite some progress, challenges persist in the implementation and effectiveness of EWS, particularly related to the integration of systems, operations and emergency control, and last-mile communication to reach remote and affected populations and farmers. To improve them, Ghana should consider:

i) Expanding and improving meteorological, hydrological, and agrometeorological systems, infrastructure, and capacities to allow for better coverage and more reliable forecasts, scaling up remote sensing techniques, and providing continuous training of staff in relevant institutions.

ii) Strengthening information and data management systems and developing risk mapping and risk-based warnings for more effective planning, response, and last-mile communication to populations at risk and farmers, in conjunction with the private sector and global/regional centers..

iii) Strengthening response and support capacities in NADMO, MMDAs, and other relevant instructions, along with creating awareness and response capacity in local communities.

iv) Fostering coordination across institutions and levels of government by further formalizing roles and responsibilities and facilitating data and information sharing. And regular simulation exercises.

v) Investing in risk mitigation for relatively frequent disaster events,[98] which are driving losses and impacts, and develop strategies to deal with residual risks.

Improve national financial protection against climate shocks

Climate and disaster risks threaten to roll back development gains and can become significant sources of contingent liabilities. Public resources shoulder a large share of response, recovery, and

[98] Potential investments include detention ponds, regular dredging of sedimented material, improved channel design, and increased O&M budgets.

reconstruction costs in the aftermath of rapid-onset shocks or as a result of long-term stresses. These costs include, for example, fiscal transfers to subnational governments, reconstruction of (public and sometimes private) assets, emergency response, welfare programs, assistance to small enterprises, and stabilization of the private sector. Slow-onset disasters such as droughts may also disrupt agriculture value chains or reduce hydropower generation, necessitating government intervention.

However, budget constraints and under-developed financial markets have been major obstacles in advancing financial preparedness against disasters and climate shocks. Approved national budget allocation to DRM related expenditures have been limited over the past years.[99] Meanwhile, about 70 percent of Ghanaians do not have access to any form of insurance. This hampers the capacity to cope and recover to shocks both in the public and private spaces.

To help increase the financial protection of public and private assets, Ghana should consider:

i) Developing a risk-layered financial strategy, developed based on findings from the conduct of a climate and disaster risk financing diagnostic.

ii) Increasing support for deepening financial markets for climate-resilient financial solutions, such as parametric insurance, including agriculture insurance.

Dedicated funds for disaster preparedness would allow the government to access immediate but limited funding for emergency response. However, beyond financing, it would be critical to ensure that such funds are made available to local implementing institutions who are the first responders post disasters. Disaster funds could be complemented by a contingent line of credit, such as the World Bank's Development Policy Credit with a Catastrophe Deferred Drawdown Option (Cat DDO). For more severe, less frequent events, Ghana could explore sovereign catastrophe risk insurance, e.g., through sovereign insurance and sovereign risk pools like African Risk Capacity.[100]

Advance adaptive health systems

Climate change and variability affect health outcomes while directly and indirectly intensifying social and environmental determinants of poor health. Increased exposure to high temperatures directly causes injuries and deaths, particularly among the elderly and other vulnerable groups, while affecting the productivity of workers and learning ability of students. Floods can also cause fatalities, serious injuries, and disabilities. For example, Accra 2015 floods resulted in the loss of over 150 lives, with many others injured.[101] [102] Victims of floods and their immediate families also suffer from long-term mental health conditions.[103] Floods and rising temperature can increase the spread of water-borne diseases[104] (e.g. diarrhea,[105] cholera,[106] schistosomiasis,[107] and cerebro-spinal meningitis[108]) and increase malnutrition (a 1 degree Celsius rise in temperature is estimated to reduce real food consumption for the average adult in Ghana by 4 percent).[109]

[99] Ghana's Third Biennial Update Report to the UNFCCC 2021 (EPA, 2021)
[100] Ghana is a Member State of the African Risk Capacity which offers coverage for significant drought, extreme weather (Extreme Climate Facility), outbreaks and epidemics (O&E), and soon, flooding, and tropical cyclones as well.
[101] Asumadu-Sarkodie S., Owusu Phebe A. and Rufangura P. 2015. *Impact analysis of flood in Accra, Ghana.* Adv Appl Sci Res 6:53–78.
[102] Amoako C. and Inkoom D.K.B. 2018. *The production of flood vulnerability in Accra, Ghana: Re-thinking flooding and informal urbanisation.*
[103] Dziwornu E. and Kugbey, N. 2015. *Mental health problems and coping among flood victims in Ghana.* Curr Res Psychol 6:15–21.
[104] Xu Z., Huang C., et al. 2013. *Is Diurnal Temperature Range a Risk Factor for Childhood Diarrhea?* PLoS ONE 8(5), e64713.
[105] Institute for Health Metrics and Evaluation. 2019. Global Burden of Disease.
[106] University of Ghana School of Public Health. 2018. *State of the Nation's Health Report. Sub-Saharan Publishers.*
[107] Adekiya, T.A. et al. 2019. *The Effect of Climate Change and the Snail-Schistosome Cycle in Transmission and Bio-Control of Schistosomiasis in Sub-Saharan Africa.* Int J Environ Res Public Health. 2020 Jan; 17(1): 181.
[108] Institute for Health Metrics and Evaluation. 2019. Global Burden of Disease.
[109] Etwire. 2018. "The economic impact of climate change on farm decisions and food consumption in Ghana." Dunedin, New Zealand: University of Otago.

To reduce the health impacts of climate vulnerability and reduce poverty, recommended policy actions and investments include:

i) Adopting universal health coverage and lowering out-of-pocket expenses.

ii) Improving hygiene practices and behaviors.

iii) Enhancing food security and strengthening the resilience of food systems.

iv) Investing in monitoring and surveillance systems in the health and environmental sectors.

Considering the importance of child health for long-term prospects, productivity, and income, even a moderate impact of climate change on health could affect poverty visibly over the long-term.[110]

3.2. Priority areas for low-carbon development

Building on its transition to a more climate-resilient pathway, Ghana can seek, over the longer term, to undertake a low-carbon development pathway that enhances its energy security and modernizes the transport system, while reducing externalities such as GHG emissions, air pollution, and health-related consequences. Over the short term, Ghana can start setting the transition for these sectors while realizing opportunities for carbon sinks in the forestry sector though the zero-deforestation commitment by 2030. To decouple economic growth from GHG emissions and air pollution, Ghana will need to reduce emissions in the AFOLU, energy, and transport sectors, which are projected to continue to account for around 90 percent of emissions through 2030. This growth in emissions, which is in line with income growth and urbanization, has gone hand in hand with increasing ambient air pollution, which has an annual cost estimated at US$1.1 billion.[111] Therefore, this report explores priority actions for low-carbon development across three key areas: (1) realizing new opportunities for carbon sinks, (2) promoting a clean energy transition, and (3) modernizing the transport sector.

3.2.1. Realize new opportunities for carbon sinks

Ghana has the opportunity to reverse the current trend of forest resource depletion and land degradation by turning its forestry sector into a net carbon sink. This will require priority actions for: (1) operationalizing its ambition for zero deforestation, (2) enhancing readiness for participation in international carbon markets, and (3) reducing the use of biomass in cooking.

Operationalize the ambition for zero deforestation

Ghana's deforestation rates are among the highest in Africa and risks from deforestation are increasing despite a strong policy framework for sustainable forest management. Ghana's forests, which contribute to 2.5 percent of GDP and 11 percent of export earnings and provide livelihoods for more than 2.5 million people,[112] are being lost at a rate of 1 to 3 percent annually, since 1990. In total, forest cover has dropped from 9.9 to 6.4 million ha,[113] which represents 27 percent of total land area. A major cause of deforestation is the conversion of forest to agriculture land, legal and illegal logging, and encroachment into reserves. Forests are also under pressure from the increasing expansion of subsistence agriculture, mining activities, woodfuel extraction mainly for charcoal production, and commercial agriculture, with substantial off-reserve fallows being converted to tree crops such as rubber, citrus, oil palm, coffee, cashew, and mango. Legal logging has exceeded the Annual Allowable Cut (AAC)[114] by almost 100 percent for more than a decade.[115]

[110] Hallegatte, Stephane, et al. 2016. *Shock Waves: Managing the Impacts of Climate Change on Poverty, Climate Change and Development.* Washington, DC, World Bank.
[111] Country Environmental Analysis, World Bank 2020
[112] https://mofep.gov.gh/sites/default/files/reports/economic/NREG%20Report.pdf
[113] Ghana Forestry Commission. 2021. *Ghana National Forest Reference Level (FRL) 2001-2015.* Submission to the UNFCCC.
[114] The AAC is the annual amount of timber, measured in cubic meters, that can be harvested on a sustainable basis within a defined forest area.
[115] Kotey, E.N.A., et al. 1998. *Falling into Place. Policy that works for forests and people.* series no. 4. International Institute for Environment and Development, London; FWP 2012, National Redd+ Strategy 2016.

While its NDC commits to reducing emissions from the forestry sector, in November 2021, Ghana pledged to an even more ambitious goal to achieve zero deforestation by 2030, which will require making tradeoffs related to the value of land conservation and productive use. To achieve this goal, Ghana will need to scaleup key actions in the forestry and agriculture sectors, including:

i) Restoring degraded forest reserves and off reserve areas.

ii) Improving the effective management of protected areas.

iii) Replanting riparian buffers along streams and rivers.

iv) Strengthening the regulation of legal logging and improving enforcement by the FC related to illegal logging, in cooperation with forest proximate households.

v) Expanding the area under new plantations by 625,000 ha between 2020 and 2040 (as envisioned under the plantation strategy) to meet the domestic timber demand while reducing the pressure on existing forest resources.

vi) Increasing crop productivity per hectare and controlling agriculture expansion into forests.

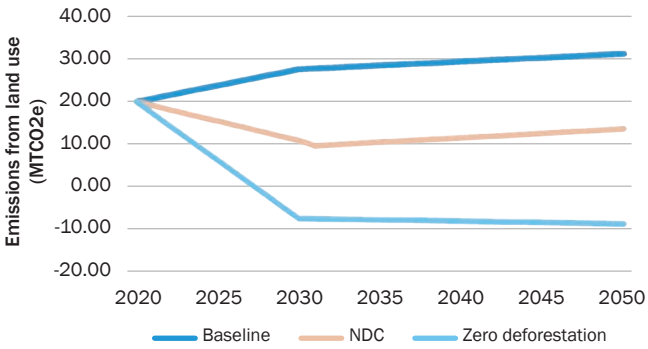
vii) Promoting agroforestry to augment rural household incomes and sequester carbon.

viii) Regulating and allocating areas for small-scale mining to reduce land degradation.

ix) Enforcing miners' land rehabilitation obligations upon completion of mining activities to protect cultivated areas and water bodies from landslides and siltation.

The net result would be an increase in forest area from 5.5 to 6.5 million ha by 2050. Conversely, following the current NDC commitment would result in a decrease in forest area to 5.0 million ha by 2050, although it would avoid the BAU scenario that is projected to reduce forest area by more than half. Even with successful implementation of all NDC actions, Ghana would continue to lose its forest resource base and miss the opportunity to turn the sector into an asset for resilient development.

Figure 11. Ghana can achieve its zero-deforestation goal by turning its forest sector into a net carbon sink



If its zero-deforestation commitment is achieved, Ghana could turn its forestry sector into a net carbon sink and transform a dwindling resource into a productive asset, with more jobs created and a more favorable cost-benefit ratio compared to the BAU and NDC scenarios. Compared to an NDC scenario, a zero deforestation scenario has the potential to sequester an additional 20 MtCO2 (Figure 11). However, increased inputs such as fertilizer could contribute to increased emissions from agriculture intensification. In addition, the investment needs to implement the full scale of actions, including adding 625,000 ha of forest plantation by 2040 and managing existing forest resources effectively, is estimated at around US$3.1 billion (discounted) for 2022-2030 and US$2 billion (discounted) for 2031-2040.[116] The annual returns from the investments would start to accrue seven years after initial investments. However, the decision to invest in forests now makes sense if Ghana intends to conserve and manage its forest resource with a longer-term perspective. Additional returns from timber extraction in the zero deforestation scenario could reach US$21.4 billion (discounted) and benefit an estimated 6.1 million beneficiaries in 2022- 2050 compared to a BAU scenario. The additional return is due to high-value timber with significant market value. The zero-deforestation scenario also presents opportunities to monetize ecosystem services such as carbon by making the sector a carbon sink and reap the benefits of international markets for deforestation-free cocoa.

[116] This could vary depending on the choice of species, silvicultural practices, type of sites and harvesting schedules, and regional variances in the type and state of forests.

International and national financing from the public and private sectors needs to be mobilized to meet the incremental investment costs. International partners, including the World Bank, should assist the government to secure financial and technical support. This could include establishing a Ghana Donors Fund for Forests and/or a World Bank DPL program, supported by private sector engagements to help unleash innovative action for enhanced productive and protective management. Already, a crediting facility for establishing sustainable plantations is being piloted by the Forest Investment Program (FIP) and a fund that provides financial and technical assistance to forest plantation growers and firms has been established under the Forest Plantation Development Fund Act. Likewise, Ghana will need to engage private sector partners in the development of non-timber forest product (NTFP) value chains such as shea and in PES schemes.

Enhance Readiness for Global Carbon Markets

While Ghana is already engaged in leveraging international carbon finance under the Ghana Emissions Reduction Program in the Cocoa Forest Mosaic landscapes, a stronger legal framework is needed to enhance its readiness for full participation in international carbon markets. Payments of up to US$50 million are expected to be made by 2025 by the Carbon Fund of the Forest Carbon Partnership Facility of the World Bank in return for action for reducing deforestation under REDD+. Ghana can build on the enabling architecture for monitoring to scale up action on forests and leverage carbon finance for meeting its zero-deforestation ambition. Ghana should consider:

i) Preparing an overarching crediting strategy.

ii) Strengthening the legal framework for tracking actions and indicators to build investor confidence to finance climate investments (see section 2.4).

Support clean cooking and more sustainable woodfuel use

Unsustainable extraction of woodfuels needs to be addressed to reduce land degradation and address health concerns associated with indoor air pollution. Approximately 54 percent of the population uses biomass fuels (wood and charcoal) for cooking.[117] However, an estimated 15 percent of the wood harvested is in excess of the mean annual increment (MAI) (i.e. the level beyond what trees can grow back for extraction on a sustainable basis). While charcoal is an important contributor to rural livelihoods, a gap-filler in slack agricultural seasons, and a safety net in case of extraordinary needs, it also results in major health risks and costs.[118] Household air pollution is second-leading health risk following malnutrition in Ghana, with an estimated total cost of US$1.37 billion.[119]

In addition to strengthening and improving the clarity of regulations related to charcoal production (see Section 3.1.1), Ghana should prioritize investments in:

i) Scaling up programs that promote the adoption of clean cooking and efficient use of biomass, including the use of LPG by households (see Section 3.2.2)

ii) Developing quality labelling and fiscal incentives for improved cookstoves.

