WORLD BANK GROUP

EASTERN AND
SOUTHERN AFRICA

ANGOLA

COUNTRY CLIMATE AND DEVELOPMENT REPORT

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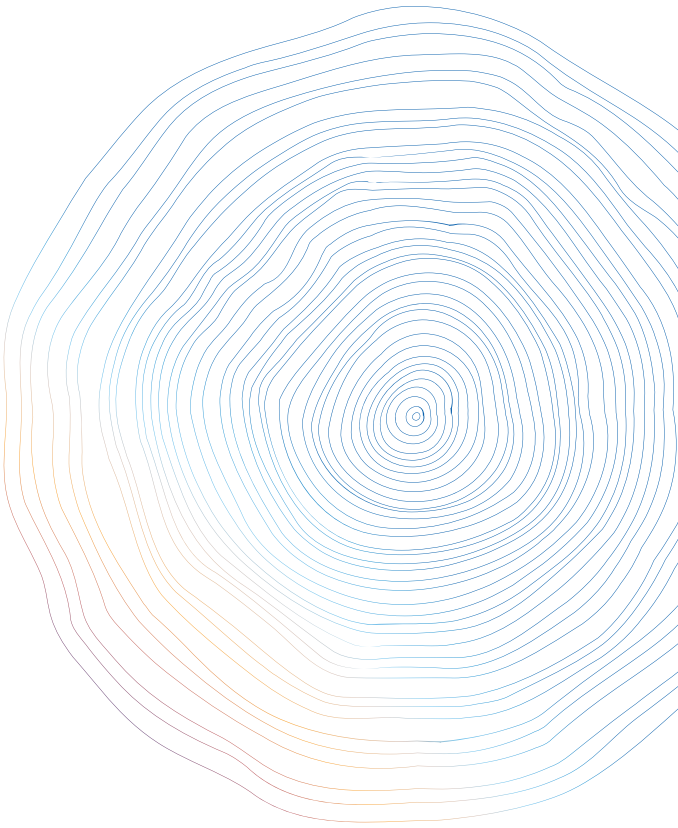

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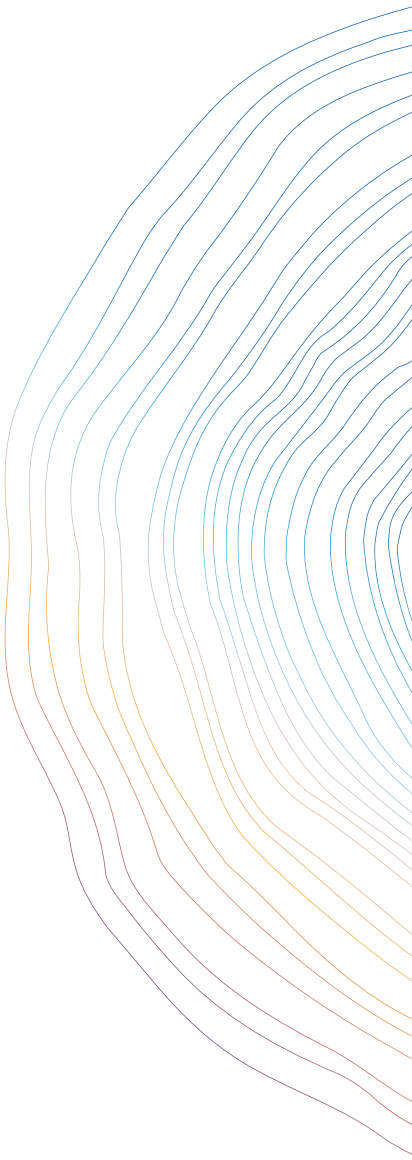

Foreword

Climate change is already affecting people's lives and livelihoods in Angola, as well as the Angolan economy as a whole. The country is experiencing increasingly severe and frequent climate hazards—including the South's worst prolonged droughts in decades. Climate change impacts also come with a heavy price tag: climate-related disasters (floods, storms, droughts) cost Angola nearly US$1.2 billion between 2005 and 2017, and on average droughts alone affect about a million Angolans every year. Impacts of climate variability on Angola's water resources are expected to be particularly severe and will affect food and energy production, as well as hydropower, on which Angola relies for most of its electricity. The future does not look much brighter: climate models predict a rise in temperatures, with most of Angola becoming 1–1.5°C warmer in 2020–2040 relative to the 1981–2010 period, with a 1.4°C increase in the annual average temperature already recorded. The imperative to adapt and transition to a proactive model for climate risk management is urgent.

Against this backdrop, and the equally urgent priority to diversify away from a highly oil-based economy, the Angola Country Climate and Development Report (CCDR) provides options for the country to adapt to a fast-warming world and adopt measures for more diversified and climate-resilient development that will underpin sustainable and inclusive growth. Angola has significant renewable capital, including agricultural land, forests, water resources, and, above all, its people, who can facilitate this process. But climate change also threatens these renewable assets, and necessary investments in climate resilience will be critical to realize their potential.

The CCDR addresses questions such as: What does Angola have to adapt to, and what does it adapt towards? What are the practical implications a climate-resilient development pathway, and what short- and longer-term actions are needed to enable, incentivize, and finance a shift to such a climate-resilient development trajectory? The report identifies five key pathways to achieving climate-resilient, inclusive, equitable, and sustainable growth: investing in the resilience of key renewable wealth sectors (water, energy, and food systems); making cities green and climate-resilient; strengthening human capital; building crucial skills and fostering a culture of climate preparedness; and reducing dependence on oil.

To inform the CCDR, a robust climate science impact analysis was undertaken, followed by in-depth analysis of macroeconomic and sectoral implications of climate impacts on Angola's future development prospects. The report was developed over the course of a year, leveraging technical teams from across the World Bank, the International Finance Corporation, and the Multilateral Investment Guarantee Agency, working in close partnership with the Government of Angola through its Ministry of Economic Planning and other key climate-sensitive sectoral ministries. It is the first of its kind linking climate and development analysis in Angola, and is part of the first set of CCDRs prepared and piloted by the World Bank Group that aim to align climate action and development priorities across all of its client countries.

We sincerely hope the findings of this CCDR can inform Angola's 2023–2027 National Development Plan, providing concrete options for achieving climate-resilient growth. We look forward to working together to act on the conclusions of this report to operationalize climate-resilient development in Angola.

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Acknowledgments

This report is a joint publication of the World Bank Group and the Government of Angola. The report was produced under the World Bank Country Climate and Development Report Advisory Services and Analytics (ASA), under the overall guidance of Victoria Kwakwa (Regional Vice-President, World Bank), Sergio Pimenta (Regional Vice-President, International Finance Corporation), Albert Zeufack (Country Director), Jean-Christophe Carret (former Country Director), Ayat Soliman (Regional Director, WB), Asad Alam (Regional Director, WB), Amit Dar (Director of Strategy and Operations, WB), Kevin Warui Nijiraini (Regional Director, IFC) and Merli Margaret Baroudi (Director, MIGES).

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The team is grateful to the following colleagues for their valuable guidance, contributions and advice throughout the production of this pilot climate and development report for Angola: Catherine Signe-Tovey (Practice Manager and Acting Regional Director), Africa Eshogba Olojoba (Practice Manager, SAEE3), Maria Angelica Sotomayor (Practice Manager, SAEW2); Vivek Suri (Practice Manager, EAEM1); Marc Lixi (Program Leader, IAEDR), Cia Sjetnan (Sr. Operations Officer, AECCD), Ana Maria Carvalho (Sr. Operations Officer, AEMAO), Vinaya Swaroop (Economic Adviser, AFEDE),), Sajjad Shah (Manager, AFEDE), Tambi Matambo (Senior Operations Officer, AFEDE), Da Lin (Program Assistant, AFEDE), Lucie Lufiauliuisu Bobola (Sr. Executive Assistant, AECC2). We also thank the following peer reviewers for their valuable inputs: Kanta K. Rigaud (Lead Environment Specialist); Kevin Carey (Adviser, EMNDR); Julia Bucknall (Sr. Adviser, AFEVP);

Somik V. Lall (Lead Economist, EFICE); Fan Zhang (Lead Economist, SWADR); Margaret Arnold (Sr. Social Development Specialist, SSIGL), Urvashi Narain (Lead Economist, SAEE3) and Dr. Simon Mason (Columbia University).