This includes scaling up efforts to achieve the government's target for the adoption of two million efficient biomass cookstoves and for LPG to be the main cooking fuel in 50 percent of households by 2030. While the government is developing a National Clean Cooking Strategy that will increase the availability of improved charcoal stoves, it is not of sufficient scale to make a major impact. Programs to promote improved household cookstoves have under-performed due to inconsistent quality, high cost, and supply-driven approaches that pay insufficient attention to consumer needs and preferences, and to the long-term financing and growth of the companies involved. To promote the next generation of

[117] Although the need is national, the Northern and Upper West regions present the most potential to increase the productivity and small farmer income by 44 percent. The potential is also high to ramp up rice production to meet growing domestic demand and substitute costly imports.
[118] Ghana Woodfuels Assessment. World Bank. May 2022
[119] Country Environmental Analysis, World Bank, April 2020. Monetary valuation is based on the Value of Statistical Life (VSL) for mortality, which reflects the society's willingness to pay to reduce the risk of death, and a morbidity cost assumed to be 10 percent of the mortality cost (Hunt et al., 2016; Stanaway et al., 2018; World Bank, 2016).

high-performance cooking appliances and meet the demand for at least 650,000 improved charcoal stoves per year, a more ambitious and scaled-up program is recommended. This should include support for working capital for manufacturers, importers, and distributors as well as for marketing and for microloans to households for purchasing improved stoves. Regulations on cookstoves standards should also be finalised, quality labelling should be introduced, and fiscal incentives such as reduced import duties and VAT on stoves should be considered. Combined, these efforts would support the achievement of SDG7, along with national targets to achieve universal access to modern energy services, as well as reduce national emissions and air pollution, given the high emissions associated with land degradation in Ghana. Promote a clean energy transition

Although Ghana has a high rate of electricity access, a relatively clean energy mix, and the energy intensity and emissions factor of the power sector are low compared to similar SSA countries, increasing demand and climate change, along with the sector's high fiscal burden, affects medium- and long-term sustainability and private sector investment appetite. In recent years, direct subsidies to the energy sector have been more than US$1 billion dollars annually. At the end of 2019, a few months after the approval of the Energy Sector Recovery Program (ESRP), the accumulated power sector revenue shortfall (legacy arrears) was estimated at US$2.3 billion. In 2020, the power revenue shortfall for the year was estimated at US$1.1 billion, which is about 1.8 percent of GDP or about half of the annual national budget spending in social sectors. The energy sector revenue shortfall stems from excess power generation capacity, excess gas supply, electricity tariffs that do not reflect costs, and large losses in electricity distribution (30 percent in 2020), with high economic and environmental costs. **Therefore, to support its achievement of energy sector targets and attain sustainability, in the face of increasing demand, a changing climate, and limited fiscal space, Ghana can: (1) increase access to clean power, (2) strengthen its role in regional energy markets, and (3) increase the share of renewable energy, particularly solar PV, in the short- and long-term.**

Universal access to clean power

Despite increasing demand and sustainability challenges, Ghana is well-positioned to scale up its efforts to ensure access to affordable, reliable, sustainable, and modern energy for all. Since 1989, the government has implemented the National Electrification Scheme (NES), a long-term planning strategy to reach universal access to electricity by 2020 (now adjusted to 2025).120 Through this program, the government has successfully mobilized public, donor, and private finance to extend the grid and install some solar-based mini-grids. Already, about 85 percent of the population has access to electricity (70 percent in rural areas)121 and the energy mix is relatively clean, dominated by gas-based thermal (64 percent) and large hydro (36 percent).[122]

To reach the remaining 15 percent of people without access to electricity and improve access to clean cooking, the government should prioritize:

i) Increasing connections to the national grid and to existing and newly constructed mini-grids.

ii) Supporting the installation of more stand-alone solar systems (see below).

iii) Incentivizing consumers to switch to LPG for cooking.

Ghana is currently preparing a geospatial analysis of the most appropriate technologies to provide electricity and an investment plan. Preliminary results show that one-third would need to be connected to the grid, one-third connected to mini-grids, and one-third with stand-alone solar systems. To reach universal electricity access, Ghana's NDC commits to install 300 solar-based mini-grids, adding around 30MW of solar PV, with an average investment need of around US$60 million.

[120] Universal access for GoG is the electrification of all communities of over 500 persons
[121] Include 2019 source
[122] Add 2020 source

In addition, to reduce the high emissions and indoor air pollution from high charcoal use and associated land degradation, Ghana will need to invest in scaling up clean cooking by promoting consumers to switch to LPG. While LPG consumption is on the rise, 54 percent of the population still uses biomass fuels for cooking and the cost of LPG has increased due to global pressure on fossil fuel prices, a fall in the value of Ghana's currency, and rising inflation. Therefore, financial support to consumers will be required if the government is to stay on track to meets its 2030 target for LPG to be the main cooking fuel in 50 percent of households. Measures such as waiving certain taxes on LPG, targeted subsidies through vouchers, or direct cash payments may be needed to reduce prices. A credit scheme could be considered for a quality-assured range of stoves and fittings. For small volume LPG purchasing, Ghana could deploy pay-as-you-go (PAYGO) technology, but the country's regulated LPG price structure limits this opportunity. Therefore, consideration should be given to deregulating LPG pricing to allow innovations like PAYGO and cylinder distribution to compete. The investments required to achieve 50 percent LPG access by 2030 are around US$500 million, with US$380 million for the private sector to invest in infrastructure and US$110 million to be provided by the government as a subsidy to households and caterers to acquire the stoves and accessories. Achieving this target could have substantial benefits, including averting the use of 9.4 million MT of woodfuel between 2021 and 2030 by domestic and productive energy users. If access initiatives are sustained and 100 percent LPG access is achieved between 2031 and 2041, 25.26 million MT of woodfuel savings and reduction in associated emissions and indoor air pollution could be realized.

Strengthen regional energy markets

Another short-term climate action that could support Ghana's power sector, reduce costs, increase efficiency, and foster the transition, is regional market integration through the West African Power Pool (WAPP). Ghana is a member of the WAPP, which covers 14 countries and aims to create a unified regional electricity market. By 2025, the entire West Africa region is planned to be interconnected, paving the way for regional power trade. This presents Ghana with the opportunity to export electricity to bring in much needed revenues while displacing more polluting and expensive oil-fired generation. A deeper regional power market also provides the flexibility for Ghana to integrate more variable renewable generation (e.g. solar PV) into its system, export its surplus power in the short term and to develop other sources (e.g. nuclear) that would otherwise be too large to be supported by the Ghanian market alone. The regional market also provides Ghana with additional supply sources that increase its climate resilience. Realizing this potential will require:

i) Supporting the WAPP to establish the commercial and operating frameworks required for regional trade, taking a leadership role in trading with others in the region.

ii) Taking national decisions regarding power sector operations and investment planning that take account of the regional opportunities to import and export electricity.

Increase the share of renewable energy sources

Ghana will need to increase electricity generation to meet increasing demand. In 2021, peak demand was about 10 percent higher than in 2020 and, in the last decade, electricity generation increased by 9 percent annually, on average. However, continuing to meet increasing demand is threatened by climate change impacts such as increasing water scarcity, land degradation, and high temperatures, particularly for sustaining hydropower output, whose large potential has been tapped already. By 2040, these factors could cause a reduction of 8 to 30 percent of hydropower outputs compared to 2020 levels. Thus, higher demand for electricity will need to be met from thermal or renewable sources, creating new risks and opportunities, which will depend on investment choices that need to be made today and will necessitate advanced planning and a careful assessment of trade-offs.

Ghana has vast untapped renewable energy potential. With an installed solar capacity of 72 MW in 2021, only 0.25 percent of its power generation is comprised of non-hydro renewable energy (52 GWh of solar). Ghana's NDC aims to scale-up renewable energy to 10 percent by 2030 and achieve universal access to electricity through off-grid electrification. To achieve this, the installed capacity of PV will need

to increase to 1.7 GW by 2030. However, the NDC target is not ambitious enough, as the least cost option estimates a 24 percent PV penetration by 2040.

To set the foundations for the next stage of its energy transition, to 2030, Ghana should invest in:

i) Enabling the deployment of PV and, in particular privately owned PV systems.

ii) Setting up efficient competitive procurement process for new RE power plants to ensure least-cost generation of renewable energy.

iii) Ensuring hydropower realizes its remaining potential and existing plants are adequately maintained under changing climate conditions.

If Ghana is to support the Paris Agreement's energy emission reduction goals by 2040, a more ambitious renewable energy program must be implemented. This will require installation of 25 GW of solar by 2040 and 7 GW/40GWh of BESS, resulting in a 60 percent emissions decrease compared to the NDC scenario. To expand PV at scale, Ghana will need to remove major bottlenecks and undertake reforms such as transitioning from negotiating unsolicited proposals for additional generation to establishing a competitive procurement framework that attracts private investments at efficient and competitive prices.

To foster the renewable energy transition, the government will also need to setup an efficient competitive procurement process for new power plants to ensure least-cost generation. Ghana has relied almost entirely on negotiated transactions of unsolicited proposals and lacks experience with competitive power project tendering, resulting in higher generation costs than benchmarks in similar contexts. Additionally, the procurement of new power generation for the regulated market is carried out by several entities, causing confusion and lack of accountability, and the 2019 Competitive Procurement Policy[123] is not fully operational, as it requires the establishment of an efficient procurement framework and implementation guidelines. Ghana will also need to ensure that its grid is sufficiently flexible to integrate solar PV. In addition to Battery Energy Storage System (BESS), this will require investing in system operations and generation control and connecting to the regional market to allow for more flexibility in generation and distribution.

In addition, hydropower will remain a key source of clean electricity in the transition, but actions are needed to avoid negative impacts of climate change. Although precipitation projections are highly uncertain for Ghana, it is expected that increasing temperatures, competition for water, and land degradation will result in a reduction of water availability that will impact the hydrology of the Volta River basin. By 2040, this could cause a reduction of 30 percent of hydropower outputs under a pessimistic scenario compared to 2020 levels, with projections of reductions ranging from 8 to 30 percent by 2040. Under a drastic hydropower output scenario, Ghana would need to plan for additional generation capacity to cover the gap, increasing investment needs between 6 and 20 percent, depending on the supply scenario considered. Even with decreased outputs, the flexibility and the energy provided by hydropower brings significant value to the system. To ensure that it will be able to fully play its role, maintaining and upgrading the existing infrastructure will also be critical.

Setting the stage for decarbonization and longer-term priorities

After 2030, to decarbonize the energy mix and meet growing demand, Ghana will need to shift dramatically towards renewable energy and leverage new technologies, including for storage. This will entail large additional investments (about US$11.5 billion in 2031-2050), which Ghana could not bear alone, and access to affordable clean technologies, which might not be available today. Moreover, it will have to make technological choices that come with trade-offs. To meet the Paris Agreement objective of keeping global temperature increase within 1.5 degrees Celsius, the power sector may need to decrease its emissions by up to 30 percent (to 4.0 MtCO2e) by 2040, despite increasing demand due

[123] http://energycom.gov.gh/files/Executed%20policies-policies.pdf

to population and economic growth. Additionally, decarbonizing the economy will lead to increased electricity demand, as some end-uses will shift from fossil fuel to electricity, such as the vehicle fleet. Increased penetration of electric vehicles in the transport fleet (see section 3.2.1) could lead to a power demand increase of 30 percent in 2040.

To decarbonize the energy sector, Ghana will need to avoid expanding gas generation or introducing new fossil fuels to meet new demand and, instead, expand renewables (VRE) and innovative green technologies, when commercially viable. Compared to a BAU scenario that would increase gas production and double emissions, a low-carbon pathway will require a dramatic and rapid increase in VRE capacity in the coming decades, particularly if alternative clean technologies are readily available and deployed. This will entail a dramatic transition, requiring a range of actions, including:

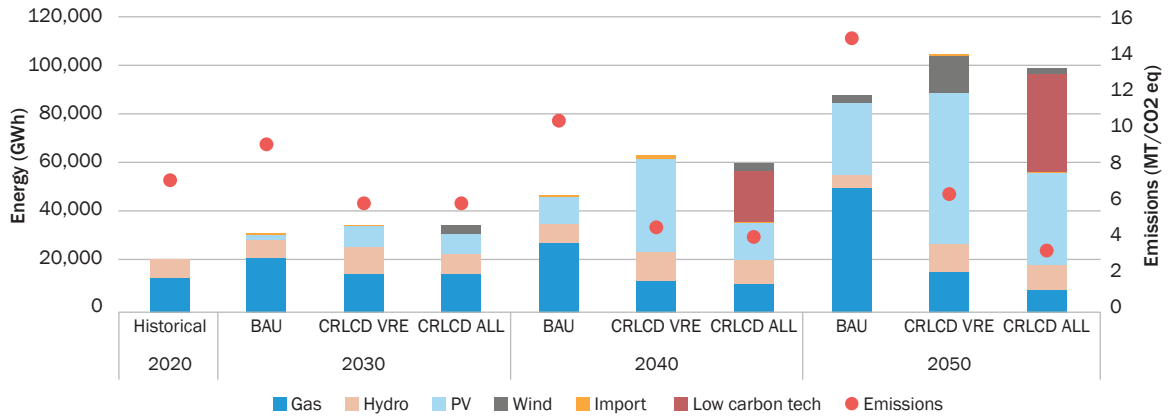
i) Expanding renewable energy generation two times by 2030 and five times by 2040, compared to 2020 levels.

ii) Investing in site preparation and the installation of power lines for larger solar power plants,

iii) Expanding the use of energy storage technologies, as the VRE penetration increases.

iv) Strengthening the professional skills of civil, mechanical, and electrical engineers.

Figure 12. Generation mix and emissions per scenario up to 2050[124]



Investing in the green energy transition will raise costs, but could reduce the sector's burden on public finance, improve medium- and long-term sustainability, and boost private investments. Generation costs under a VRE-only scenario may be 30 percent higher. Total investment needs (CAPEX only) are also projected to be around three times as much by 2050, compared to BAU, (also due to higher electricity demand from Evs) reaching US$23.3 billion in 2022-2050,[125] compared to US$8.6 billion in the BAU scenario (also due to higher demand from Evs in a green transition scenario), (Figure 13). Simulations show that higher emission reductions (in line with Paris Agreement objectives) could be achieved with the additional introduction of nuclear power[126] and carbon capture and storage technologies to VRE (ALL scenario).[127] In this case, the required investment (US$22.1 billion in 2022–2050) and average generation costs are roughly similar to the VRE-only scenario, but with larger uncertainties about technical and commercial viability of new technologies. In both cases, a green energy transition, with policy reforms that foster competition and private sector participation, could reduce the burden on public finance, considering the current direct subsidies to the energy sector of around US$1 billion per year.

[124] BAU: Business as Usual is a pure least cost, CRD VRE is a net zero scenario by 2050 where candidate generators are all currently used technologies in Ghana as well as wind and CRD ALL is similar to CRD VRE with additional candidate generators like nuclear and gas+CCS

[125] Discounted at 6 percent

[126] Since 2008, Ghana has showed interest in including nuclear power in its energy mix and engaged with the International Atomic Energy Association (IAEA). In 2019, the IAEA certified the transition of Phase 2 of Integrated Nuclear Infrastructure Review (INIR). Since then, the Ghana Nuclear Power Porgramme Organization has launched feasibility studies for the construction of nuclear power.

[127] If these technologies are commercially available for Ghana in the next 20 years.

Figure 13. Capacity mix and annual CAPEX investments (undiscounted) under BAU, VRE-only (renewable) and ALL (renewable and other technologies) scenarios

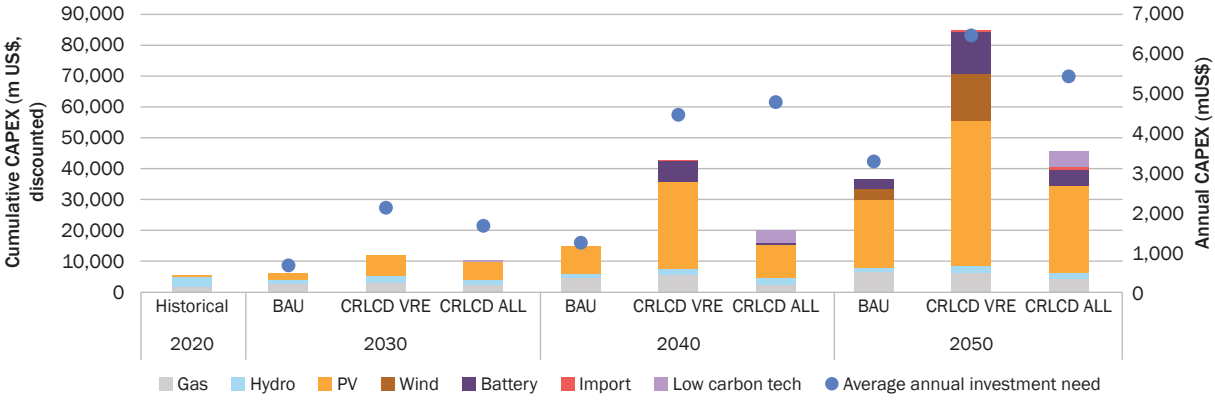
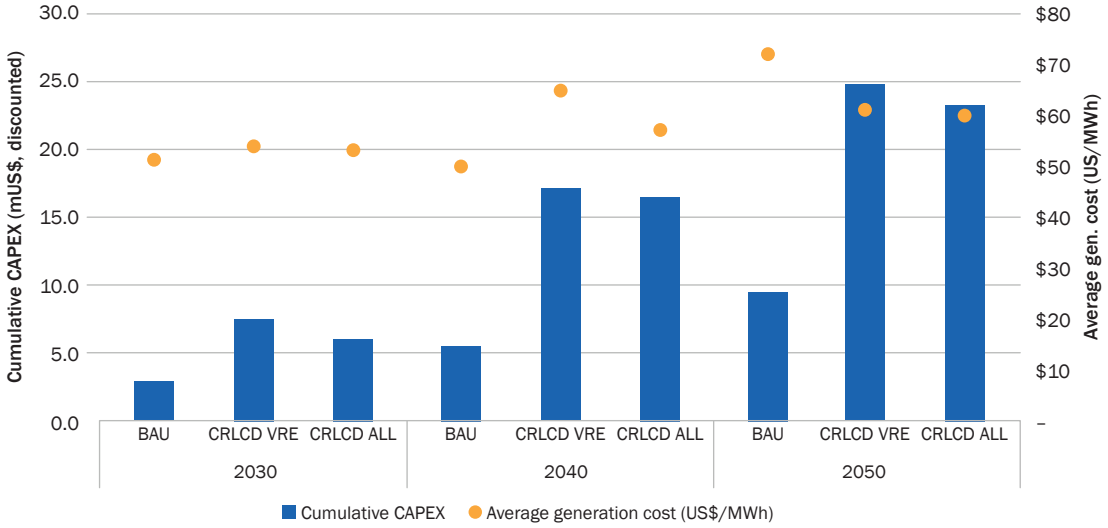


Figure 14. Cumulative Capex (discounted) and Average Generation Cost, by scenario



Although the government does not own physical assets in oil or gas, power purchasing agreements (PPAs) with gas power suppliers risk slowing the transition to renewables in the near term and might put the country at risk of having stranded assets in the future. PPAs signed in 2011-2016 commit the government to purchasing agreed amounts of (gas-based, grid) power at pre-agreed prices. Power purchased under these contracts can exceeded demand, creating a fiscal burden while crowding out space for new renewables investments from the public and private sectors. This is at odds with the doubling of renewables generation needed by 2030 under CRLCD. Ghana is at a critical juncture—with most PPAs due to expire by 2030 and its National Energy Transition Policy under preparation, it has the chance to choose a greener energy strategy for the longer-term sustainability of the sector.

Decarbonizing the power sector will bring significant co-benefits, such as new green jobs, which will require skills in electrical, construction, and engineering. Around 382,000 green energy jobs could be created by 2038 if Ghana invests in green energy, mostly in construction and installation.[128] For solar PV, the main skills required will relate to electricity generation, including making grid connections and installing metering technology. Establishing larger solar power plants will also require construction work, including site preparation and the installation of power lines, and the professional skills of civil, mechanical, and electrical engineers. Wind power projects are mostly expected to be executed by construction companies and professional services firms, with civil and mechanical engineers for the design of foundations and towers and technicians for operations and maintenance.

[128] Walsh. Forthcoming. *Macroeconomics and Climate Change.*

3.2.2. Modernize the transport sector

To fully embrace the green transition, Ghana needs to decouple economic growth from motorization and associated emissions. Transport is a large and growing source of GHG emissions, accounting for 17 percent of national GHG emissions in 2016.[129] From 2000 to 2018, GHG emissions from transport more than doubled.[130] Fossil fuel consumption in road freight and passenger vehicles represent the majority of GHG emissions and their growth in the sector (86 percent in 2018).

As Ghana's economy grows, movements of goods and people will also increase dramatically, with transport-related emissions projected to nearly quadruple by 2050 unless significant action beyond the country's current NDC commitments is taken. Increasing levels of personal motorization and expanding logistics systems will make curbing transport emissions without jeopardizing economic growth and development increasingly challenging. While Ghana's NDC includes five measures for the transport sector, they are not ambitious enough to achieve a decoupling of economic growth from transport emissions nor to reach the goals of the Paris Agreement. Under a BAU scenario, Ghana's transport sector emissions are expected to increase by 75 percent by 2030 (to 16.17 $MtCO_2e$) and nearly quadruple by 2050 (to 34.5 $MtCO_2e$).[131] If fully implemented, Ghana's five transport NDC actions would only reduce emissions by 1.1 $MtCO_2e$ by 2030 and by 4.0 $MtCO_2e$ by 2050.

Therefore, Ghana will need to pursue a development pathway that avoids lock-in to carbon-intensive transport networks and achieves significant decoupling of transport emissions from economic growth, focused on: (1) investing in alternatives to road-based freight movement, (2) managing passenger and freight vehicle fleets, and (3) improving fuel quality. Complementing improvements to urban mobility systems (see Section 3.1.2), these priorities can help Ghana meet growing travel demand in a less carbon-intensive and more resilient way, with GDP expected to expand by almost 400 percent in 2022-2050, while transport emissions grow only 40 percent.

Investment in alternatives to road-based freight movement: rail and inland waterway

Ghana has ambitions to establish itself as a regional logistics hub for West Africa, presenting an opportunity to rethink the national approach to freight movement. Supporting Ghana's economic ambitions and ensuring efficient connectivity will require significant investment in large-scale transportation infrastructure. If the country continues to move the majority of its freight by road, its economic growth will exacerbate GHG emissions and other externalities, such as road traffic accidents involving trucks, air pollution and traffic congestion around ports and other hubs. Therefore, the country needs to prioritize its investments towards rail and inland waterway systems.[132]

However, Ghana's once vibrant railway system is in a state of disrepair as a result of neglect and underfunding over the years. From an initial network size of 947 km in 1960, its operational rail line was just 160 km in 2020. As a result, Ghana experienced a substantial decrease in freight volumes transported (81 percent) between 1990 and 2020.[133]

In the immediate- to short-term, Ghana needs to provide support for:

i) Reviving the country's defunct right-of-way and restructuring the railway sector to increase private sector participation in the delivery of rail services.

ii) Creating the enabling conditions for development finance and private capital mobilization to fill the large investment gap.

[129] Calculated using emissions data (1990, 2000, 2010, and 2016) from EPA (2019), 'Ghana's Fourth National Greenhouse Gas Inventory Report'.
[130] Own analysis based on historical GHG emissions from the CAIT database https://www.climatewatchdata.org/ghg-emissions
[131] EPA of Ghana. 2021. *Ghana's Third Biennial Update Report to United Nations Framework Convention on Climate Change.*
[132] Solomon, Boadu, et al. 2021. *Inland Waterway Transportation (IWT) in Ghana: A case study of Volta Lake Transport*. International Journal of Transportation Science and Technology, Volume 10, Issue 1.
[133] Atuah Obeng, Daniel, et al. 2022. *Ghana's railway transport services delivery: A review.* Transportation Engineering, Volume 8.

Improving Ghana's rail services is an opportunity to support socio-economic development and provide a climate-friendly competitor to polluting and unsafe road freight. While boosting the rail and inland waterway systems is a conditional measure included in Ghana's NDC, a clear financial strategy is still not available. Leveraging on the PPP law and expanding access to other financial structures, such as Project Finance, could maximize the outcomes of limited public resources for infrastructure.

Management of passenger and freight vehicle fleets

Even with substantial investment in alternative modes of transport to private cars and motorcycles for passenger trips in cities (see Section 3.1.2) and for road-based freight, Ghana will continue to motorize. Managing the quality and quantity of vehicles on the country's roads will be imperative to ensure traffic safety, air quality, and climate goals.

The management of passenger and freight vehicle fleets requires a package of policies that include:

i) Regulating and certifying new vehicle sales through import restrictions and fuel efficiency and emissions standards.

ii) Ensuring good quality maintenance of vehicles and their emission control technologies.

iii) Deploying end-of-life recycling programs to limit use of the oldest, highest polluting vehicles.

This builds on Ghana's NDC, which proposes restricting the import of used cars and improving efficiency of diesel cars, but expands the focus beyond passenger cars. It also cover heavy-duty freight vehicles and emphasizes the importance of inspecting and enforcing compliance throughout the lifecycle of the vehicle, not just on sale or entry. Together, a full package of motorization management policies could make major contributions to emissions reductions, with an estimated reduction of 4.2 $MtCO_2e$ by 2050, compared to the NDC scenario. These climate benefits are coupled with significant benefits to public health since newer, more fuel-efficient vehicles also come with improved safety features and local air pollutant emissions control technologies. Therefore, investing now in the institutional capacity building needed to implement and maintain motorization management programs is a no-regret option to support growing travel demand and economic activity with a reduced carbon footprint. Since the cost of a complete motorization management program typically scales with the size of the vehicle fleet in the country,[134] putting these policies in place early, while motorization levels remain low, is the most cost-effective way to realize results.

Improving the management of vehicles and their emissions now can lay the ground for the future transition to electric vehicles. In the short term, Ghana can continue to explore the feasibility of electrification of public transit vehicles (public buses and tro-tros) and two- and three-wheeler fleets. Very aggressive electrification of two- to three-wheelers (up to 35 percent of stock in 2030 and 80 percent in 2050) and, later, substantial electrification of passenger cars and taxis (up to 40 percent of stock in 2050) is needed to double the mitigation contribution of vehicle standards and reduce externalities. While much of the cost of electrification of private vehicles can be assumed to be borne by individual consumers or private operators, achieving such a rapid and large-scale electrification of the vehicle fleets would likely require significant government subsidy on the consumer side.[135]

Improve fuel quality

Improving the quality of gasoline and diesel fuels sold in Ghana is a short-term action that can reduce GHG emissions and improve air quality, with associated public health and productivity benefits. Fuel standards refers to numerous properties, including the maximum content of sulfur, lead, manganese, and other metal additives, or, for example, forbidding lead and manganese in gasoline. While Ghana was one of the first West African countries to legislate sulfur content in fuels, national standards are poorly enforced and still do not meet international standards.[136] Because vehicle pollution control

[134] https://openknowledge.worldbank.org/handle/10986/36518

[135] India's FAME-II program provides a potential benchmark for consumer incentives for electrification of 2-wheelers.

[136] Broni-Bediako, Eric, R. Amorin, and G. Mensah-Ametum. Assessment of the Quality of Diesel Fuel from Some Selected Filling Stations in Tarkwa,

technologies operate best when using better refined fuels, vehicle and fuel standards will need to be progressed in an integrated way. Neither supply nor cost are the limiting factor for adopting better fuel quality standards, such as reducing sulfur content, with the cost differential of low-sulfur compared to high-sulfur fuels is within the noise of day-to-day price volatility.[137] [138] The limiting factors are, instead, the enforcement of regulatory standards and the reform of business practices in place for blending fuels. Therefore, in the short-term, Ghana should consider:

i) Adopting and enforcing stricter fuel quality standards.

ii) Reforming business practices in place for blending fuels.

These actions can benefit national welfare, economic growth, and GHG emissions mitigation.

3.3. Putting resilient and low-carbon development together

The CRLCD scenario requires large investments, but they are relatively small compared to Ghana's economy (2 to 3 percent of cumulative GDP). The CRLCD scenario is projected to have additional investment costs of US$13.6 billion (in present value terms) over 2022-2030 (2.0 percent of discounted cumulative GDP over the same period), excluding investment needs to retrofit existing infrastructure, which have not been estimated.[139] This estimate is in line with Ghana's NDC financial requirements. After 2030, as decarbonization ambitions raise, this number increases to US$25.1 billion over 2031-2040 and US$18.7 billion over 2041-2050 (in present value terms), which are 3.5 and 2.9 percent respectively of discounted cumulative GDP over the same period. The total additional investment need for the period 2022-2050 amounts to US$58 billion[140] (in present value terms), which is 2.8 percent of discounted cumulative GDP.

A conservative analysis shows that economic benefits outweigh investment costs over 2022-2030 and increase further over longer time horizons. The analysis shows that these investments pay for themself over the long term, as they provide substantial economic benefits, which exceed the investment costs (Table 4). For instance, the power sector CAPEX costs could increase by US$13.4 billion by 2050, but also reduce operational costs by US$1.5 billion for the same period and create large job opportunities in new technologies. Investing in clean cookstoves (US$0.4 billion by 2030) could avert up to 28,400 disabilities and 770 deaths per year due to reduced internal air pollution and save 2.5 MT of woodfuel per year, and associated deforestation. Climate-smart solutions and early warning systems have relatively low investment costs (US$0.4 billion by 2030) compared to the economic benefits of reducing climate impacts on the population, assets, and yields for key crops such as cereals and cocoa. Expanding irrigation (currently at only two percent of total agriculture land)[141] could increase the production of maize and rice and associated revenues. Investing in public mobility, better transport infrastructure, and early electrification could provide major savings in avoided traffic congestion, road safety, air quality, and fuel costs, even considering the cost of additional electricity generation and fleet renewal. Under the net zero deforestation scenario, additional timber revenues from increased tree plantations can outweigh the costs of investment for planting, maintenance, and enforcement, if the right socio-economic conditions are in place to support the livelihoods of communities in forested and buffer areas. When accounting for savings and positive externalities (although conservative and non-exhaustive), the net economic cost is negative: the CRLCD scenario leads to a net US$4.3 billion gain over 2022-2030, US$26 billion gain over 2022-2040, and a US$66.8 billion gain over 2022–2050, largely due to reductions in fuel imports, timber production and agriculture productivity. Many positive

Ghana. *Petroleum and Petrochemical Engineering Journal,* 4(5): 000239. United Nations Environment Programme [UNEP]. 2022. Diesel Fuel Sulphur Levels: Global Status.

[137] Guéniat, Marc, Marietta Harjono, Andreas Missbach, and Gian-Valentino Viredaz. (2016). *Dirty diesel: How Swiss traders flood Africa with toxic fuels*. A Public Eye Investigation.

[138] Fuel quality assurance programs typically cost around US$1 per vehicle per year for fuel sampling, lab analysis, compliance and reporting systems, and administration (https://openknowledge.worldbank.org/handle/10986/36518).

[139] Investment needs are provided (without costing) in: Adshead, D. et al. 2022. Ghana: Roadmap for resilient infrastructure in a changing climate. Ministry of Environment, Science, Technology & Innovation, Accra, Ghana.

[140] Discounted using a 6 percent rate.

[141] Ghana Ministry of Food and Agriculture. 2020.

externalities, such those associated with a reduction PM2.5 pollution, have also not been monetized but could make the net economic cost even more negative.

Achieving this transformation will require substantial financial resources, particularly from the private sector, along with innovative approaches and policy reforms to ensure long-term sustainability. Investments will be needed from various sources, including the national budget, municipal finance, private sector, and increased access to international climate finance. While there are no definitive estimates of the share of investments covered in each sector by public or private finance, using market-based assumptions from global experiences,[142] the additional cumulative cost is estimated at US$9 billion until 2030 and US$25 billion until 2050 for the public sector, and US$5 billion and US$19 billion for the private sector (Figure 15). Actual private finance levels will depend on market preference, attractiveness of projects to investors, and business climate (see chapter 4). Furthermore, given the long-term horizon of climate investments, these will need to be complemented with financial and institutional measures, such as boosting decentralization and local government capacity, supporting the private investment climate with PPP practices based on international and competitive standards, and widening the use of climate-smart technologies.