Finally, the World Bank team is indebted to the following scientists and researchers commissioned to conduct the climate impact modelling work for the Angola CCDR, for developing new findings on Angola's current and future climate impacts presented in this report: the Red Cross Climate Centre team led by Izidine Pinto, Technical Advisor (with Eddie Wasswa Jjemba, Urban Resilience Advisor; Erin Coughlan de Perez (PhD), Senior Advisor; Catalina Jaime, Manager Climate and Conflict and Jasmijn Flores Suidman, Junior Researcher); the Climate System Analysis Group team led by Piotr Wolski, Chief Research Officer (with Lisa van Aardeene, Chief Scientific Officer); and the Columbia University team led by Simon Mason, Senior Research Scientist. We thank the climate modeling groups for producing and making available their model output, the Earth System Grid Federation (ESGF) for archiving the data and providing access, and the multiple funding agencies who support CMIP5, CMIP6 and ESGF. Finally, we thank Silvia R. Santos Da Silva and Fernando Miralles-Wilhelm, George Mason University, for their GCAM modeling contributions. Each scientific team produced an in-depth report, accessible in the Annexes document.

The Government of Angola team was under the guidance of His Excellency Mr. Mario Caetano, Minister of Economy and Planning (MEP); His Excellency Mr. Filipe Zau, Ministry of Culture Tourism, and Environment (MCTA); Her Excellency Ms Paula Coelho, Secretary State of Environment (MCTA); His Excellency Mr. Milton Reis, Secretary of State of Planning (MEP); His Excellency Mr. Lucrécio Costa, Secretary of State of Water (MINEA); His Excellency Mr. Antonio Costa, Secretary of State of Energy (MINEA); Mr. João Afonso, General Director (INAMET) and Mr. Patrício Neto, Director of International Relation office (MINFIN).

Lastly, the analytics and original climate and macro-modelling work presented in the Angola CCDR report was made possible thanks to generous support from the Climate Support Facility Trust Fund (TF0B7158), a Multi-Donor Trust Fund created to help developing countries accelerate their transition to low-carbon and climate-resilient development and elevate the decarbonization agenda.

Acronyms and Abbreviations

AFOLU	agriculture, forestry, and other land use
CH_4	methane
CO_2e	carbon dioxide equivalent
DRF	disaster risk finance
DRM	disaster risk management
EEZ	exclusive economic zone
ENAC	Estratégia Nacional para as Alterações Climáticas (National Strategy for Climate Change)
GABHIC	Gabinete Para a Administração das Bacias Hidrográficas do Cunene, Cubango e Cuvelai (Office for the Administration of the Cunene, Cubango, and Cuvelai Basins)
GDP	gross domestic product
GHG	greenhouse gas
IFC	International Finance Corporation
INAMET	Instituto Nacional de Meteorologia e Geofísica (National Institute of Meteorology and Geophysics)
INRH	Instituto Nacional de Recursos Hídricos (National Water Resources Institute)
IPCC	Intergovernmental Panel on Climate Change
MCTA	Ministério da Cultura, Turismo, e Ambiente (Ministry of Culture, Tourism, and Environment)
MINEA	Ministério da Energia e Águas (Ministry of Energy and Water)
MIREMPET	Ministério dos Recursos Minerais, Petróleo e Gás (Ministry of Mineral Resources, Petroleum, and Gas)
Mt	million tonnes (metric tons)
N_2O	nitrous oxide
NBS	nature-based solutions
PFM	public financial management
PIM	public investment management
RCP	representative concentration pathway
WBG	World Bank Group

Luanda, Angola ©mtcyrado/iStock.com

Executive Summary

EXECUTIVE SUMMARY

1. Angola's Climate and Development Challenge

Angola's oil-based economic growth of the past two decades has not delivered inclusive development and is now losing steam. Oil production has declined from a peak of 1.9 million barrels per day (mbpd) in 2008 to 1.2 mbpd in 2022 and is likely to continue to decline gradually in the coming decades, as low-cost reserves are exhausted and the global transition to a low-carbon pathway reduces new investment. Meanwhile, oil-driven GDP growth has failed to reduce poverty or build the human and physical capital foundations for sustainable and more diversified economic growth. As of 2018, 32.3 percent of the population was below the national poverty line, and in 2020, Angola ranked 148th out of 191 countries on the Human Development Index. Due to weak growth in the non-oil sectors, as of 2021, oil and gas still contributed 27 percent of GDP, 55 percent of government revenues, and 95 percent of exports, and per capita GNI was just US$1,770, down from $4,830 in 2014.

Angola's development priority is therefore to use the revenues from its dwindling oil wealth to diversify its economy, reducing its dependency on the petroleum industry and creating opportunities for sustainable growth and job creation. Recognizing this challenge, Angola's President has stated that diversification is "a matter of life or death" for the country, and the next National Development Plan (2023–2027) features economic diversification as one of three focus areas (along with human capital and infrastructure). Angola's 2018 Systematic Country Diagnostic identifies agribusiness, fisheries, and manufacturing as potential (non-extractive) industries where Angola's economy could diversify and create more employment opportunities. The potential of these sectors is also acknowledged as part of the most recent Country Private Sector Diagnostic by the International Finance Corporation (IFC). Agriculture in particular has substantial potential to positively impact growth, economic diversification, employment, and social inclusion, but it can only thrive if productivity can be significantly increased.

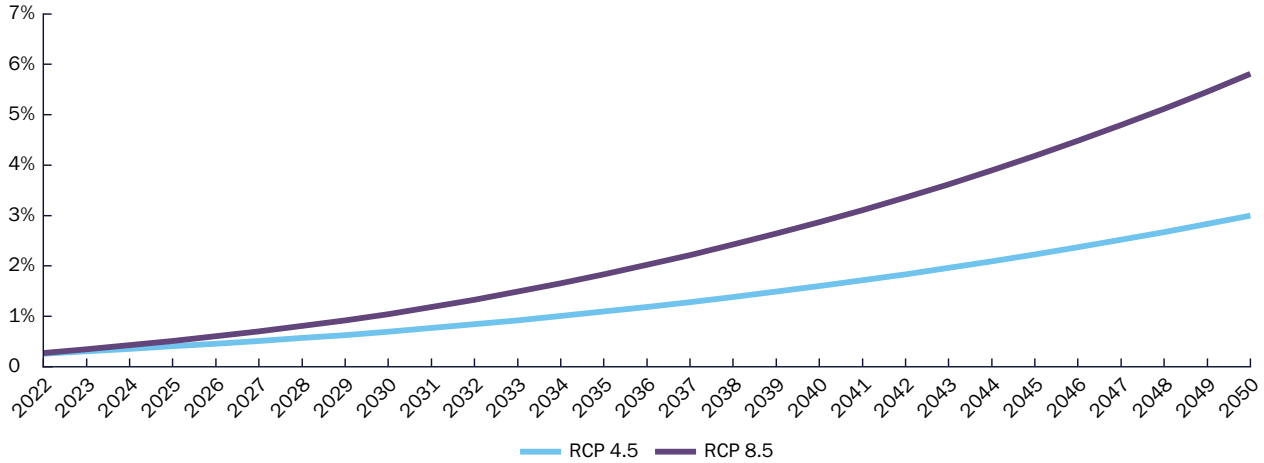
Achieving climate resilience is inextricably linked to the success of Angola's economic diversification, as most promising non-extractive sectors are highly climate-sensitive and already under increased stress from climate variability. Projected increases in rainfall variability and extremes have serious implications for agriculture, fisheries, energy production, and cities. Unreliable water availability and increased extreme events are expected to pose growing challenges to agricultural production. Direct economic losses in

agriculture from droughts may rise from as much as $100 million per year nationwide today, to more than $700 million per year by 2100. The productivity of fisheries is also projected to decline, with the maximum catch potential expected to decrease by 43.7 percent by 2050 and 64.0 percent by 2100. With southern and southeastern Angola projected to become dryer, hydropower production on the Kunene River, for example, is expected to decline. Meanwhile, in urban areas—where two-thirds of Angolans already live, and a majority of jobs are—climate change is likely to exacerbate water scarcity, bring more intense storms and coastal flooding, and increase the risks associated with inadequate sanitation.

Climate change is not just a future threat, but already a reality in Angola. A state-of-the-art climate impact assessment conducted for this CCDR confirmed that warming has accelerated significantly in recent years. The annual mean temperature has increased by 1.4 °C since 1951 and is expected to keep rising. Southern Angola has been the hardest hit, and experienced a severe and protracted drought over the past decade, with conditions described as the worst in 40 years. In 2021, an estimated 3.81 million people in the six southern provinces were reported to have insufficient food, and over 1.2 million people continue to face water scarcity because of the drought. By 2040–2060, most of the country is projected to be 1.5–2.5 °C warmer, except near the coast, with significant implications for water availability, drought severity, and, in some areas, extreme heat. Precipitation trends are more uncertain, but rainfall variability is clearly increasing, with longer dry spells, worse droughts, and also more floods.