Figure 15. Public and private investment needs

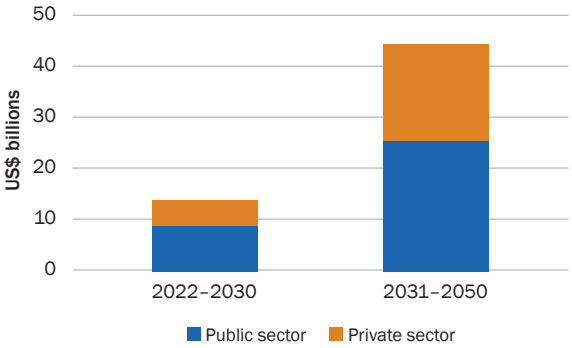


Table 4 provides a non-exhaustive and preliminary overview of investment need and economic costs of proposed climate actions in the short and longer term under the CRLCD scenario. Large retrofitting needs in the housing, energy, transport, and water supply infrastructure have not been estimated and remain a knowledge gap for future analysis.[143]

Table 4. Benefits outweigh costs for priority climate actions in the CRLCD scenario. Estimated investment needs and economic costs for selected areas under the CRLCD scenario developed in this report.

	2022–2030 US$ billion	2022–2050 US$ billions
Power		
Additional investment: CAPEX (1)	1.9	13.4
Other economic costs: fix and variable O&M, fuel costs (1)	-0.5	-1.5
Transport		
Additional investments: electrification of public and private, walking biking and public transport, freight to rail (2)	4.0	11.2
Other economic costs: lives lost and injuries due to road accidents (3)	-2.5	-10.8
Additional investments: electricity demand from electrification	0.8	5.1
Other economic costs: fuel import (4)	-9.1	-50.1
Other economic costs: reduction in external air pollution PM2.5 (%) (5)	-23%	-69%
Forestry		
Additional investment: management, planting, and enforcement (6)	3.1	6.2
Other economic costs: additional timber extraction (6)	-0.1	-21.4

continues

[142] Assumptions considered based on global experience: i) power investments are covered by 80 percent from the private sector given the large interest and financial flows into RE projects; ii) the public sector covers 70 percent of the costs, including infrastructure and subsidies/incentives for electrification; iii) the public sector covers 80 percent of the costs of the forestry and agriculture sectors, while the private sector supplies plantation costs for additional extraction and operational costs of CSA and irrigation; iv) the private sector covers 70 percent of waste sector investments due to high level of reuse and recycling; v) costs are equally shared between the public and private sector for clean cooking with LPG.
[143] Adshead, D. et al. 2022. Roadmap for Resilient Infrastructure in a Changing Climate, provides a detailed analysis of these sectors (without costing).

Table 4. *cont.*

	2022–2030 US$ billion	2022–2050 US$ billions
Waste		
Additional investments: treatment capacity (7)	0.3	1.5
Additional investments: operational costs (7)	0.4	2.5
Other economic costs: public health outcomes (8)	-1.2	-6.0
Agriculture		
Additional investments: CSA (9)	0.4	1.1
Other economic costs: productivity of CSA (9)	-1.0	-3.0
Additional investment: expanding irrigation to 150,000 Ha (10)	2.3	15.9
Other economic costs: productivity from irrigation (11)	-3.5	-31.6
Households		
Additional investment: LPG program for clean cooking (12)	0.4	0.7
Other economic costs: internal air pollution (%)	-50%	-100%
Total	-4.3	-66.8
- of which investments	13.6	57.6

Assumptions for the CRLCD scenario: (1) Highest investment cost scenario with VRE, nuclear and CCS mix in 2050 (own simulations); (2) Electrification of 2/3-wheelers up to 35 percent of stock in 2030 and 80 percent in 2050. Slower electrification of passenger cars and taxi fleets up to 40 percent of stock in 2050. Costs include private and public investments. Shifting freight from rail to road costs from NDC (US$1,000 by 2030). (3) Constant Incident rate of 4.85 fatalities and injuries per million vehicle-km traveled and US$40,138 per road crash fatality or serious injury for economically productive age groups.[144] *(4) Due to vehicle electrification. Average gasoline and fuel prices from February to May 2022. (5) Emission from direct combustion of diesel and gasoline fuel in vehicles. (6) Investment to reach and maintain zero deforestation targets in 2030 and add 625,000 ha of forest plantation by 2039. Additional extraction form forest plantations (own simulations). (7) Waste generation increase from 7.9 million tonnes/year to 20.5 tonnes/year in 2050. CRLCD scenario, of total volumes: zero open burning by 2030, reduce open dumping to 34 percent of total volumes by 2030 and zero by 2050, increase landfill disposal to 15 and 28 percent in 2030 and 2050; By 2050, increase anaerobic digestion to 50 percent, composting to 16 percent, plastic recycling to 12 percent (own simulations). (8) Assuming US$1 spent in solid waste management produces 4 times public health benefits;*[145] *(9) From IMPACT model in CSAIP.*[146] *(10) Based on country estimates, out of a total agriculture land potential of 1.9Mha. Cost of irrigation is US$15,000 per hectare including construction and maintenance147 (11) Considering an incremental increase up to 200 percent in 2050 for maize and rice output under expanded irrigation (own assumption). (12) Based on investment costs of national LPG for clean cooking program, covering 50 percent of the population in 2030. All estimates are present value using a 6 percent discount rate.*

[144] Constant rate calculated based on 2018 WHO data.
[145] Jonathon P. Leider, Natalia Alfonso, Beth Resnick, Eoghan Brady, J. Mac McCullough, and David Bishai (2018) "Assessing The Value Of 40 Years Of Local Public Expenditures On Health" HEALTH AFFAIRS. 37, NO. 4 (2018): 560–569, doi: 10.1377/hlthaff.2017.1171
[146] World Bank. 2020. Climate-Smart Agriculture Investment Plan for Ghana.
[147] Construction costs could be as low as US$5,000 but World Bank experiences in Ghana suggest costs of US$11,000. US$15,000 includes O&M.

4.

Rooftop solar generation at Ghandour Cosmetics Ltd in Accra, Ghana. Photo: © Ghandour

Macroeconomics, finance, and a just transition

4. Macroeconomics, finance, and a just transition

4.1. The socio-economic impacts of investing in climate action

Strategic climate action can benefit Ghanaians, beyond contributing to a more sustainable planet. Historically, Ghana has made a negligible contribution to global warming and it will continue to be a small emitter globally. Meanwhile, it faces pressing development needs and significant financing constraints, with every dollar invested in climate action coming at a high opportunity cost. This section considers whether and under what conditions it makes sense for Ghana to commit scarce resources to foster climate resilience and decarbonization. It examines key investments from Chapter 3 to assess their impact on development outcomes, including growth and poverty reduction, supported by modeling in a general equilibrium framework complemented by microsimulations (Table 5). The findings suggest that certain investments offer large development and climate benefits, while others pose more difficult financing challenges with more uncertain long-run payoffs.

Table 5. Climate investments simulated in the MANAGE CGE Model for Ghana

Sector	Overview of investment and O&M costs, 2022-2050[148]	Co-benefits modeled	Parameter impacted by the co-benefit
Transport	Public transport, nonmotorized transport, electrification, vehicle and fuel standards, and land use – calibrated to limit emissions to 14MtCO2e by 2050 (instead of 35 Mt CO2e under "do nothing") + higher electricity demand	Reduction in local air pollution (PM2.5)	Labor productivity
		Health savings from lower traffic accidents	Aggregate finance
		Reduced fuel consumption and imports	Fuel costs
		Reduced congestion	Labor productivity
Waste	Modern waste management, including 100% collection and zero burning by 2030	Reduction in local air pollution (PM2.5)	Labor productivity
Forestry	REDD+, calibrated to make forest a net sink of -8-9 MtCO2e annually by 2050 (instead of a net emitter of 11 MtCO2e under "do nothing") + less farmland	Higher timber revenues	Timber TFP
Agriculture	CSA, per Ghana's CSA plan, maintaining benefits until 2050 (costs peek in 2030 and reduce after for O&M)	Crop productivity and resilience	TFP for crops
Energy	VRE scenario: Increase the renewables share to 87% VRE by 2050 (vs. 50% under "do nothing"),[149] with additional power from gas and imports. All scenario: Progressively increase the renewables share to 60% VRE, and other clean energy technologies (e.g. nuclear and CSS) to 39%, by 2050.	Reduced fuel consumption and fuel imports	Fuel costs

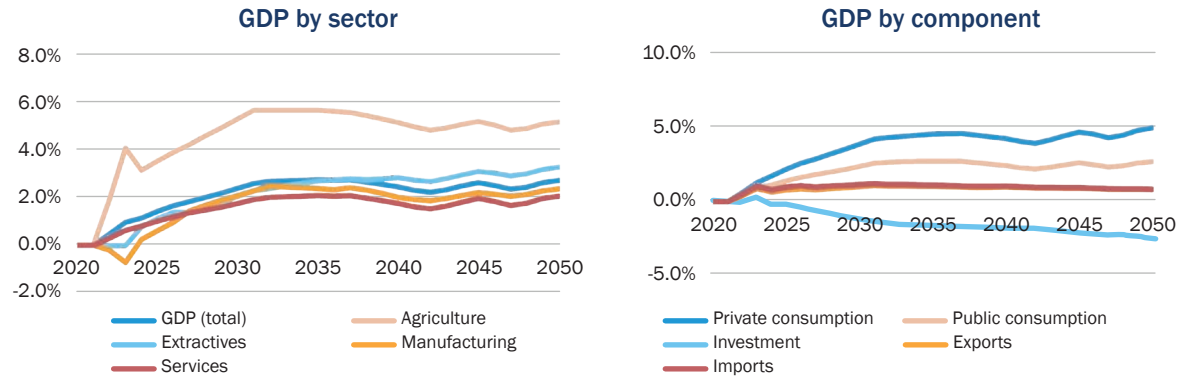
CSA investments offer large and equitable returns for a relatively small price tag. Implementing Ghana's CSAIP will mitigate risks to agriculture from global climate change while supporting agricultural modernization and potentially generating lower food prices, for a price tag of 0.07 percent of GDP annually until 2030.[150] Simulating CSA investments in the MANAGE model (Box 5) shows that they could raise annual GDP growth by 0.2 percentage points from 2020 to 2030, resulting in 2.6 percent higher GDP by 2030. Although the biggest gains are in agriculture, services, manufacturing, and extractives, GDP also benefits from second-order factors like lower food prices and the release of agricultural labor. Regarding expenditure components of GDP, CSA benefits private consumption (Figure 16), with positive impacts for poverty. CSA yields poverty rates (at US$3.20 2011 ppp) that are 0.7 percentage points lower by 2030 and by 2050, compared to a scenario with no CSA (12.8 percent with CSA, compared to 13.5 percent without CSA).

[148] For a full, quantified, specification of each measure, see the Background Note on Macroeconomics and Climate

[149] (1) the CGE model considers the full investment and O&M cost, rather than the 'delta' cost compared to BAU; (2) the CGE does not 'net out' costs and benefits upfront, rather modeling the full upfront investment and O&M cost, then separately modeling benefits such as reduced fuel costs.

[150] Costs as a share of current agriculture budgets are however higher. The annual cost of US$97 million is equivalent to about 55 percent of the total budget for MOFA in 2022, or the total annual allocation for the Planting for Food and Jobs program.

Figure 16. Impact of CSA investments on GDP, compared to "do nothing" scenario

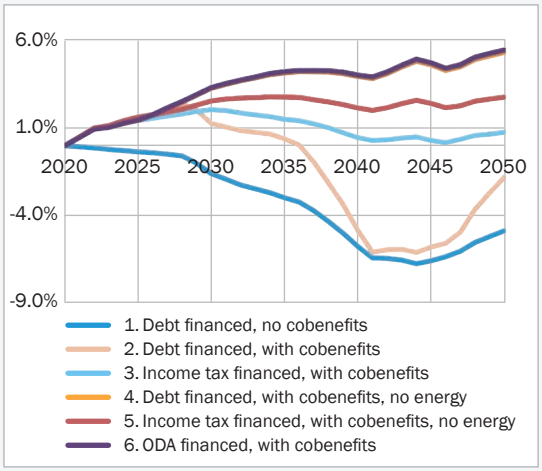


Source: MANAGE CGE Modeling in Macroeconomics and Climate Background Note

Box 5. Climate Resilient and Low Carbon Development scenario in the MANAGE CGE model

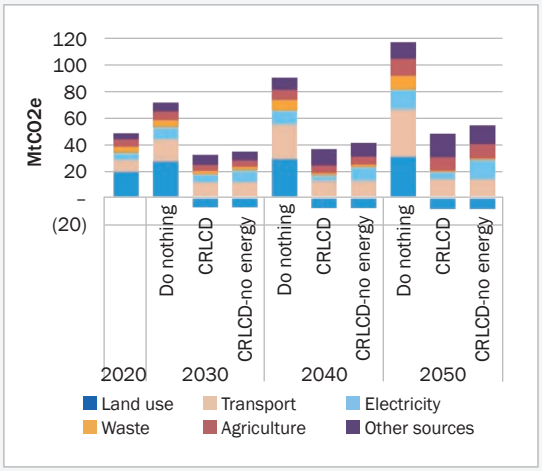
The CGE model outlined in Chapter 1 can analyze the impact of proposed climate actions on key economic outcomes in Ghana. It models a "medium" global scenario for 2020-2050, consistent with SSP2-4.5 and RCP4.5, and compares it to a "do nothing" scenario. The model simulates the effects of selected actions from Chapter 3 that are most pivotal and have adequate data (Table 5), separately and combined under the CRLCD scenario, accounting for: (a) *Costs*: Investment, O&M, fuel, and (for forestry) land consumption; and (b) *Co-benefits* through which the investments raise productivity. Three options for financing (debt, income tax, ODA) are simulated. From the macroeconomic results, microsimulations were conducted that exploit household and population heterogeneity (in household surveys) to analyze impacts on poverty and inequality though the Growth and Income Distribution Dynamics (GIDD) model.[151]

Figure 17. Impact of CRLCD and CRLCD no energy scenarios on GDP (% change from "do nothing" scenario), by financing type (debt, income tax, ODA)



Scenarios combine all measures in Table 5, except scenarios labeled "no energy", which exclude (only) energy measures

Figure 18. Emissions under the do nothing, CRLCD and CRLCD no energy scenarios (CGE)

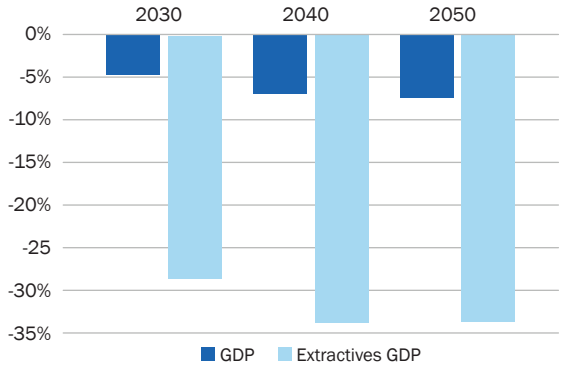


"CRLCD" simulates all measures in Table 5. "CRLCD no energy" simulates all measures in Table 5 except those for energy.

[151] Maurizio Bussolo & Rafael E De Hoyos & Denis Medvedev, 2010. "Economic growth and income distribution: linking macro-economic models with household survey data at the global level," International Journal of Microsimulation, International Microsimulation Association, vol. 3(1), pages 92-103. GLSS-7 was used as the underlying data for the simulations.

Source: Medium-Term Fiscal Framework and results from MANAGE CGE

Figure 19. Impacts of global decarbonation oil prices on Ghana's GDP



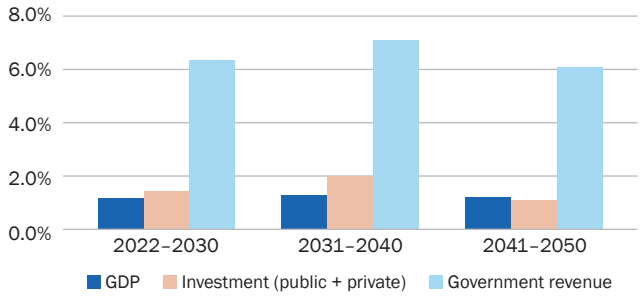
CSA has small direct impacts on emissions but could enable large indirect impacts through contributions to forest conservation. Ghana's CSA measures primarily target adaptation, with modest direct impacts on emissions (reducing annual emissions by around 2.5 percent by 2050). However, enhancing the productivity of agricultural land through CSA can curb Ghana's reliance on the higher-emitting expansion of agriculture onto forest land. Strong forest conservation can reduce Ghana's total emissions by one-third (40 MtCO2e) by 2050, compared to a "do nothing" scenario, but imposes a substantial opportunity cost, with forests occupying land that could host agriculture. The CBA for forestry and MANAGE CGE modeling, however, suggest forest conservation will benefit the economy, with co-benefits from sustainable timber alone exceeding the costs from lost agricultural land.[152]

Certain clean transport and energy reforms also offer strong synergies between climate and development. Measures like public transport, traffic management, land use efficiency, infrastructure for non-motorized transport, and regulation of vehicle and fuel standards have strong development co-benefits that can raise productivity – reducing congestion, fuel costs, air pollution, and injuries from traffic accidents. In the power sector, a 40 percent shift towards renewables by 2040 is the 'least cost' power plan for Ghana, thanks to improving costs, particularly of solar. Renewables offer a range of further economic benefits, including better tailoring for remote communities and reducing exposure to macroeconomic instability from global fuel price fluctuations. Cleaner energy may also help Ghana uphold export competitiveness as global trading partners shift to cleaner development models. The EU's Carbon Border Adjustment Mechanisms (CBAM), for example, will tax emissions embedded in imports to the EU.[153] Phase 2 of CBAM (from 2025) is expected to tax Scope 2 emissions, such as emissions from electricity used in manufacturing or extractives, which could precipitate more energy-intensive production shifting to countries with 'greener' power supplies. Paris Agreement commitments are also expected to precipitate a steep and long-term decline in global oil prices, which (compared to a 'do nothing' global scenario) would depress Ghana's extractives sector by approximately 30 percent throughout 2030-2050. Despite the recent uptick in oil prices, these longer-term trends underscore the case for reducing exposure to oil, by strengthening economic diversification and avoiding the acquisition of heavy sunk cost investments in the sector.

However, certain more ambitious climate actions for transport and energy may not be feasible in the absence of external support. As transport and energy demand soars with income and population growth, energy and transport emissions are expected to triple or quadruple by 2050, even with the above synergistic transport measures and renewables least-cost scenario. To maintain energy emissions at 2020 levels and transport emissions at 1.5 times 2020 levels, Ghana would also need to invest in aggressive electrification of the public and private vehicle fleet[154] and expand renewables and/or other low carbon technologies to 85 percent of generation by 2050. The financing costs of these pathways are estimated at one-third of the government's capital budget in the near-term (2022-2025). An aggressive energy transition to VRE or other low carbon technologies, including nuclear and CSS, would

[152] Ghana could more than triple the value of its timber sector through ambitious forest conservation, compared to a 'do nothing' scenario with forests depleted along historic trends. Modeling the opportunity cost of reduced agricultural land alongside only the economic benefit of sustainable timber revenues, modest net returns from conservation over 2020-2050 are expected. These net returns would be higher after accounting for wider forest ecosystem services such as reduced environmental degradation (estimated to cost 0.67 percent of GDP), tourism revenues, and shade for cocoa.
[153] Ghana has limited exposure to Phase 1 of CBAM, which targets Scope 1 emissions from five sectors in which it has minimal export to the EU (iron and steel, cement, fertilizer, electricity, aluminum). The most significant is aluminum, but EU exports are just 0.5 percent of Ghana's total export value.
[154] Aggressive electrification would help keep transport emissions to around 14 MtCO2e by 2050 (up from 9MtCO2e in 2020), compared to 35 MtCO2e by 2050 in a "do nothing" scenario, or around 30 MtCO2e by 2050 with more synergistic measures such as those in Ghana's NDCs.

Figure 20. VRE Energy investments (as a percent of key macroeconomic variables), NPV by decade



require an even higher upfront investment in PV towards the end of this decade to prevent any increase in generation from fossil fuels, including gas. In the case of the most ambitious transport decarbonization scenario, the MANAGE CGE model suggests that net impacts on GDP will be neutral by 2050,[155] thanks to large co-benefits and despite the large investment needs (Figure 20). Compared to the transport sector, local co-benefits from climate action in the energy sector are more uncertain (varying with global shifts such as carbon border taxes and fuel prices), and generally expected to be smaller.

Despite being significant in absolute terms and as share of total fiscal revenues, ambitious climate investments in energy could have little influence on growth in percentage points terms and could unlock private investment in renewables. Accounting for investment and O&M costs as well as fuel savings, the ambitious energy scenario is estimated to reduce the average annual GDP growth rate from 2020 to 2050 by 0.1 percentage points, resulting in 4 percent lower GDP by 2050.

While some investments in infrastructure resilience will require external support, Ghana should start prioritizing low-cost approaches that can deliver resilience at scale. Traditional grey hazard-prevention infrastructure tends to have unfavorably high investment costs, limiting their affordability and scalability, while nature-based solutions such as restoring and protecting ecosystems (e.g. mangroves for coastal risk), greening urban spaces to reduce urban heat island effects, and water retention basins to reduce flood peaks, can reduce certain risks at lower costs.

A critical low-cost and no-regret action is to reduce risk by avoiding new exposure and maintaining infrastructure. Measures like risk-sensitive land-use planning and building codes, including their enforcement, reducing informal waste dumping, and upholding regular maintenance of drainage systems can be effective and affordable options. In Greater Accra's Odaw basin, regular dredging and silting was estimated to reduce flood losses by about 25 percent, at a cost of approximately US$20-25 million for initial investments and around US$1-1.5 million annually for maintenance, and with benefits valued at US$11.8 million annually in 2020, rising to US$37 million annually by 2050.[156]

Better data and information systems will also be critical to protect and adapt to climate change. Few economic activities are immune to climate conditions, as climate change affects temperature and the water balance. CGE modeling results in chapter 1 illustrate how private adaptation can moderate the final economic impacts. Benefit-cost analyses in contexts similar to Ghana suggest returns of around 4-36:1 from modern hydromet information systems that provide reliable climate information and guidance to the right agents at the right time – leveraging both large global investments (e.g. in satellites and global weather forecasts) and the capacity for private adaptation.[157] [158] In these analysis the largest benefits are provided by better outcomes in weather-sensitive productive activities, with more moderate benefit-cost ratios (0.3-2.0) from reduced asset losses.[159]

[155] Modeling benefits include: (1) a major reduction in outdoor PM2.5 (85 percent lower by 2050, compared to the "no policies" scenario), which raises urban labor productivity (by 4.15 percent, assuming a 5 percent elasticity of urban labor productivity to outdoor PM2.5); (2) a reduction in congestion (with a 4.5 boost to urban labor productivity by 2050, compared to the "no policies" scenario); and (3) lower fuel costs.
[156] World Bank. 2019. "Ghana - Greater Accra Resilient and Integrated Development Project." Washington, DC., World Bank Group.
[157] Hallegatte 2012, "A Cost-Effective Solution to Reduce Disaster Losses in Developing Countries: Hydro-Meteorological Services, Early Warning, and Evacuation". World Bank Policy Research Working Paper 6058.
[158] Quiroga 2020, "Socioeconomic Analysis of the Potential Benefits of Modernizing Hydrometeorological Services in the ECOWAS region". World Bank.
[159] EWSs have been estimated to reduce asset losses from flooding by 20-60 percent in Europe and Central Asia (Pozo et al 2015). Benefits are expected to be somewhat lower in Ghana, considering the reduced capacity of lower-income households and firms to protect themselves or their assets in response to warnings and information.

Models are embedded with significant limitations and uncertainties about costs, affordability, and benefits of climate actions, especially in the long run. This includes uncertainty about future technologies and prices, international demand and exchange rates, policies of other countries, and effects of migration, conflicts, and ecosystem tipping points. Affordability will also depend on Ghana's growth, poverty reduction, and macroeconomic management, including revenue mobilization and debt management, which may differ from projections due to unforeseen circumstances. Therefore, Ghana should revisit its climate strategy regularly (e.g. every five years) to take stock of how such developments have impacted the feasibility and attractiveness of various climate actions.

At the same time, it is important to look beyond 2030, or even 2050, to consider how actions in the short to medium run may set Ghana up for longer-term resilience and competitiveness. The payoffs of averting climate damages may be modest in the short-term, but some climate actions in 2020-2050 are important to containing post-2050 damages that are expected to become much larger. Likewise, they can help Ghana uphold competitiveness as technology prices and global demand shift. For example, land use zoning is needed to prevent physical development in locations exposed to high post-2050 risks, and to encourage urban density and land use efficiency that can support multi-modal and mass transit and electric vehicles, as technology and affordability allow. Similarly, when possible, stepping out of more polluting energy sources will be important for Ghana to be able to take advantage of falling costs of renewable and to maintain global competitiveness as trading partners increasingly seek green imports and supply chains.

4.2. Financing the transition

Despite strong development synergies for many climate actions, Ghana's ability to invest is highly constrained in the near-term by the macroeconomic situation. Many actions with strong long-run economic returns have high upfront costs. For example, PV is already a least-cost power option, but with 95 percent of PV costs consisting in capital, financial constraints drag its adoption. In the near-term, financing constraints will be binding for Ghana. Debt has risen to over 80 percent of GDP, with debt service obligations absorbing almost half of government revenues. Elevated risks of debt distress have left Ghana without access to international financial markets and the need to pursue tighter fiscal consolidation until at least 2024 as an urgent priority for fiscal and debt sustainability. In this context, even if the government's ambitious revenue targets materialize, Ghana is not expected to be in a position to raise public investment as a share of GDP before at least 2025.

Ghana cannot easily finance climate action from other spending cuts. In addition to pursuing tight fiscal consolidation, including cutting spending by 4 percent of GDP from 2020 to 2024, Ghana aims to identify further efficiency savings. However, there would be pressure for any savings to support the many unmet development needs in education, healthcare, social protection, and basic infrastructure and services. Ghana's limited ability to raise debt above budgeted levels underscores that public investments should focus on those offering strong net benefits for poverty reduction and growth.

In the near-term, Ghana will need to focus on relatively low-cost, high-return measures that avoid lock-in to the worst scenarios. In the medium- to long-term, it may become more feasible to finance larger-ticket items, but needs will continue to exceed what the public sector alone can provide. Therefore, Ghana will need to consider a range of fiscal reforms and tools (4.2.1), along with reforms and incentives for participation of the private and financial sectors (4.2.3).

In addition, in both the near- and longer-term, Ghana is likely to need considerable external financial assistance to pursue a robust green transition consistent with the Paris Agreement. In the medium term, Ghana will require ODA, particularly for measures that have high costs without comparable benefits for the local economy, such as a net zero energy transition and widespread vehicle electrification. Financing an ambitious green transition, including high-cost transport and energy investments, through domestic financing alone is expected to depress GDP by 2 percent by 2050 and raise poverty (at the US$3.20 2011 ppp line) by nearly 1 percentage point. By contrast, if the transition is fully financed by

ODA, it is expected that GDP will be 6 percent higher and poverty will be half a percentage point lower by 2050.[160] The CRLCD scenario is expected to keep emission in 2050 at approximately the same levels of 2020 (49 MtCO2e in 2020 and 39 MtCO2e in 2050), effectively decoupling growth from emissions. In contrast, the "do nothing" scenario will more than double emissions to 117 MtCO2e by 2050.

4.2.1. Fiscal reforms can redirect resources and boost private investments

Ghana can reduce the debt burden and regain access to international finance through strong fiscal consolidation. With a tax-to-GDP ratio well below the SSA average, Ghana's efforts should prioritize revenue mobilization by broadening the tax base (expanding registration and addressing noncompliance) and reducing tax expenditures (including implementation of the forthcoming Tax Exemption Bill). It will also be critical to phase out large COVID-19 expenditures, implement the ESRP to rationalize energy spending, and pursue other measures to be agreed under a forthcoming IMF program. Following almost a year of above-target inflation (reaching one of the highest rates globally), Ghana must also strengthen monetary policymaking, improving the predictability and transparency of monetary policy decisions, and curbing monetary financing.

Carbon taxes can support Ghana to finance and incentivize a green transition and, if used to shift the tax burden away from less efficient taxes, they can also bring benefits for growth and incomes. In a study of 75 high- and low-income countries between 1994 and 2018,[161] environmental taxes were found to have a far less negative impact on GDP than income taxes and did not reduce aggregate consumption or employment. Where revenues were used to reduce sales taxes or finance household transfers, this can also counteract any losses in household real income caused by the direct price impact of a carbon tax. Over the past decade, Ghana has introduced several environmental taxes,[162] raising them from 0.5 percent of GDP in 2014 to 2 percent in 2021. A 2021 study[163] estimated that shifting the tax burden from income taxes to environmental taxes in Ghana would bring expansionary output effects from around 1.5 years after the policy change, as well as the indirect co-benefits.

Simulations suggest a moderate carbon tax in Ghana could support emissions reduction and revenue mobilization, with positive or negligible GDP impacts. A World Bank study using the Carbon Pricing Assessment Tool (CPAT) found that a carbon charge of US$25 per ton in 2022, rising to US$50 per ton in 2030,[164] would reduce Ghana's emissions by 4 percent by 2030, raise 0.5 percent of GDP in revenues annually, and moderately boost GDP, thanks to development co-benefits like reduced air pollution and traffic fatalities. Similar aggregate impacts are found by simulating the same moderate carbon tax in the MANAGE model for Ghana. The tax is expected to raise 1.5 percent of GDP annually in revenues, reduce emissions by 4 percent by 2040, and have insignificant impacts on GDP (-0.3 to -0.7 percent by 2050, depending on the use of revenues), before any co-benefits are modeled.

The effectiveness and political feasibility of carbon taxes depend on the presence of viable non-polluting alternatives and limited sunk costs in carbon-intensive capital. A fast green transition can result in the decommissioning of stranded assets (e.g. oil rigs, refineries, private vehicles, inefficient appliances) before they cease to be productive, at a cost to efficiency. If viable alternatives to polluting technologies are not available, carbon charges may raise costs without changing behavior. For example, in the absence of viable public transport, carbon taxes on fuel may simply leave commuters paying more for the same polluting car commute and limit others to commuting by foot, thereby limiting their employment opportunities. Reflecting these dynamics, the Ghana MANAGE model estimates only small impacts of a moderate carbon tax on transport emissions (-3-4 percent by 2050), due to inelastic

[160] All scenarios here include modeling of both investment costs and co-benefits.
[161] Schoder. 2021.
[162] Including an airport tax, a petroleum tax, a special petroleum tax (January 2015), and the energy debt recovery levy (January 2017).
[163] Schoder. 2021.
[164] The tax rate represents the lower-bound recommendation from the High-Level Commission on Carbon Prices (US$50-100 per ton of CO2e) for 2030, considering Ghana's income levels. The CPAT analysis estimated this would raise the price of fuels like electricity, diesel, and LPG by 6 to 9 percent by 2030. The commission, led by Joseph Stiglitz and Nicholas Stern, concluded that a range of US$40-80 per ton of CO2e in 2020, rising to US$50-100 by 2030, was consistent with achieving the core Paris Agreement objective of limiting temperature rises to 2 degrees, provided a supportive policy environment is in place. Source: Carbon Pricing Leadership Coalition. 2017. *Report of the High-Level Commission on Carbon Pricing*.

transport demand. This contrasts with electricity, where the tax is expected to reduce emissions by 10 percent by 2050, thanks to the availability of cheap solar alternatives. Such dynamics underlie some popular opposition to carbon taxes, despite their many benefits. Therefore, costs to consumers and firms will need to be accounted for by ensuring strong, affordable alternatives are available and averting heavy sunk cost investments in polluting assets.