Economic modeling shows that without adaptation measures, climate change impacts could reduce Angola's GDP by 3–6 percent by 2050 (Figure ES.1). Agriculture will be hard hit, and the model shows that in a high-emission scenario (RCP8.5), agricultural productivity would be as much as 7 percent lower by 2050 than in a scenario with no climate damages. Overall worker productivity could be 4 percent lower due to higher temperatures. The capital stock in the non-oil sector, meanwhile, could be Losses and damages from floods could reduce the value of non-oil capital stock in Angola by 3–4 percent due to floods and reduced labor productivity due to higher temperatures are also expected to result in significant headwinds to Angola's development. As a result, by 2050, the capital stock in the non-oil sector could be 4 percent lower, as assets such as roads, factories, and machinery are destroyed by floods and other extreme events.

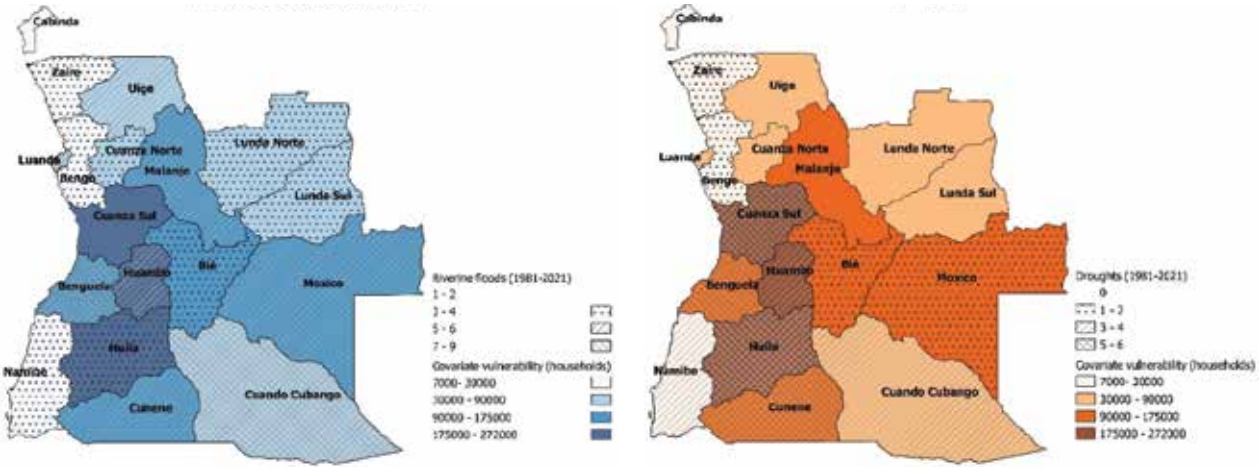
Figure ES.1. Projected loss of GDP due to climate change impacts under RCP4.5 and RCP8.5



Many Angolans who are vulnerable to falling into poverty live in areas of high exposure to climate change, which will make it harder for the country to achieve its poverty reduction goals. Chronic poverty and vulnerability to poverty are already widespread, and this increases vulnerability to covariate shocks—events that affect large swaths of the population at once (see Figure ES.2). Some of the areas with the largest numbers

of vulnerable households, shown by the dark blue and brown areas in the maps, are also areas with the highest frequency of floods (such as in Huambo) and droughts (such as in Huila). Economic and climate shocks that affect entire areas or populations, combined with high levels of vulnerability to poverty, can translate into substantial increases in the incidence and severity of poverty, food insecurity, and child malnutrition.

Figure ES.2. Vulnerability to major climate-related shocks in Angola and number of events, 1981–2021: Riverine floods (left) and droughts (right)



Given the mounting climate risks faced by Angola and its small contribution to global greenhouse gas (GHG) emissions, this CCDR prioritizes adaptation and resilience, while seizing opportunities for low-carbon growth. Angola contributes 0.21 percent of global GHG emissions, and it already gets most of its electricity from renewable sources. Angola's largest source of GHG emissions is currently the oil and gas sector (mainly from gas flaring and fugitive methane emissions), followed by agriculture, forestry, and other land uses (AFOLU). The report recommends ways to reduce the carbon intensity of Angola's oil and gas production, especially a fee on gas flaring and venting, as well as stronger enforcement of existing regulations. Other key measures include further expanding renewable energy; removing fuel subsidies to promote more rational fuel use and efficiency in transportation; and adopting measures to reduce emissions from agriculture, reversing land degradation and deforestation. Thus, recommended pathways are consistent with low-carbon development, as many investments and reforms needed for resilient development and diversification also contribute to meeting national mitigation targets.

Pathways to Climate-Resilient Development in Angola

This report identifies five pathways to achieve a vision of a future Angolan economy that is low-carbon, diversified and climate-resilient, with opportunities for all. Tailored to the national context, these approaches were identified in dialogue with the Government of Angola and build on national development priorities. Angola is rich in natural capital, not only oil, gas, and diamonds, but also abundant water resources, renewable energy potential, and fertile arable land. Therefore, to shift away from an economy driven by oil and gas extraction and toward a sustainable and diversified economy based on renewable natural capital, this CCDR recommends investing in and building the resilience of key sectors, notably 1) water resources, 2) agriculture and fisheries, and 3) renewable energy. Delivering the vision of a climate-resilient and diversified economy also entails 4) enabling green and resilient cities with economic opportunities for all Angolans; and leveraging Angola's young population by 5) boosting human capital, through expanded, climate-resilient access to basic services and by fostering a culture of climate preparedness.

1. Manage water resources as a pillar of climate resilience

Angola is endowed with plentiful water resources that, if well-managed in the context of rising climate variability and change, can continue to generate clean electricity, produce abundant food, and ensure water security in both rural and urban areas. Angola's water resources are unevenly distributed, however, and there is high seasonal and interannual rainfall variability is high, and in much of the country, models point to a decrease in overall water availability. Sustainable water resources management is central to Angola's economic diversification efforts, as the sectors with most potential depend on water: the energy sector, which relies extensively on hydropower, agriculture, and urban sectors that depend on livable cities with adequate water supply and sanitation, as well as flood and drought resilience. Water is also tied to human capital development: as of 2020, only 57 percent of people nationwide had at least basic drinking water access, and 73 percent had access to an improved sanitation facility.

Key recommendations include strengthening basin water management offices and councils to balance competing demands with limited and variable water resources; investing in water storage, including groundwater and watershed storage (i.e. nature based solutions) to mitigate flood risks and store water for dry periods; expanding access to clean water and sanitation across rural and peri-urban areas ((a US$2 billion investment); rehabilitating and strengthening the operation and maintenance of dams and rural infrastructure to serve productive uses ($1 billion).

2. Ensure a green and climate-resilient power supply

Renewable energy—especially hydro, but also solar and wind—offers a key opportunity for Angola. Angola's power generation capacity has grown rapidly, mainly through large-scale hydropower. Hydro capacity has quadrupled in just one decade, and in 2020, total domestic power generation in Angola was 13,991 GWh, 88.5 percent of which from hydropower. Angola's solar and wind potential are also very strong. Angola has already partnered with international companies to develop seven on-grid solar PV power plants that will add a total installed capacity of 370 MW. Angola could generate large amounts of clean electricity and also produce hydrogen fuel made entirely with renewable energy—a key resource in a low-carbon future. If generation grows to exceed domestic demand, there is also potential for export to neighboring countries. However, Angola's reliance on hydropower makes it especially exposed to climate variability and climate change, and over half the population is not connected to the grid—implying that building resilience and expanding electrification will be key conditions to ensure the power sector contributes to Angola's resilient and inclusive development vision.

Key recommendations include prioritizing investments to expand the transmission and distribution grid (US$5 billion), as well as off-grid solutions (another $1.3 billion). The report advises to prepare and regularly update a climate-adjusted Power Sector Master Plan, and highlights opportunities to improve the sector's system operation and expansion planning, as well as the enabling environment for private sector participation in solar PV and wind projects.