Global experience and research points to lessons for how Ghana may tailor any carbon taxation to address equity, efficiency, welfare, and political economy priorities:

- **The best time for environmental tax reform is when fuel prices are low,** given that they only had a negative effect on GDP when fuel prices were above their median value.[165]
- **Communicate plans early** to help households and firms avoid lock-in to carbon-intensive technologies and investments and kick-start innovation towards more efficient products and processes. This can dramatically lower the costs of the decarbonization transition.
- **Provide a conducive business environment for firms** to innovate in response to new price signals, including macroeconomic stability, access to credit, streamlined licensing and registration of new products and activities, and access to land and utilities.
- **Ensure quality alternatives are available.** For example, when raising fuel taxes, ensure road users can access quality alternatives such as sidewalks, bike lanes, and bus services.
- **Consider feebate models** that allow producers to swap their tax obligation for an incentivizing tax rebate by demonstrating that they are low-GHG producers.
- **Mobilize trading partners and regional neighbors to align carbon tax rates** to reduce the potential for diminished comparative advantage in tradable sectors affected by the tax.

4.2.2. Private sector investments can help fill the climate finance gap and unlock innovation

The private sector has a significant role to play in climate adaptation and mitigation in Ghana. It will need to fill a large gap, that the public sector cannot bridge for lack of finance, expertise, or comparative advantage. In some cases, firms will find it in their interest to take action, including in sectors such as agriculture, forestry, fisheries, and tourism that are vulnerable to climate risks.[166] In other instances, private finance and investment will materialize only if it is embedded in a supportive green growth ecosystem, with adequate policy and financial incentives.

The government has identified barriers to adaptation action by the private sector167 and prioritized key sectors to engage. The bottlenecks include: (i) limited access to finance, (ii) low awareness of climate challenges and adaptation solutions, (iii) limited capacity of the private sector to conceptualize and implement solutions and of the financial sector to assess climate risks, and (iv) institutional weaknesses such as lack of coordination, policy continuity, and regulatory authority. Priority sectors for engagement are agriculture and fisheries, construction, finance, and mining.

There are also opportunities to attract significant capital in clean technologies that support GHG mitigation while helping the economy leapfrog to the technological frontier in production. In its NCCP, the government recognizes the importance of attracting clean technology investments for promoting a low-carbon growth strategy. However, Ghana is starting from a low base. Between 2003 and 2009, there were no greenfield Foreign Direct Investment (FDI) projects in sustainable sectors and, since 2009, investments in sustainable sectors have accounted for less than 15 percent of annual investments. Catalyzing green investments through new green businesses or FDI necessitates not only

[165] Schoder. 2021.
[166] From rising temperatures, increased extreme weather events, and rising sea levels.
[167] "Private Sector Engagement Strategy for the National Adaptation Plan".

strong environmental regulations but also a supportive investment climate to safeguard the often large and risky investments needed. As such, a transparent legal and regulatory environment that protects the property rights of investors and eases compliance and administrative costs for businesses is an essential foundation, and Ghana has room for improvement in this regard.

The government has also put in place incentives and measures to support green sectors, but more policy consistency is needed. Between 2009 and 2015, the government offered a seven-year tax holiday to firms in the waste processing sector, which subsequently evolved to a reduced corporate tax rate of one percent. Since 2017, young entrepreneurs operating in energy production and waste processing can qualify for a five-year tax holiday, followed by a five-year reduced tax rate of 5 to 15 percent. Conversely, the government has imposed higher taxes on extractives (mining and petroleum) while requiring mining support services to pay a 5 percent National Fiscal Stabilization levy. At the same time, however, mineral companies that have an investment agreement with the government are not bound by the higher corporate income tax rate and pay an agreed reduced rate and can carry losses forward. The EPA is in the process of adopting a policy to operationalize the legal requirements of miners to ring-fence funds for mine rehabilitation upon completion of their operations.

Ghana should consider revisiting its incentives policy to ensure a coherent approach regarding sustainable green practices. This could involve:

i) Undertaking a more detailed mapping of the relevant tax and incentive policies to identify potential misalignment of policy objectives.

ii) Reviewing the costs and benefits of incentives in terms of green outcomes.

iii) Improving the governance of incentives and their value for money, potentially by streamlining or redesigning schemes, and/or considering alternate non-incentive policies.

Box 6. Policies can help unlock opportunities for private investment and decarbonization

Some examples of opportunities for private investments in low-carbon technologies in Ghana, include:

- **The "Drive Electric Initiative"** seeks to promote the adoption of electric vehicles and leverages excess electricity supply in the system, including by creating an enabling environment for the private sector to participate as charging station operators.

- **Energy-efficient Steel Plants** can become the new standard, with the right incentives and support. For instance, Rider Iron and Steel Ghana Limited is constructing a manufacturing plant that will use mostly locally sourced scrap steel and operate with an induction furnace. It will increase Ghana's production by more than 75 percent. Using scrap steel will result in lower emissions than manufacturing steel from iron ore and, by sourcing scrap locally, the project will result in a gross avoidance of import-related emissions of 330,000 tonnes of CO2e per year.

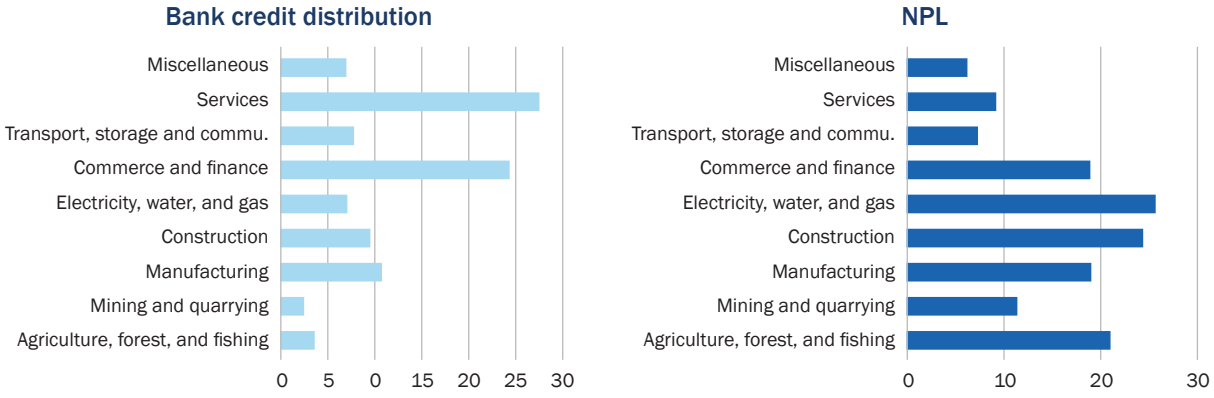
- **Clean Cooking with LPG:** To overcome challenges with LPG availability, security, safety, and affordability, the government introduced a Cylinder Recirculation Model in which cylinder ownership is transferred from the consumer to LPG Marketing Companies. Customers pay a deposit to sign-up rather than the full price of the cylinders. The National Petroleum Authority's roadmap to guide this transition estimates an implementation cost of US$25 million and private investment of US$335 million[168] to expand the supply chain (excluding import and production). To facilitate private capital mobilization in LPG filling, storage, and distribution, a regulation will enable the professionalization of the value chain to make it safer and financially viable.

[168] KfW, 2019. *LPG for Clean Cooking in Ghana: Investment and Implementation.*

4.2.3. Green finance can reduce climate risks and catalyze investment

Ghana's financial sector is exposed to physical and transition climate risks, which could jeopardize the stability and profitability of the financial system. Climate physical risks stem from both the gradual and abrupt impacts of climate change on the value of real assets and their underlying financial instruments. Climate transition risks originate from efforts to decarbonize the economy, which may create economic adjustment costs in multiple sectors. These costs can create financial risks for firms and investors that did not anticipate the transition, reduce borrowers' ability to repay debt, and, ultimately, could jeopardize the soundness of financial institutions. Climate physical risks could affect Ghanaian businesses that (a) are in vulnerable areas, such as unprotected coastal areas and areas exposed to flooding, (b) depend on stable climatic conditions, such as agriculture and tourism, and (c) depend fossil fuel. Vulnerable industries may face a decline in productivity and profitability, thereby increasing their credit risk over time if they fail to adjust to new climatic conditions or regulations in a timely manner. Ghana's non-performing loan (NPL) ratio has been high (14.4 percent in February 2022) and the five sectors with the highest NPL ratio include electricity, water, and gas; construction; agriculture, forestry, and fisheries; and commerce and finance (Figure 21). Physical and transition risks in some of these sectors could exacerbate vulnerabilities and push NPLs even higher.

Figure 21. Distribution of Bank Credit and Non-performing Loans, by Sector (percent, February 2022)



The Bank of Ghana (BoG) should assess the impact of climate-related financial risks and provide guidance to the banking sector on how to better manage climate risks. The BoG recently joined the Central Banks and Supervisors Network for Greening the Financial System (NGFS), which is a leading global knowledge sharing platform for regulators. While that signals ambition, so far, the BoG has not undertaken substantive steps to better understand and manage climate risks. The BoG could undertake a study to highlight the climate physical risks and likely impacts (e.g. worst-case scenarios) faced by the banking sector. As a first step, the BoG could assess the impacts and channels by which climate physical and transition risks could affect the banking sector. Depending on data availability, an initial analysis could explore exposures in climate-sensitive sectors and regions. As a follow up, more detailed climate risk stress testing could be conducted to quantify transition and physical risk scenarios. The BoG could follow a similar methodology as the one used for the qualitative assessment of climate physical shocks in Western Africa, which estimated that the WAEMU region and its banking sector will, on average, experience close to US$2 billion of direct losses per year (about 1.5 percent of regional GDP) from climate physical risks as well as substantial indirect economic losses that could exceed direct losses over time.[169] Based on these assessments, the BoG could then consider introducing guidance to the banking sector on climate risk management, governance, and disclosures, taking account of proportionality given the stage of development of the sector.

[169] World Bank. 2021. "*Climate Physical Risks in the WAEMU Banking Sector: A Qualitative Analysis.*"

Boosting green finance alongside overall financial sector development could help mitigate climate-related financial risks while increasing investments to address climate impacts. The financial sector should play a crucial role in mobilizing and allocating the capital needed to help the private sector and the entire economy realize investment opportunities to transition to a climate-resilient and low-carbon economy. Increasing overall access to credit is key to ensuring that more bank credit is channeled to green investments. The banking sector is the main source of external finance for firms in Ghana, including in sectors that will be critical to Ghana's adaptation and transition. Given firms' low access to credit in Ghana (credit to GDP of 11 percent as of 2021), improving overall access to finance is a pre-condition for increased availability of green finance. This requires removing constraints such as government excessive borrowing and crowding out of the private sector,[170] limited availability of term funding, deficient credit infrastructure, and challenging business environment.

A green finance strategy and roadmap could be developed, which would clarify and coordinate public and private sector actions to boost green finance. Currently, Ghana doesn't have a clear vision and action plan on the role of the financial sector in greening the economy. Following international examples, a green finance strategy could provide guidance to the financial sector and its stakeholders on how to align it better with climate and development goals. The development of a green finance strategy could be supported by a high-level green finance committee or inter-agency council, consisting of relevant authorities, including the BoG, MoF, National Insurance Commission, National Pension Regulatory Authority, and the SEC. In 2021, the MoF and the SEC launched a 10-year Capital Markets Master Plan (CMMP), which sets an ambitious roadmap for capital market development and calls for the establishment of the legal and operational framework for the issuance of green and social bonds. However, it does not elaborate on the key aspects of such a framework.

Supported by a knowledge sharing platform, commercial and public development banks could start integrating climate aspects in their loan origination. Leading banks operating in Ghana have demonstrated appetite to explore green finance and they could benefit from the development of specific climate strategies, green loan products and client engagement, key performance indicators and systems to track their green finance progress, and overall capacity building in loan origination and risk management. The new wholesale Development Bank Ghana (DBG) is expected to play a catalytic role by channeling part of its lending to climate-sensitive sectors, including by leveraging credit guarantees to increase private financial institutions' risk appetite. Following successful examples in markets such as South Africa and Morocco, a green or sustainable finance forum could be introduced, which would bring together relevant regulators, government authorities, and private sector representatives to build and share knowledge and jointly address green finance barriers.

Greening public credit guarantee schemes can enable private capital providers to scale-up green financing to micro, small, and medium enterprises (MSMEs) while helping them cope with climate-related natural disasters. MSMEs dominate the enterprise landscape in Ghana and account for more than 80 percent of employment and 70 percent of private sector output.[171] While their environmental footprint can exceed that of large businesses, extreme natural events impact MSME businesses and financial performance. Therefore, MSMEs can play a crucial role in climate mitigation and adaptation, acting as key drivers of eco-innovation while building resilience. Public credit guarantee schemes such as the Ghana Incentive-based Risk Sharing System for Agriculture Lending and the DBG's future Partial Credit Guarantee Facility can be mobilized to de-risk private green finance for creditworthy MSMEs and facilitate access to emergency finance to MSMEs hit by climate-related natural disasters.

The capital market has a limited potential in the short-term to boost green investments given its small size, although there may be opportunities for the government to issue green bonds. Ghana's capital market is dominated by government domestic debt, with total value outstanding of GHS 121 billion (32 percent of GDP) in 2020. Corporate bond issuance (GHS 11 billion outstanding in 2020) is growing but

[170] Banks' holdings of government debt account for about 40 percent of their total assets while loans and advances account for only 27 percent.
[171] Ghana Statistical Service. 2017. *Integrated Business Establishment Survey Phase II.*

dominated by a government-sponsored special purpose vehicle (ESLA Plc). Equity market development has been slow, with only 38 listed equities on the Ghana Stock Exchange, many of which are not trading. While banks are often pioneer and regular issuers of corporate bonds in other countries with developing capital markets, no bank has recently issued a bond in Ghana. Ghana has been planning to issue a sovereign green bond in the international debt market. To this end, the MoF has developed a Sustainable Financing Framework, in line with international market standards, to screen potential projects by MMDAs for green and social elements. In addition, the Debt Management Office (DMO) of the MoF could use the opportunity of green bond issuance to further engage market participants on ESG and strengthen DMO's investor relations program. The opportunity for sovereign green bonds will depend on Ghana having access to international bond markets.

Developing a national green taxonomy and supporting the mandatory disclosure of climate-related factors by banks and corporates can support the allocation of resources towards greener activities. The development of a green taxonomy that is interoperable with the EU Taxonomy would support the ability of financial sector participants to identify eligible green projects. The MoF could build off the areas identified, at a high level, as 'green' in the government's Sustainable Financing Framework and the BoG could build off its Sustainable Banking Principles (SBPs). In parallel, Ghanaian regulators should develop guidelines to enable mandatory sustainability reporting by banks and corporates. This can be facilitated by aligning with the IFRS-backed International Sustainability Standards Board, which has committed to the release of a global sustainability accounting standard by the end 2022.

4.3. Fostering a just transition for all

Climate change will disproportionately hurt the poorest and most vulnerable. In general, poor people face the greatest impacts, as they have less access to services, infrastructure, and resources to bounce back. For example, in the aftermath of the 2015 Accra floods, poor households lost significantly higher shares of their assets and income compared to higher income households and took longer to recover.[172] Most extremely poor households in Ghana reside in the Guinea and Sudan Savannah agro-ecological zones, where vulnerability of crop production to drought is also highest, as farming is highly reliant on rain-fed agriculture.[173] Climate change will worsen the situation by increasing the frequency and magnitude of shocks, thereby increasing the divide and making it more difficult for poor households to step out of poverty and lowering their quality of life, leading to a more unequal welfare distribution. However, even those at the top of the welfare distribution will suffer, particularly those with less education, as they will be least able to adapt to changing labor markets. This is more pronounced in rural areas, but increased food prices under a high emissions scenario also means urban dwellers in the lower end of the distribution will be further pushed into precarity.