3. Become a hub of climate-smart and abundant food production

Agriculture in Angola is crucial to food security and holds tremendous commercial potential, but climate change will require significant reforms to realize the sector's potential as an engine of growth. As Angola's NDC notes, the sector is "underdeveloped and not very productive," employing 51 percent of the population—mainly as subsistence farmers—but contributing only 9 percent to GDP. However, the potential for growth is immense: only about a third of the arable land is cultivated, and only about 2 percent of arable land benefits from machinery or even animal traction. Irrigation is also rare, and unsustainable practices are common, resulting in forest loss, reduced biodiversity, and other environmental burdens. Meanwhile, as

noted above, without effective adaptation, climate change is likely to have a major negative impact on agriculture. Addressing these challenges while building climate resilience will thus be crucial if agriculture is to become a pillar of Angola's economic diversification. Angola also has large potential for fisheries and aquaculture, but it needs to carefully manage its resources to protect ecosystems and promote sustainable growth. Overfishing and changes in hydroclimatic conditions have greatly affected the sector.

Key recommendations include scaling up climate-smart agriculture practices and climate-smart fisheries technologies, rehabilitating old irrigation perimeters and infrastructure left in neglect following the civil war, and building flexible, decentralized systems for farmer-led irrigation development, while also expanding extension services support and repurposing agricultural subsidies to benefit all farmers.

4. Build green and resilient cities

Cities can be catalysts for growth and job creation, but they need to be resilient, livable, and inclusive to realize this potential. Two-thirds of Angolans live in urban areas, and by 2050, the share is expected to rise to 80 percent, with cities hosting three times as many residents as they do today. Angola has yet to realize the economic potential of urbanization, which can contribute significantly to diversification in the industrial and service sectors. But urban areas also face significant climate risks, including water scarcity, more intense storms, coastal flooding, and disruptions to sanitation systems. To realize the potential of Angola's cities, it is crucial to build their resilience, to safeguard economic assets and protect the most vulnerable populations, including the large share of urban residents who work in the informal sector without a safety net.

Key recommendations include promoting clean, compact, and connected development in Luanda and secondary cities, and investing in comprehensive solid waste management systems to curb methane emissions, reduce flooding, and improve quality of life. Local governments will need to coordinate and lead implementation of urban resilience measures–such as risk analyses, integration of risk maps into territorial plans, inspection and enforcement of zoning regulations. Flood early warning systems, especially for coastal zones, and nature-based solutions for flood and landslide protection, will also be critical measures to live with rising climate risks.

5. Boost human capital and foster a culture of climate-preparedness

Angola's most important wealth are its people, who are young (the median age is 17) and can power climate-resilient development across sectors—but only if they are healthy, well-nourished, and properly trained. Currently, Angola's human capital index stands at 0.4, similar to the average for Sub-Saharan Africa, but lower than the global average of 0.57. Climate change threatens Angola with more food and nutrition insecurity and a higher incidence of vector-borne diseases, such as malaria. Therefore, investments in health and nutrition, especially the most vulnerable and food-insecure Angolans, are a first shield against rising climate shocks, and crucial to building climate resilience, reducing poverty, and supporting inclusive growth. Angola also needs to strengthen social protection.

Key recommendations include expanding Angola's flagship anti-poverty program, Kwenda, to incorporate adaptive features that can quickly enhance benefits and expand coverage to a larger population when shocks occur. In addition, creating a culture of climate preparedness, especially through education reforms, will contribute to enhancing national capacities for climate resilience. In order to raise a climate-conscious generation, it is critical to start in the early years and instill values of shared responsibility and environmental stewardship in primary education. As Angola prepares a new strategy for its tertiary education sector, prioritizing programs that prepare workers for careers in adaptation and low-carbon technologies ("green jobs") is an opportunity to boost its future competitiveness. Investments in research and development

capacity for climate action are also crucial. Inequitable financing of climate science has left large knowledge gaps that hinder adaptation and disaster risk reduction across Africa. Enabling a vibrant local climate research industry in Angola will also have many benefits.

Financing Angola's Climate-Resilient Development

Fiscal revenues from the oil sector will remain a key source of financing for climate-resilient investments for the next decade, calling for careful management of the remaining oil wealth. Even if efforts to diversify the economy are successful and despite a gradual decline in oil production, Angola's fortunes will remain tied to oil for at least the next decade. Therefore, Angola needs to maximize the benefits from its oil wealth by boosting the sector's competitiveness through reducing emissions upstream and enhancing competition downstream. Oil revenues then need to be managed and deployed to achieve the highest impact in realizing Angola's resilient development vision.

Growing interest in oil and gas with low upstream emissions presents opportunities for Angola—if it can bring its levels of gas flaring, venting, and fugitive emissions close to the world's best performers. Recent geopolitical developments have led to a fundamental reconsideration of where oil and gas are sourced, and European governments in particular are seeking new suppliers. However, the European Union has also prioritized reducing GHG emissions along the oil and gas supply chain. World Bank data show that Angola in 2021 flared 4.4 cubic meters (m^3) of associated gas per barrel of oil produced, while Norway flared 0.2 m^3 and Saudi Arabia, 0.6 m^3. Angola has already started monetizing associated gas (rather than flaring it), and many more opportunities exist to further reduce flaring and put the gas to productive use. In the downstream sector, refining will be economic only if the domestic refineries are able to compete on the global market. To ensure competitiveness, it is important not to provide direct or indirect government support to the refineries through the state-owned oil company Sonangol, or through trade and other restrictions that limit competition.

Effectively deploying oil revenues requires improvements in public financial management. Managing oil revenues poses significant challenges, as oil prices are highly volatile and expected to decline in the coming decades with the global transition to a low-carbon pathway. To address these challenges, oil revenues need to be saved (in Angola's case, primarily through debt reduction) or channeled to productive, climate resilient investments. But to ensure investments are productive and climate resilient, it is crucial to improve the management of fiscal policy and public investments, and to create the right incentives for optimal prioritization. Angola's institutional and regulatory frameworks need to evolve by mainstreaming climate into planning and fiscal management. In particular, consolidating the responsibilities of selection, preparation, implementation, and monitoring of public investments in a central agency with oversight powers and capable staff could lead to efficiency gains.

Reforming Angola's fuel pricing policy will free up public resources for climate action and have co-benefits for low-carbon development. Eliminating fuel subsidies (and ultimately introducing a carbon tax) will promote a more rational use of fuel, reduce consumption and emissions, and free up limited government resources that can be used to finance adaptation investments. Any reforms should be accompanied by measures to shield the poor from the impacts of subsidy removal—for instance, by providing cash transfers through an expanded Kwenda program, itself a tool for climate adaptation.

Climate and disaster risk financing will help build resilience across all sectors of Angola's economy. The cost of enhancing social protection—through Kwenda or otherwise—to support communities affected by a climate shock such as a drought can easily reach US$50 million, and is likely to be higher after more severe shocks. Some climate-related disasters, such as floods and landslides, may also cause significant damage to infrastructure. Currently, the overwhelming majority of these costs are borne by the Government, as few losses are insured. Pre-arranged disaster contingency financing will speed its deployment. Adopting a risk-

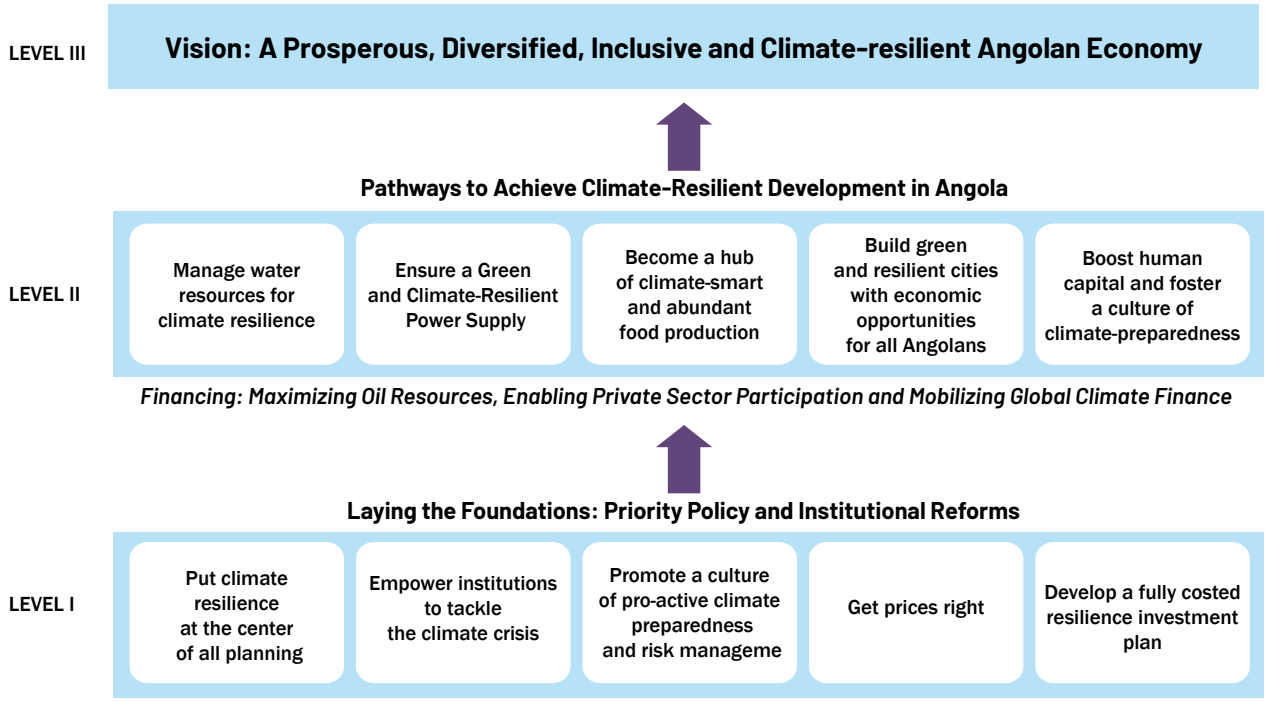
layered combination of financial instruments will also lower the overall cost of response, both on average and for extreme events, with projected savings of more than US$480 million (over two-thirds) in a 1-in-50-year event. A national disaster-risk financing strategy, a loss database and expenditure tracking system, and insurance products for households, farmers, and small and mid-sized businesses can all help make Angola more resilient to climate shocks.

Private and concessional climate finance will also need to be mobilized to enable Angola's climate-resilient and diversified development. To attract private investments in clean energy and other priorities for climate-resilient and low-carbon development, Angola needs to create an enabling environment, including defining a clear adaptation investment plan, a well-defined pipeline of investable projects and ensuring target sectors (such as renewable energy) are financially sustainable. At the same time, Angola needs to develop a strategy to leverage the increasing amount of funds available for green and blue (related to ocean ecosystems) financing, both concessional and market-based, and to enhance its environmental, social, and governance (ESG) scores, which are increasingly watched by global investors. Another priority is to establish a competent entity for mobilizing international climate finance in line with the treaties and conventions ratified.

Operationalizing Climate-Resilient Development in Angola

The CCDR identifies a set of priority actions for operationalizing the pathways towards climate-resilient development, starting with foundational, cross-cutting reforms of policies and institutions (Figure ES.3). While a number of priority investments have been identified, reforming policies and institutions are either preconditions for, or highly conducive to, realizing investments under the pathways.

Figure ES.3. Framework for operationalizing climate-resilient development in Angola



With this framework, the report concludes with five priorities for action that Angola can implement in the next three to five years:

1. Put climate resilience at the center of all planning, integrating climate risks and adaptation measures into all sectoral plans and strategies, the medium-term fiscal strategy, and territorial planning instruments. Sectoral, national, and subnational planners need to ask, "What new climate risks/opportunities do we need to adapt to, and what can we adapt towards?" The next National Development Plan can propose an integrated package of climate resilience investments, policy reforms, and institutional changes. The Ministries of Economic and Planning and Finance play a key role and can lead an inter-ministerial coordination structure with specific responsibilities and timelines for line ministries engaged in implementing climate action. Planning is especially critical in the climate-sensitive water sector, to address competing demands amid growing variability. Finally, public investment management needs to be strengthened and made more climate-responsive, employing mandatory assessment of new investment projects in line with national climate priorities.

2. Empower key government institutions to tackle the climate crisis, ensuring adequate financial and human resources. Professional and well-trained staff and adequate resources are both critical. Across all sectors analyzed in this CCDR, existing capacities will need to be enhanced to tackle the new exigencies of climate risk management. Data are also essential, as such it will be critical to bolster the National Hydrometeorological Agency (INAMET), mandated to monitor and predict climate risks, as well as related agencies involved in early warning/early action systems.

3. Promote a culture of proactive risk management and climate preparedness. Such a shift is crucial in a world where multiple sequential and often overlapping crises are the "new normal." As basic services improve, they need to incorporate disaster preparedness plans. Mainstreaming climate-related disaster risk management, including through better early warning systems, will reduce the costs and shorten the response time when disasters hit. Finally, Angola needs to have the financing in place to deal promptly with climate-related disasters, while avoiding a large diversion of expenditures from its development priorities. This requires financial planning and pre-arranged disaster contingency resources.

4. Get prices right to pave the way for private sector participation, improve economic efficiency, and generate additional resources for investment in climate resilience. A key example is reforming fuel pricing while providing compensation to the poor and lower middle class, which will create fiscal space, reduce waste in fuel consumption, and open the way for a competitive refining sector. Gas flaring needs to be priced (taxed) to reflect its social costs. This requires strengthening the regulatory framework for controlling gas flaring and fugitive emissions by introducing a fee for flaring and venting, and over time for fugitive methane emissions. In parallel, enforcement capabilities need to be strengthened to ensure accurate fee determination and its timely and full collection.

5. Jointly develop a fully costed resilience investment plan through collaboration between the Ministry of Finance and the Ministry of the Economy and Planning. A key next step from this CCDR is to develop a costed investment plan that identifies the full set of priority investments and financing sources. Because achieving climate resilience is a cross-cutting issue requiring coordination across the Government, these two ministries play central roles in strategically allocating limited resources. **Before committing to large investments, ministries will need to fully understand the tradeoffs between investment choices and develop a comprehensive portfolio of climate resilience projects, with clear public and private financing sources identified to fund them.**

Table ES.1 provides a summary of priority investments recommended from the report for each sector, as well as important related policy reforms. We hope that the insights and recommendations provided by this CCDR can provide a strong foundation for Angola to develop a national climate resilience investment plan and a climate-informed National Development Plan 2023–2027.

Table ES.1. Summary of priority investments and reforms under each pathway

Pathway	Priority investments	Priority reforms			
		Climate at the center of planning	**Strengthen institutions**	**Proactive risk management**	**Get prices right**
Water Resilience	Expand access to clean water and sanitation across rural and peri-urban areas nation-wide ($1B) Invest in Greater Luanda's resilience by implementing the Luanda Province Water and Sanitation Master Plan ($1B) Fund rehabilitation and sustainable operation and maintenance of dams and water resources infrastructure ($600M)	Prepare comprehensive strategy for water storage at basin level, integrating watershed, groundwater, and surface storage For this, invest in groundwater studies and promote nature-based solutions (NBS), such as soil and water conservation measures, sand dams, and managed aquifer recharge, to maximize "sponge" effect of watershed, mitigate flood risks and store water for dry periods	Strengthen river basin admin offices and councils, including capacity to monitor and allocate resources Enhance technical and financial capacities within the Ministry of Energy and Water (MINEA) for dam operation and maintenance Professionalize provincial water and sanitation utilities Strengthen IRSEA, the electricity and water services regulator, for a well-functioning sector	Implement municipal water plans that integrate local supply with local water management Implement drought preparedness and contingency plans for river basins and for all provincial water and sanitation utilities in Angola	Implement the bulk water abstraction tariff to help promote the rational use of water resources Electricity and water tariffs to ensure the financial sustainability of the utilities and the provision of an improved and reliable service
Renewable Energy	Expand and densify transmission and distribution grid, and interconnect the northern-central, southern, and eastern regional systems to allow clean energy from hydropower to reach South and East (~US$3 billion in transmission, $2 billion in distribution grid expansion and densification, and another US$13 billion in off-grid will be needed to increase electricity access rate to 77 percent by 2030 Develop cross-border transmission lines to tap into South African Power Pool	Complete a climate-adjusted Power Sector Master Plan Adopt a National Electrification Strategy based on least-cost technical solutions Explore green hydrogen potential	Improve the distributor's (ENDE) operation and commercial performance Strengthen enabling environment for private sector investment in solar and wind energy to diversify the energy mix	Adopt state-of-the-art methodologies and tools for power system operation and expansion planning (savings estimated at < US$11 million per year)	Electricity and water tariffs to ensure the financial sustainability of the utilities and the provision of an improved and reliable service
Climate-Smart Agriculture & Fisheries	Rehabilitate old irrigation perimeters and infrastructure and build flexible, decentralized systems for farmer-led irrigation development Build drainage and flood mitigation infrastructure Invest in climate-smart agriculture (CSA)	Scale up CSA to restore degraded landscapes, stem deforestation and biodiversity loss, and advance climate goals, while supplying diverse products for consumption and income	Strengthen agricultural extension services Establish network of marine protected areas covering >10% of Angola's exclusive economic zone Improve transparency and statistics in the fisheries sector	Facilitate farmer access to risk management tools such as insurance programs, especially weather index insurance	Repurpose agricultural subsidies to promote climate-smart agriculture
Green & Resilient Cities	Invest in comprehensive solid waste management systems to curb methane emissions, reduce flooding, and improve quality of life Implement urban resilience measures (risk analyses, risk maps integration into territorial plans, inspection and enforcement) Flood early warning systems, especially for coastal zones	Promote risk-informed urban planning and sectoral coordination, while building the resilience of vulnerable populations Adopt NBS for flood and landslide protection	Set national standards for urban development that promote more efficient, sustainable, and inclusive urban growth, with budget support, coordination and capacity-building Enhance capacities for coordinated planning across sectors to boost resilience	Support subnational governments to coordinate resilience planning across sectors	Mobilize private capital to accelerate adoption of critically needed infrastructure Public-private partnerships to improve service delivery Build a circular economy, minimizing waste
Human Capital	Expand Kwenda to reach all the poorest households and incorporate adaptive features Invest in jobs and economic inclusion programs to train workers for a green economy and build resilience Raise a climate-conscious generation, starting in the early years	Incorporate climate-considerations in health sector and provincial health plans Provide cross-ministerial coordination and develop national and subnational mechanisms for action on climate-related health impacts	Enhance capacities to identify climate-related health risks and provide care even during extreme events Improve climate research capacity and build a strong local R&D sector with a vibrant local climate research industry	Agile adaptive social safety net programs can respond quickly to crises Add climate skills agenda under the strategic plan for the future of tertiary education	Develop an investment strategy for climate and human capital actions, and allocate funding for adaptation measures within key sector budgets