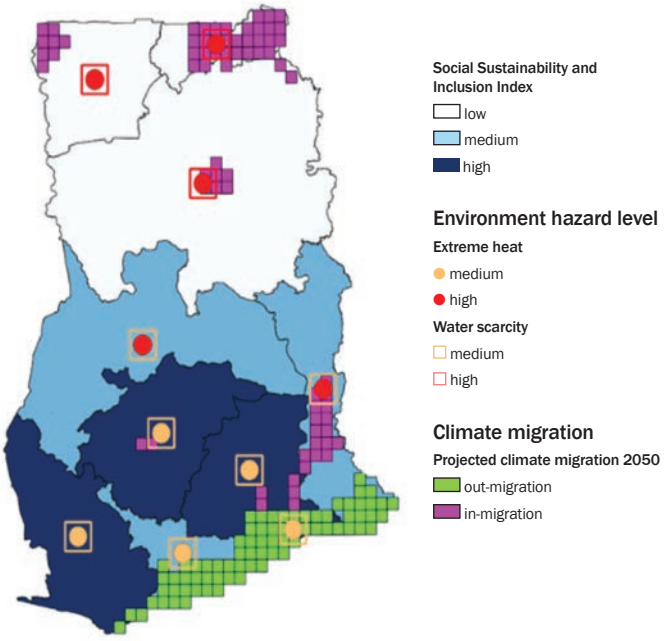
Undertaking a just transition approach can turn climate change into an opportunity to reduce vulnerability and poverty. A just transition refers to greening the economy in a way that is as fair and inclusive as possible, creating decent work opportunities, and leaving no one behind, maximizing the social and economic opportunities of climate action, while minimizing and carefully managing any challenges. Policy scenarios with investments in clean transport and CSA suggest that the situation of most Ghanaians will be improved by 2030, compared to a scenario where nothing is done to address climate change. In particular, Ghana could consider three priority actions in fostering a just transition: **(1) improving responsive social protection systems and safety nets for vulnerable groups; (2) strengthening financial inclusion, and (3) building skills for new green jobs and livelihoods.**

These actions should target areas that are most vulnerable, such as northern regions, and be tailored for four vulnerable groups: women, youth, rural populations, and persons with disability. The Ghana SSI profile shows negative results for northern regions in all three sub-pillars of social inclusion (markets,

[172] Erman et al. (2018). The Road to Recovery. Policy Research Working Paper 8469. WBG-GFDRR.
[173] Antwi-Agyei, Philip, Evan DG Fraser, Andrew J Dougill, Lindsay C Stringer, and Elisabeth Simelton. 2012. "Mapping the Vulnerability of Crop Production to Drought in Ghana using Rainfall, Yield, and Socioeconomic Data." *Applied Geography* 32 (2): 324–334.
World Bank 2018. *The World Bank's Systematic Country Diagnostic (SCD) for Ghana.*

services, and spaces) (Figure 22). Availability of assets in the household, an indicator of social resilience, is lower in northern and rural households. The upper east has the highest share of Households that have gone without food at least once or twice (70 percent). Climate in-migration in the North is likely to place further stress on natural resources and coastal regions could see high levels of out-migration if coastal management policies and plans remain insufficient.[174] In terms of social cohesion, high levels of unfair treatment and discrimination are reported in the North, based on ethnicity, religion, sexual identity, disability, and gender. Perceptions of exclusion in northern communities exacerbate vulnerability to FCV from the Sahel. In addition, rainfed agriculture employs more than half of Ghana's female labor force, or 70 percent of the rural labor force, and women living in rural areas face a greater income disparity than women in urban areas.

Figure 22. Social vulnerability, climate hazard, and climate migration in Ghana



Source: Nxumalo, Mpumelelo, and Dhushyanth Raju. 2022. Shocks and Social Safety Net Program Participation in Ghana: Descriptive Evidence from Linking Climate Risk Maps to Programs Beneficiary Rolls. Washington, DC, World Bank.

4.3.1. Safety nets and adaptive social protection can help poor households respond to shocks

Financial support from families, communities, and government can significantly help poor households build resilience and respond to shocks. The government has already put in place two large social protection programs, the Livelihood Empowerment Against Poverty (LEAP) program and the Labor-Intensive Public Works (LIPW). Scaling these up and making them more adaptable would be highly beneficial to address climate change and weather extremes.[175] There is evidence that pre-shock coverage of drought-prone areas by these programs made post-shock responses more efficient. This can include, for example, adjusting transfers before a shock occurs, as predicted by seasonal warning systems, or scaling them rapidly in case of fast onsets, like flooding or a pandemic.[176]

While current systems are effective under current circumstances, climate change provides the opportunity to improve adaptive social protection (ASP) capacities. Key actions could include:

i) Establishing an up-to-date strategy and policy that clearly defines the role of social protection and DRM in shock response.

ii) Improving the quality of EWSs (see section 3.1.3) and integration with social protection systems, including the timeliness and availability of beneficiary data (current databases cover only 50 to 70 percent of the population).

iii) Building government capacity to respond to shocks.

iv) Setting up a payment system where the majority of payments are mobile/digital.

v) Enhancing the effectiveness of gender-targeted responses.

[174] Rainfed croplands and rice-growing areas in Ghana are expected to see climate in-migration up to 129,000 and 25,000, respectively, in 2050 due to increased water availability trends in these areas (World Bank, 2021, Groundswell Africa: Internal Climate Migration in West African Countries, p. 151).
[175] The LEAP program and Labor-Intensive Public Works (LIPW) program are "flagship" social protection programs noted in the government's social protection policy. The LEAP program offers small, regular cash transfers, while the LIPW program offers temporary wage employment on small public works activities (referred to as "subprojects"). Both target poor households through different approaches.
[176] Nxumalo, Mpumelelo, and Dhushyanth Raju. 2022. *Shocks and Social Safety Net Program Participation in Ghana: Descriptive Evidence from Linking Climate Risk Maps to Programs Beneficiary Rolls.* Washington, DC, World Bank.

ASP systems will need to consider options for gender-specific targeting, as women tend to be more affected by climate change than men. Women are often found in informal jobs with lower earnings, higher job insecurity, and less regulated working conditions.[177] Persistent vulnerabilities, including the feminized nature of poverty, unequal access to economic opportunities, education, health, and productive resources such as land and finance as a result of socio-cultural factors aggravate the impact of climate change on women. Furthermore, in flood- and drought-prone districts, more women are engaged in the at-risk employment activities such as farming or livestock rearing.[178]

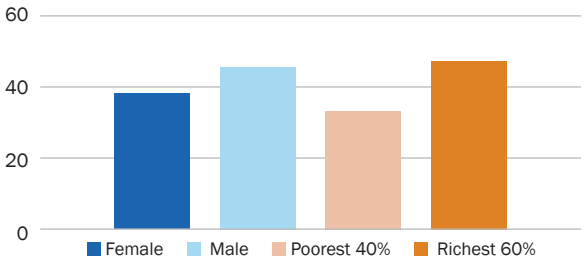
Scaling up ASP systems will create liabilities in public finance, which may need to draw on contingency mechanisms, reserve funds, and international aid on emergency bases. These liabilities can be mitigated by risk financing instrument such as the ones described in the section above, such as catastrophic bonds, reinsurance products, and contingency deferred options.

4.3.2. Financial inclusion can enhance climate risk management and recovery

Improved access to financial services helps households increase financial resilience. Access to financial services, including digital accounts and insurance, can help households build savings, instead of investing in precautionary assets such as livestock that can be affected by climate shocks. Those financial services will help them better protect their assets and ultimately their livelihoods.

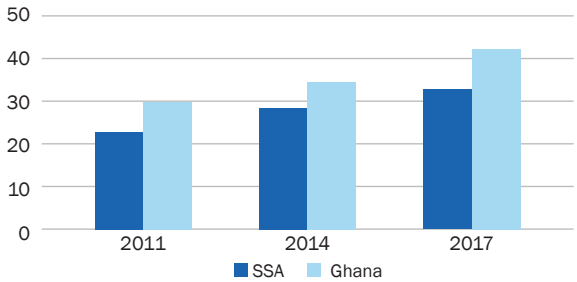
While low-income households are particularly vulnerable to shocks and the least prepared when they hit, strengthening financial inclusion can enable them to better manage risk before a shock and to recover after. Despite recent improvements, less than 50 percent of adults in Ghana have access to accounts at financial institutions, with even lower access levels for the poorest 40 percent and for female clients. Well-designed financial products and services can play a role in increasing low-income families' resilience by helping them be prepared and reduce risk and respond when a shock occurs. However, limited financial literacy, distance from an access point, and lack of documentation are among the most prevalent constraints preventing individuals and businesses from accessing an account. The commonly cited 'insufficient funds' may be more indicative of a lack of understanding of how low-income households can use financial services effectively than a real constraint. A large share of low-income individuals receives remittances, indicating a minimum income threshold. However, most domestic remittances are cash-based rather than through financial institution platforms.

Figure 23. Percent of adults in Ghana with financial institution accounts, by gender and income



Source: Findex 2017

Figure 24. Percent of adults in Ghana and SSA with accounts at a financial institution



Source: Findex 2017

Financial inclusion could be deepened and digital financial services such as mobile money can be leveraged to increase access to financial services for the bottom 40 percent. Access to mobile financial accounts encourages savings by providing a safe and effective means for people to hold their savings, and increased use of mobile transaction accounts facilitates access to credit while familiarity with

[177] ILO. 1997. *Breaking the glass ceiling: Women in management.* Adepoju, A. (2004) Feminisation of poverty in Nigerian cities: insights from focus group discussions and participatory poverty assessment. African Population Studies, Vol. 19 No 2, pp. 141-154.
[178] Climate Risk, Population Dynamics, and At-Risk Employment Composition in Ghana. Based on district statistics on prime-working-age population numbers and shares engaged in farming, livestock rearing, and poor employment in 2010.

financial services drives insurance uptake. In addition, the government could consider:

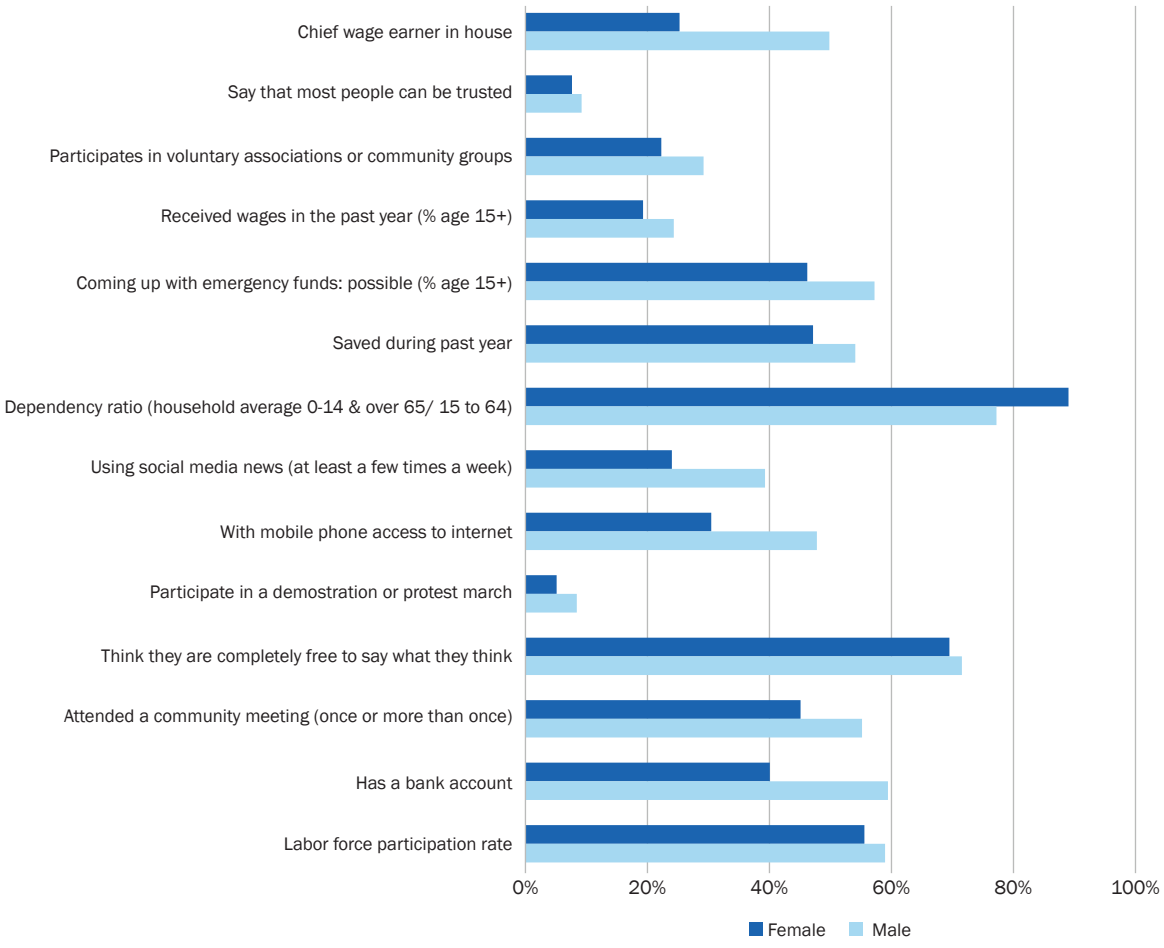
i) Initiating a national climate risk assessment to identify critical sources of financial vulnerability across sectors, geographies, businesses, and populations and to help improve climate-related financial risk management.[179]

ii) Developing effective and transparent delivery channels (e.g. dedicated disaster funds, adaptive social protection) to ensure that pre-arranged funding can be disbursed quickly and effectively to the targeted beneficiaries post disasters.

4.3.3. Building skills can empower Ghanaians to make the most of new green jobs and livelihood opportunities

Although climate impacts will worsen gender inequalities (Figure 25), improving the capacities and skills of women and youth through economic programs can strengthen their climate resilience. With rural areas experiencing increased climate shocks and rainfall volatility, a drier climate, and reliance on rainfed agriculture, the situation for rural women is expected to worsen. Support for capacity building can empower them to make the most of new green jobs and livelihood opportunities. This could include training on alternative green livelihoods, business management and marketing, access to regional markets, crop diversification, value-addition to produce, and accessing microfinance.

Figure 25. Gender inequalities are highest for financial inclusion, earnings, and empowerment



[179] The Financial Stability Council, which comprises the MoF, financial regulators, and the Deposit Protection Corporation could coordinate these efforts.

Civil society and existing community engagement models should be leveraged to build trust and social accountability in climate decision making. Trust towards other people (only 8 percent report being able to trust others) and institutions is low and can gravely compromise the legitimacy of Ghana's institutions and future climate action. Accountability for financing climate actions and ensuring that resources reach those who are most vulnerable and most affected by climate change is weak.[180] There is a relatively high level of civil society participation (0.81 on a scale from 0 to 1), including among women (0.80).[181] CSOs can play a valuable role in facilitating community engagement with government at national and district levels on climate change issues, providing information to communities for this engagement and building communities' knowledge about their entitlement to services, existing budget allocations and gaps, and responsibility of state actors. At the local level, CREMA has evolved to become a successful community-based governance system for managing Ghana's forest resources for climate adaptation and mitigation, including REDD+ opportunities.[182] The potential to upscale the CREMA model in local climate decision making should be explored.