Huambo, Angola © Mike63/iStock.com

1

Angola's Climate and Development Challenge

1. Angola's Climate and Development Challenge

1.1 Climate and Development Context

Angola is an oil-rich country, but it has so far been unable to leverage its oil wealth to support broad-based economic growth. After the end of a 27-year civil war in 2002, Angola enjoyed several years of robust, if uneven, economic growth, led by oil exports. As of 2020, it was the eighth-largest economy in Sub-Saharan Africa,[1] but still categorized as a lower-middle-income country, with gross national income (GNI) per capita of $2,140.[2] Angola has made some strides in diversifying its economy, but national accounts show the oil sector still contributed 27 percent of gross domestic product (GDP) in 2021. Angola is also one of the world's most unequal societies, with a Gini index of 51.3 in 2018.[3] Due mainly to a decline in the oil sector, gross domestic product (GDP) has shrunk significantly since 2015.[4] Angola finally saw modest growth again in 2021 (an estimated 0.8 percent). Due to high oil prices, GDP is projected to grow by about 3 percent in 2022.[5]

Angola's oil-based growth has thus far generally failed to reduce poverty or build the human and physical capital foundations for sustainable growth. The country's quarter-century of conflict reversed development progress, and the GDP growth since then has not been accompanied by commensurate human development gains. As of 2018, 32.3 percent of the population was below the national poverty line.[6] Angola was ranked 148th out of 191 countries on the 2020 Human Development Index,[7] reflecting not only widespread poverty, but low life expectancy and limited schooling. Angola's scores also show high levels of multidimensional poverty and insecure employment, among other challenges. A large portion of the population still lacks adequate access to food, potable water, sanitation, education, healthcare, electricity, and other basic services. Almost 70 percent of workers in Angola are in the informal sector— without contracts, legal protections, or access to social security benefits—and as of 2014, 28 percent of youth were neither employed nor in school.[8]

Roughly half of Angolans work in agriculture, almost all as subsistence farmers. Although agriculture contributes only about 9 percent to GDP and uses only about a third of the country's 5 million hectares (ha) of arable land, it employs about 51 percent of the labor force.[9] There is very limited commercial agriculture, mainly coffee and cotton, though the government has recently sought to expand coffee as well as sugarcane production. Ineffectual farming practices, poor soil fertility, and low access to high-quality seeds and mechanization all contribute to low productivity in the sector.[10] As discussed further in Section 3.2.3, Angola's agricultural subsidies mainly benefit large-scale producers, and increase food prices for consumers, which affects food access and nutrition.[11]

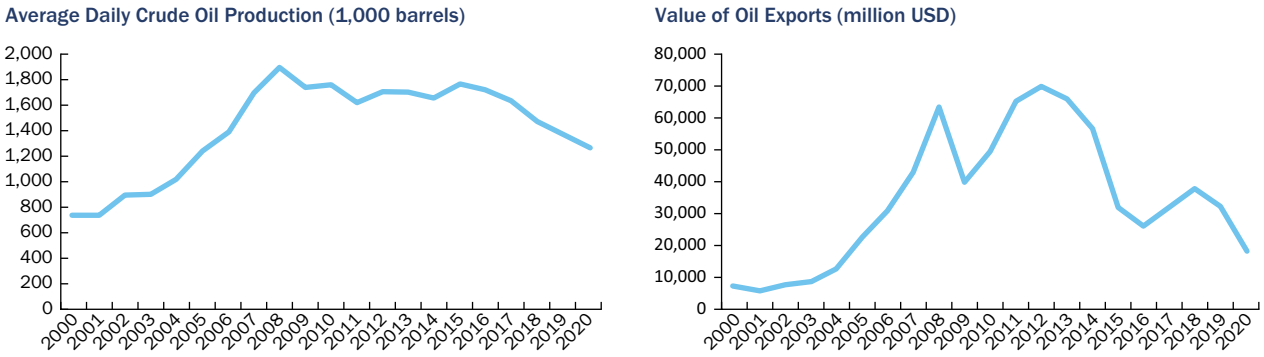
Climate and development are inextricably linked in Angola. Climate-related hazards—chiefly flooding, coastal erosion, and droughts—are already impeding Angola's development and are expected to intensify with climate change. Southern Angola has experienced a severe and protracted drought over the past decade, with conditions now described as the worst in 40 years.[12] In 2021, an estimated 3.81 million people in the six southern provinces were reported to have insufficient food, and 1.32 million faced high levels of acute food insecurity. Over 1.2 million people continue to face water scarcity because of the drought, with precarious water access, sanitation, and hygiene conditions.[13] During the previous severe drought in the South, in 2015–2016, 80 percent of existing boreholes were nonfunctional due to water scarcity and disrepair. Overall economic impacts in 2016 across all sectors were estimated at over $749 million in the three most affected provinces (Cunene, Namibe and Huíla), with the agriculture, livestock, and fisheries sector being by far the hardest-hit.[14] At the same time, other parts of Angola, including Luanda, have experienced devastating and sometimes deadly floods.[15] The growing concentration of people and infrastructure in coastal cities, including Luanda, exacerbates climate risks, as those cities are threatened not only by flash floods caused by heavy precipitation and swelling rivers, but also by sea-level rise, storm surges, and coastal erosion.[16]

Angola's greenhouse gas (GHG) emissions make up less than 0.21 percent of global GHG emissions. The country's updated nationally determined contribution (NDC) estimates total GHG emissions in 2015 at 99.99 million tonnes (Mt) CO_2e,[17] or 3.74 tonnes[18] per capita. This is well below the global average that year (6.39 tonnes).[19] With global emissions estimated at 46.87 billion tonnes (Gt) CO_2e in 2015, Angola's contribution would represent about 0.21 percent of global emissions.[20] The NDC commits unconditionally to reducing GHG emissions by 14 percent by 2025 relative to a business-as-usual trajectory, or about 15.4 Mt CO_2e.[21] With international support and funding, the NDC pledges to reduce emissions by another 10 percent.

Given the urgent climate risks faced by Angola and its small contribution to global GHG emissions, this CCDR prioritizes adaptation and resilience, while seizing opportunities for low-carbon development. The recommendations presented in this report focus on helping Angola to achieve resilient, inclusive, and sustainable[22] growth. Angola's main development challenge is to transition from heavy dependence on the oil and gas industry to a diversified economy built on renewable energy; a productive and climate-resilient agriculture sector; compact, connected, and inclusive cities; and strong investments in human capital and in the capacities needed to support sustained green and resilient growth.