Ultimately, the most impactful just transition intervention would be to ensure Ghana's youth are equipped with the necessary skills to make the most of new opportunities in the labor market created following climate investments. As mentioned in Chapter 2, the government expects that implementing priority NDC actions will generate nearly one million jobs. New jobs can be created, such as for solar panel technicians, and certain jobs will be eliminated, but most jobs will experience changes in occupational profiles. For example, this could involve farmers adopting CSA techniques or bottling companies changing to new materials and products. Broadly speaking, a lack of scientists and engineers will impede the deployment of green technologies. In a review of 21 countries, the ILO found significant gaps between the skills demanded in renewable energy, manufacturing, and green buildings and the skills produced by tertiary institutions. In Ghana, only one-fifth of senior high school graduates pursue programs in Science, Technology, Engineering, and Math (STEM) and it is estimated that the country only produces 1,000 university graduates each year who can perform high-level IT tasks.[183] The transitions in occupations will also put emphasis and demands on core skills lacking in Ghana, including communication and critical thinking skills and collaborative teamwork. Employers have reported that 29.6 percent of employees lacked creative and critical thinking skills, 25.9 percent lacked teamwork skills, and 32.1 percent lacked problem-solving skills.

Therefore, to facilitate and leverage the transition, Ghana should:

i) Conduct a skills readiness assessment, taking advantage of the upcoming labor force surveys and incorporating measures of green skills and feeding the findings in efforts to modernize the TVET and Higher Education system.

ii) Prioritize basic cognitive skills and invest in STEM by: (i) expanding Open University programs, focusing on STEM, ICT, and green skills; (ii) mainstreaming blended delivery through online courses and digitally enhanced learning technology; (iii) introducing micro-degrees and accelerated learning programs; (iv) introducing specialized institutions and implementing a hub-and-spoke model through regional collaborations; and (v) providing subsidies or vouchers to private tertiary institutions for delivering programs linked to priory sectors.

[180] CABRI 2021, Climate finance accountability in Africa, Inclusive Budgeting and Financing for Climate Change in Africa
[181] Varieties of Democracy. https://www.v-dem.net/
[182] IUCN. 2017. *Upscaling Community Resource Management Areas as a Delivery Mechanism for REDD+ Implementation in Ghana.*
[183] International Labour Organization 2018; OBG, 2012

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Academic City University College. Kanda Weather Balloon Project. Students launch a weather balloon to collect atmospheric data for weather forecasting. Photo: © World Bank

Conclusions and policy recommendations

5. Conclusions and policy recommendations

This CCDR shows that Ghana can simultaneously pursue development and climate objectives if it adopts a strategic approach. Since climate change and local emissions impose high costs on people and firms, significant gains can be derived from climate actions. Because of its current macroeconomic constrains, Ghana will need to identify policies that maximize synergies between climate and development, because they offer maximum protection at the lowest cost, or they foster growth-enhancing transformations and generate win-wins. Ghana also needs to sequence interventions with respect to both the projected timing of climate impacts and broader macroeconomic constraints.

In the short term, given its low emissions and major financing constraints, Ghana should focus on: (i) bolstering the resilience of its economy and society and avoiding the creation of additional risk; and (ii) setting the foundations to leverage the opportunities of global decarbonization and avoid costly lock-ins. In the immediate term, there are low-cost investments that can deliver significant payoffs and stroke-of-the-pen measures that can set the right incentives for citizens and firms.

Setting the right foundations is critical, given that Ghana's emissions will grow rapidly with increased urbanization, and demand for energy and mobility. Curbing the pollution intensity of urban mobility could generate significant health savings and better management of cities could minimize energy requirements for residential uses as well as reduce the vulnerability of urban dwellers and infrastructure to extreme events. Likewise, demand for power will grow with development, but many of today's technologies to produce and use power will become obsolete in the face of technological change and global decarbonization. Therefore, it is critical to set the stage today for decades to come.

Over the medium-term, although adapting to climate change and promoting greener development will require significant additional investments, they can yield significant payoffs and are economically viable. However, financing these investments will remain difficult. Therefore, emphasis is needed on: (i) prioritizing investments with the largest cost-benefit ratios and with benefits that accrue locally for the Ghanaians, (ii) crowding-in the private sector and leveraging the financial sector, and (iii) seeking development assistance in pursuit of those actions with benefits that are pure global public goods.

This CCDR explores a Climate Resilient and Low Carbon Development pathway that will bring Ghana towards a more green, resilient, and inclusive society. The CRLCD pathway focuses on priority areas and actions that have different degrees of urgency, affordability, impact, and development trade-offs.

Table 6. Ghana Climate Resilient and Low Carbon Development pathway: priority development areas, and recommended actions

Pathway	Priority areas	Recommended actions		
Climate-Resilient and Low-Carbon Development (CRLCD)	Adopt an integrated approach to agriculture and the environment	Foster integrated landscape management	Promote climate-smart agriculture	Support adaptation of coastal communities
	Build sustainable cities and infrastructure systems	Improve urban development and resilient infrastructure	Enhance resilient mobility infrastructure and services	Improve waste management
	Boost disaster risk preparedness	Enhance early warning systems	Improve national financial preparedness against climate shocks	Advance adaptive health and social protection systems
	Realize new opportunities for carbon sinks	Operationalize the ambition for zero deforestation	Enable participation in global carbon markets	Reduce use of biomass with clean cooking
	Promote a clean energy transition	Increase access to clean and efficient energy	Scale up the share of renewable energy sources	Strengthen regional energy markets
	Modernize transport	Develop public transport systems	Improve vehicle standards	Electrify mobility
Cross-cutting enabler	Enhance the enabling environment	Strengthen institutional capacity and legal framework	Unlock finance for climate action and sustainable development	Manage distributional impacts to ensure a just transition

5.1. Immediate priorities (2-3 years)

Given current binding financing constraints and the time lag before which climate impacts will become critical, Ghana should prioritize (i) investing in 'no regret' actions that deliver clear economic benefits, while (ii) laying the ground for important policies and investments that may only be feasible over the medium- to long-run by adopting and implementing low-cost regulatory and institutional measures. In particular, the following specific priority actions are recommended:

- **Improve macro-fiscal fundamentals, including debt sustainability and creditworthiness:** (i) Strengthen revenue mobilization, focusing on broadening the tax base and reducing tax expenditures; (ii) Rationalize spending (including by implementing the ESRP) and addressing major contingent liability risks from SOEs, and (iii) adopting clear and realistic fiscal and debt anchors.

- **Strengthen institutional capacity for climate action and the legal framework:** (i) Enhance coordination, anchoring in law climate policy priorities in the NDC, (ii) Establish a legal framework for participation in international carbon markets; (iii) Develop a LTS under the Paris Agreement; and (iv) Integrate climate considerations in planning and budgeting.

- **Begin to unlock private climate finance:** (i) Improve the business environment for private investment (e.g. in green technologies); and (ii) Anticipate the preparation of bankable projects for international climate finance.

- **Integrate agriculture development, forest, and water management:** (i) Develop enabling policies and incentive packages for CSA, integrated water management, and reducing deforestation; (ii) Clarify tree tenure and rights of landholders to strengthen role of communities in forest management; and (iii) Establish sound landscape governance structures for setting of common resource management goals that are understood and endorsed across sectors and stakeholder groups.

- **Create the conditions for resilient cities and infrastructure:** (i) Prepare city-specific risk analyses and integrate risk data into land use plans, building codes, and city-wide infrastructure plans; (ii) Develop and enforce urban plans to reduce urban sprawl and introduce zoning of flood risk areas; and (iii) Prepare and implement climate-informed design criteria for urban infrastructure and new residential construction.

- **Boost disaster risk preparedness:** (i) Support the development of early warning systems in priority cities and strengthening emergency response capacity; (ii) Raise risk awareness in communities; and (iii) Pilot options for disaster risk financing.

- **Set the foundations for low-carbon development in energy and transport**: (i) Support solar PV penetration, through competitive procurement for new power plants and supporting privately owned PV generation; (ii) Roll-out clean cooking LPG programs; (iii) Upgrade and enforce regulation of private motor vehicles and fuel standards; and (iv) Improve traffic management and regulation (e.g. walkways, bus/bike-only lanes).

- **Foster a just transition:** (i) Conduct a skills readiness assessment and integrate the findings in the modernization of the TVET and Higher Education system; and (ii) Explore opportunities for adaptive social protection systems.

5.2. Short- to medium-term priorities (before 2030)

As financing constraints are relaxed and initial actions pay off, Ghana should consider boosting climate resilience through sectoral interventions, deepening insurance and response mechanisms, and setting the foundation for a low-carbon transition in energy and transport. Sectoral interventions should be prioritized in agriculture, forestry, water, costal management, urban development, mobility, and waste, while mechanisms that require strengthening should focus on disaster risk management and financing, social protection, and climate-proofing the health and financial sectors. Finally, early action on mitigation in energy and transport will create conditions to leverage opportunities from technology, innovation, and financing, avoiding stranded assets and reducing externalities. In particular, the following specific priority actions are recommended:

- **Continue unlocking finance and fiscal space for climate action and development:** (i) Continue rebuilding fiscal and financial buffers to enable public investment and/or external resource mobilization; (ii) Consider carbon taxes to finance and incentivize a green transition; (iii) Revise private sector incentive schemes, consider alternative non-incentive policies to ensure a coherent approach on green practices, and mobilize private finance; (iv) Implement a green finance strategy; (v) Enable private capital providers to scale-up green financing to SMEs through public credit guarantee schemes; (vi) Develop a national green taxonomy and support the mandatory disclosure of climate-related factors by banks and corporates; and (vii) Create the conditions for trading in carbon markets.

- **Strengthen national-level institutional capacity and the legal framework:** (i) Amend existing or enact dedicated regulations to enshrine into law a framework for standardized MRV procedures and ensure the proper functionality of G-CARP; (ii) Integrate climate change in PFM at the subnational level; (iii) Mainstream climate change in PIM, including the introduction of GPP; and (iv) Mainstream climate change in SOEs, with KPIs in APCs.

- **Strengthen integrated agriculture, forest, and water management:** (i) Establish integrated landscape governance strategies and plans at the district level; (ii) Scale-up community-level natural resource management; (iii) Reform land and tree tenure to encourage farmers to adopt natural regeneration and manage trees on-farm; and (iii) Strengthen charcoal regulation.

- **Increase investments in climate-smart agriculture:** (i) Rebalance public spending and de-risk CSA adoption by appropriate planning; (ii) Develop bankable proposals and business models that can be self-sustained in the medium- to long-term; (iii) Train farmers on CSA practices and digital skills; And (iv) Expand irrigation, both large- and small-scale schemes.

- **Improve coastal management:** (i) Clarify institutional roles and responsibilities for coordinated ICZM approaches; (ii) Strengthen environmental and social risk management regulations and capacity, especially around ports and coastal protection infrastructure; and (iii) Strengthen enforcement capacities of agencies around protected coastal ecosystems.

- **Build more sustainable cities and resilient infrastructure systems:** (i) Establish an institutional mechanism to coordinate metropolitan scale planning and build local urban planning and management capacity; (ii) Expand water supply and wastewater treatment to underserved areas, especially urban slums; (iii) Invest in high-quality walking and biking infrastructure and improve public transport; (iv) Prepare a solid waste sector plan; (v) Expand waste segregation and sanitary disposal capacity; (v) Mainstream climate risk in the design of new infrastructure and climate-proofing existing infrastructure; (vi) Improve O&M; and (vii) Implement NbS solutions.

- **Boost disaster risk preparedness:** (i) Expand early warning systems at the national level and continue strengthening emergency response capacity at NADMO and local levels, including risk communication and public awareness; (ii) Implement selected options for disaster risk

financing, including insurance and contingency financing; and (iii) Develop and implement climate adaptive safety nets, social support, and health systems.

- **Realize new opportunities for carbon sinks in the forestry sector:** (i) Achieve and maintain the zero-deforestation commitment; (ii) Enable participation in global carbon markets; and (iii) Expand coverage of LPG to 50 percent and scale-up the use of efficient cookstoves.

- **Promote a clean energy transition:** (i) Scale-up solar PV penetration beyond 10 percent by 2030 and achieve universal access to electricity through off-grid electrification; (ii) Maintain hydropower plant capacity and exploit remaining potential; (iii) Integrate in the WAPP; and (iv) Manage increased demand by increasing appliance and building efficiency and reducing network losses.

- **Modernize transport:** (i) Scale-up investments in alternatives to road-based freight with rail and inland waterways; (ii) Improve the passenger and freight fleet by enforcing the regulation and certification of vehicle sales, imports, and emissions standards and creating an end-of-life program to limit the use of the oldest vehicles; and (iii) Support the electrification of two- and three-wheelers, targeting 30 percent of the stock.

- **Foster a just transition:** (i) Invest in STEM, including through online courses and subsidies to private tertiary institutions for delivering programs linked to priory sectors. (ii) Introduce specialized institutions and implement a hub-and-spoke model through regional collaborations; and (iii) Build green skills into education curricula.

5.3. Longer-term priorities (Beyond 2030 or even 2050)

This CCDR also considers how medium-term actions may set Ghana up for longer-term resilience and competitiveness. The short-term payoffs of averting climate damages may be modest, but some early climate actions may bring substantial benefits, as damages are expected to become much larger post-2050, if/when tipping points materialize. They also position Ghana to uphold competitiveness as technology prices and global demand shift. For example, infrastructure and land use zoning can prevent development in locations that will be highly exposed to natural hazards and climate risks such as flooding and water shortages. It can also promote urban density and land use efficiency that supports multi-modal and mass transit and electric vehicles, as technology and affordability allow. Similarly, when possible, decommissioning more polluting electricity assets can allow Ghana to take advantage of falling renewables costs and maintain global competitiveness as trading partners go green.

Most of these climate actions have clear economic benefits that more than compensate for their costs,[184] but financing them from the national budget will be challenging, even over the medium- to longer-term. As such, there is a clear role for both development assistance and private finance to fill the gap. Ghana can encourage private sector-led green growth by promoting a sustainable investment climate and creating opportunities in selected sectors for private green investments such as energy efficiency improvements, CSA technologies, and electric vehicles. The role of the financial sector will also be key to leverage opportunities for green and blue bonds, insurance, and other financial protection mechanisms that can help address climate and disaster risks. Meanwhile, ODA will be critical to support measures that have high costs without comparable benefits for the local economy, such as a net zero energy transition and widespread electric vehicle infrastructure.

Flexibility will be key, given the high uncertainty about costs, benefits, and affordability of climate actions. Costs and benefits estimated today are highly sensitive to future exchange rates, commodity prices, technology prices, and the evolution of global climate change. Any estimates for the post-2030

[184] Additional investment costs are estimated at around US$14 billion in 2022-2030 and US$58 billion in 2022-2050 (present value using 6% discount rate). These costs do not include large retrofitting adaptation investments on existing infrastructure systems. A non-comprehensive analysis suggests that economic benefits amount to US$18 billion in 2022-2030 and US$124 billion in 2022-2050.

period, therefore, embed a high degree of uncertainty, including those in this report. Therefore, Ghana should consider revisiting its climate strategy at regular intervals (e.g. every five years) to take stock of how such developments and outcomes from interim climate actions have impacted the feasibility and attractiveness of various future climate actions.

The most effective option for Ghana to tackle the climate crisis is to grow sustainably and reduce poverty, and climate actions can support these dual goals. All other things equal, fast-growing and prosperous countries will be much better placed than others to protect themselves from the most harmful effects of climate change. Therefore, sound macroeconomic management, a conducive business environment, and broad and nimble safety nets are key foundations for building resilience and laying the foundations for the low-carbon transition. This report demonstrates that climate action is not only compatible with foundational development goals, but highly complementary and beneficial to keep Ghana on track to meet its ambitions. It identifies actions that are good for Ghana's development, build resilience, and set the foundations for future decarbonization, when conditions will be in place, while flagging risks of costly lock-ins into obsolete development directions and opportunities to leapfrog to more a green, inclusive, and resilient development pathway.

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