Angola's oil and gas sector can provide crucial revenue for the transition, but improvements are needed. Angola remains heavily dependent on oil for its exports (91 percent in 2020)[23] and fiscal revenues (over 60 percent).[24] Yet, as a result of the limited investments in new exploration and extraction in recent years, oil production has declined considerably, from a peak of 1,896,000 barrels per day (b/d) in 2008 to 1,271,000 b/d in 2020 and to 1,166,000 b/d in the first five months of 2022.[25] The value of oil exports fluctuated with global oil prices, but is down significantly overall, from $63.2 billion in 2008 to $18.7 billion in 2020 (Figure 1). Oil and gas prices are currently high, but the trend toward a low-carbon pathway is accelerating globally, with implications for medium- and long-term oil demand. Climate concerns have already affected investment decisions by global oil companies, which have started to diversify their portfolios and invest in renewable energy. Global oil companies are also committing to reduce the carbon footprint of their production, which means that, in order to stay competitive, Angola will need to reduce upstream emissions in its oil and gas sector (see Section 3.1).

Figure 1. Trends in Angola's oil production and the value of its oil exports, 2000–2020



Data source: OPEC, 2021[26]

Building climate resilience is crucial to the success of Angola's economic diversification efforts. Most promising non-extractive sectors are highly climate-sensitive and under growing stress from climate variability. Angola's 2018 Systematic Country Diagnostic identifies agribusiness, fisheries, and manufacturing as potential non-extractive industries where Angola's economy could diversify and create more and inclusive employment opportunities.[27] The potential of these sectors is also acknowledged as part of the most recent

Country Private Sector Diagnostic by the International Finance Corporation (IFC).[28] Agriculture in particular has substantial potential to positively impact growth, economic diversification, employment, and social inclusion, but it can only thrive if productivity can be significantly increased, and the sector can be protected from the large impacts of climate variability. To capitalize on these growth opportunities, government policies will thus need to incentivize investments not only in production, but also in resilience-building measures.

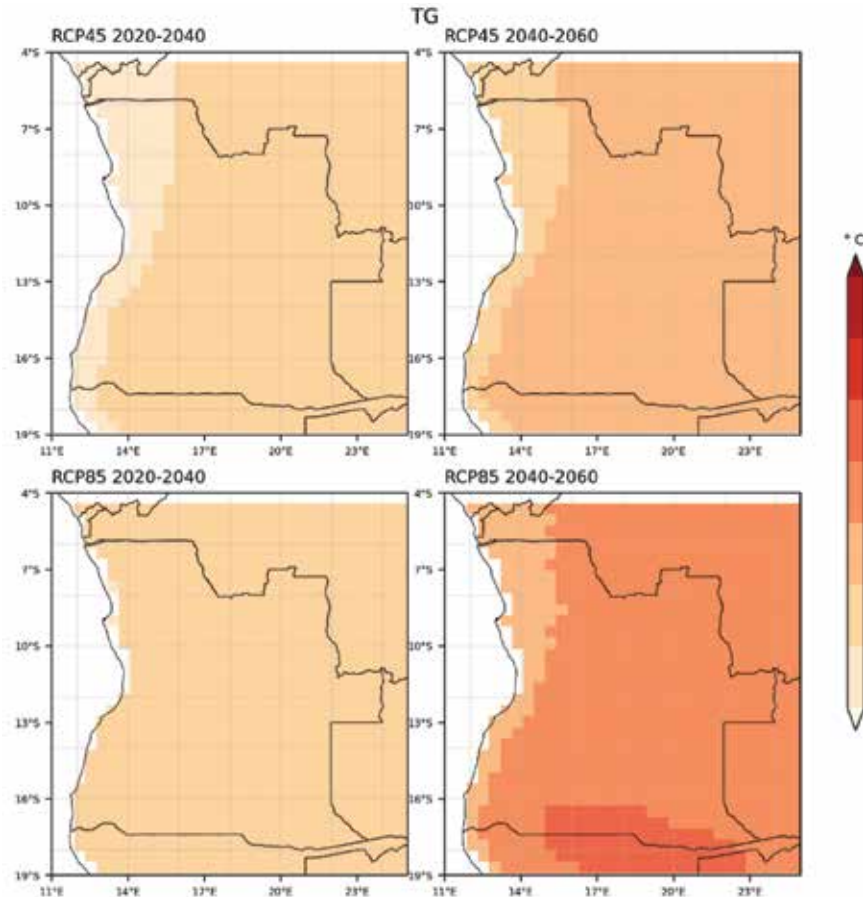
1.2 What Climate Change means for Angola

The mean annual temperature in Angola has increased by an average of 0.2°C per decade since 1951, adding up to a 1.4°C temperate increase since mid-last century. Angola's climate map spans arid, temperate and tropical conditions. A state-of-the-art future climate assessment was conducted for this CCDR, examining climate trends over the past several decades, and modeling future temperature and rainfall trends through 2060. Its findings confirm that Angola has experienced warming since the middle of last century, but that warming has accelerated significantly in recent years.[29] It also aligns with findings by the Intergovernmental Panel on Climate Change (IPCC) highlighting that across Southern Africa, mean annual temperatures increased by 1.04–1.44°C from 1961 to 2015, and the number of hot days has increased.[30]

Rainfall outlooks in Angola are less evident than for temperature, and there are large variations in the direction and magnitude of precipitation changes. However, as noted, the South of Angola has suffered the brunt of these changes experiencing severe droughts in the past 30 years. Angola's rainy season runs from about October to April, when the Inter-Tropical Convergence Zone (ITCZ) runs over the country. Both temperature and rainfall vary annually and over longer time scales. Year-to-year differences are influenced by large-scale seasonal atmospheric patterns as well as the changing conditions over the cool South Atlantic Ocean. Parts of southern Angola were unusually dry in the 1980s and 1990s and unusually wet in the 2000s and 2010s, while other parts experienced the opposite pattern.

Temperatures are projected to keep rising, particularly in a high-emissions scenario, while future rainfall is highly uncertain. The Angola CCDR analysis considered two climate scenarios—a moderate emissions scenario, corresponding to representative concentration pathway 4.5 (RCP4.5); and a high-emission scenario (RCP8.5), In both RCP4.5 and RCP8.5, the modeling consistently shows annual mean temperatures in most of Angola becoming 1–1.5°C warmer in 2020–2040 than the 1981–2010 average. By 2040–2060, most of the country is projected to be 1.5–2°C warmer in RCP4.5. In RCP8.5, it is projected to be 2–2.5°C warmer (except near the coast), and parts of the South are projected to be 2.5–3°C warmer (Figure 2). This has significant implications for water availability, drought severity, and, in some areas, extreme heat. An additional analysis cited by the IPCC found that even if the global temperature increase is kept below 1.5°C, Angolans born in 2020 will experience 7–8 times more heat waves in their lifetime than those born in 1960, compatible with current climate pledges (about 2.4°C of global warming), they would experience over 10 times more.[31]

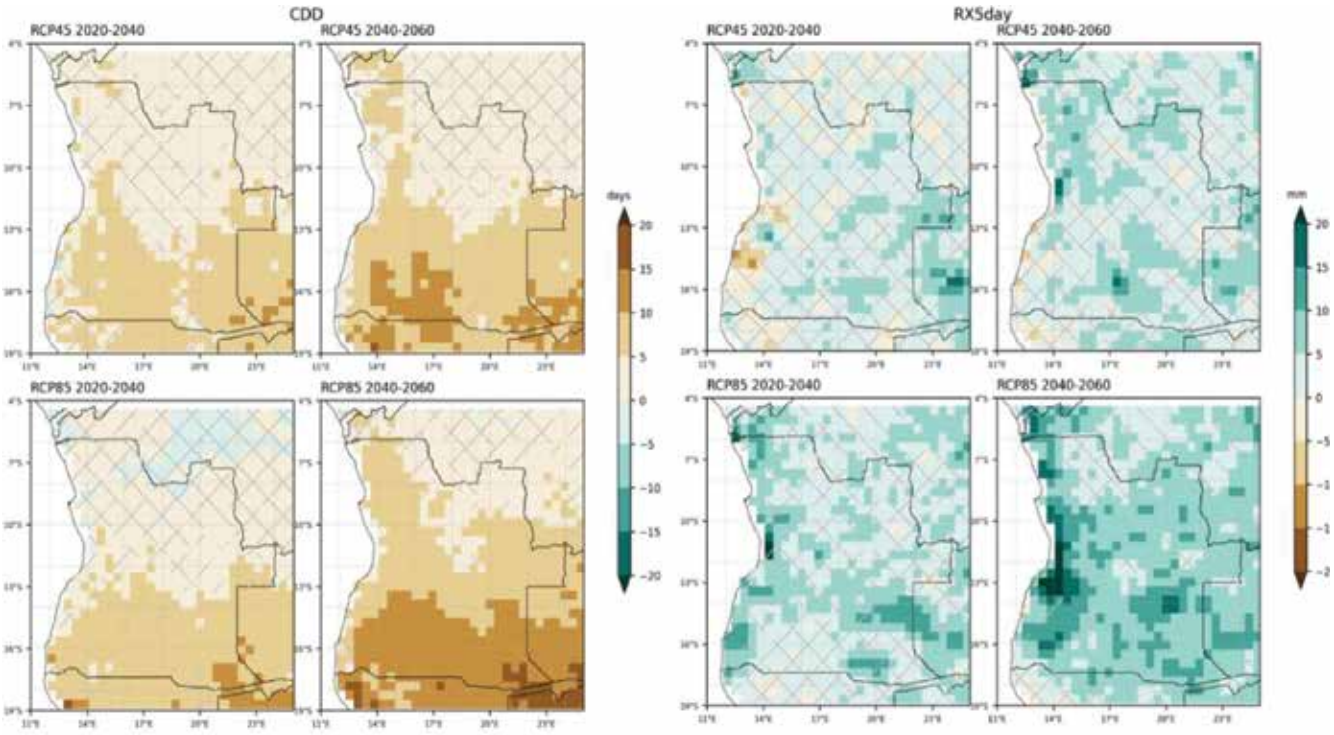
Figure 2. Projected change in mean annual temperature across Angola relative to the 1980–2010 average in 2040–2040 and 2040–2060 in a moderate- and high-emissions scenario (RCP4.5 and 8.5)



Future rainfall projections vary greatly by province. Overall, there may be a shortening and intensification of the wet season, but with little overall effect on total annual rainfall, with these seasonal differences in rainfall likely stronger in the western part of the country. The future water availability ranges expected from the various climate change projections for each basin of Angola are included in Annex 3. For some basins, such as Cuvelai, the models are highly uncertain on both the direction and magnitude of change. Most basins, however, are likely to have generally decreasing water availability, with the notable exception of the North Coast, where models show water availability is more likely to increase.

The severity of heavy precipitation events is projected to increase, though rainfall events will likely be less frequent, with longer dry periods in between. Future extreme storm risk (expressed as the maximum five-day precipitation index) is projected to be 5–10 percent higher in 2020–2040 than the 1981–2010 average, rising to 10–15 percent higher in some regions for the period 2040–2060 under RCP8.5 (Figure 3). Dry extremes (expressed as the consecutive dry-day index) are also projected to increase consistently across the country. The increases of dry extremes are higher and statistically significant in the southern regions of Angola, particularly in the period 2040–2060 under RCP8.5. A recent United Nations analysis found that while in 1979–2018, an average of 7.5 percent of Angola's population was affected by droughts, in the second half of this century, the share could rise to 13 percent—some 8 million people per year. The area affected by droughts is also expected to expand from the southern provinces (Huila, Cunene, Namibe) northward and eastward.[32]

Figure 3. Projected future change in extremes in Angola: consecutive dry-day index (left) and maximum five-day precipitation (right)



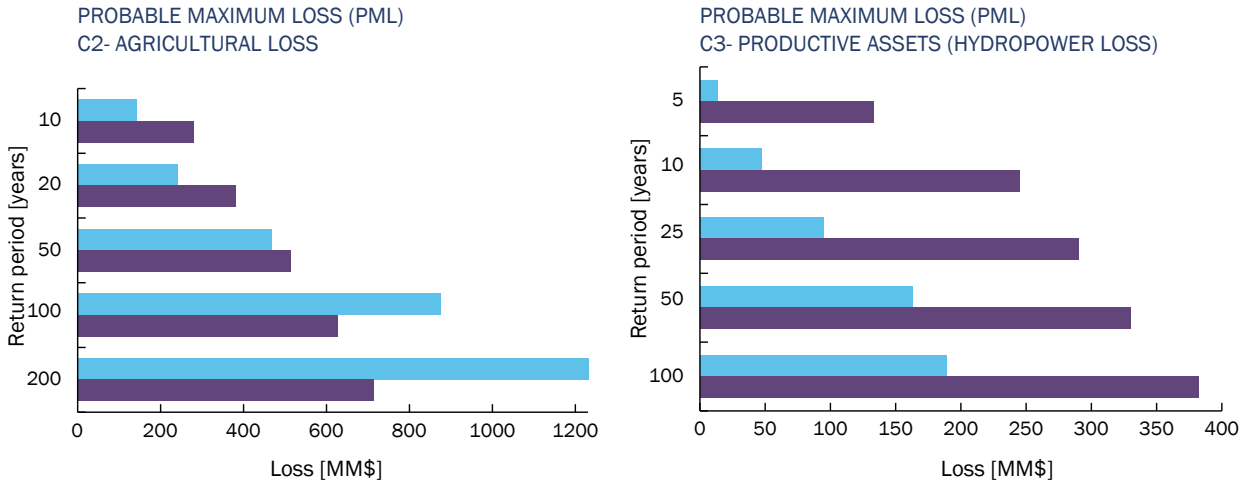
1.2.1 Impacts on Key Economic Sectors

A warming trend and more frequent extreme climate events have significant implications for water availability, hydropower, agriculture, livelihoods, and the economy. Angola's hydropower potential is among the highest in Africa, estimated at 18,200 MW,[33] and hydropower has long been the main source of electricity. In 2020, almost 90 percent of the power generated in Angola came from hydro, up from about 70 percent in 2019 (the rest from oil products and gas).[34] Hydropower generation depends on upstream flow conditions that were already variable and are becoming less reliable with climate change. Climate projections suggest that southern and southeastern Angola will become dryer, implying lower hydropower production, for example, in the Kunene River that borders Namibia. Some river basins may benefit from increased runoff, though increased precipitation intensity may result in floods and accelerated soil erosion, carrying sediment to reservoirs and reducing their storage capacity; this can reduce average annual generation and also amplify flood risks. Dam failures, such as the overtopping of Sendi Dam in December 2019, can cause serious floods, potentially harming communities, infrastructure, and crops.

The direct economic impacts of climate change to agriculture could rise sevenfold. Direct economic losses in the agriculture sector under climate change from droughts may rise from as much as $100 million per year today, to more than $700 million per year across the whole country by 2100.[35] Climate change is likely to affect the agriculture sector's potential contribution to the country's economic growth and poverty reduction. The greatest economic losses will be concentrated in the central, eastern, and northern regions of the country, where negative climate impacts have been less severe in the past, but will likely range between $45 million and $100 million per year in multiple provinces. Total economic losses due to drought are driven by losses in agricultural production (comprising 75 percent of average annual loss).[36] The probable maximum loss (PML).[37] from drought with a 10-year return period for agriculture is expected to more than

double, while the PML for hydropower generation over same 10-year return period is expected to increase four- to fivefold in future climate conditions (Error! Reference source not found.).[38] The PML curve for flood indicates that the frequency of small to medium losses is likely to decrease, while losses higher than a 50-year return period are likely to increase, especially in the housing sector. Greater exposure to infrequent, short-duration, extremely high-loss events also challenges prearranged financing before disasters occur.

Figure 4. Economic losses due to drought in a) agriculture and b) hydropower production



Data source: CIMA and UNDRR, 2019.[39]

Annually, over 35 percent of the country's total crop area is exposed to drought—and, as noted earlier, only a tiny fraction of the country's arable land is irrigated. Recent modeling presented on the World Bank Climate Knowledge Portal shows all provinces are likely to see decreased early-season rainfall (September–November period) by the 2060s, and there is some likelihood that rainfall in March–May will also decrease.[40] A shorter, more concentrated rainy season would negatively affect the growth cycles of most crops.[41] An increase in the magnitude (high likelihood) and extent of droughts (medium likelihood), will likely have devastating impacts on agriculture,[42] as shown on Table 1.

Table 1. Climate variables that pose significant risks to agriculture and water security in Angola, based on potential impact and likelihood in 2050

IMPACT				
	High	Increase in drought frequency Increase in dry spells and dry days	Increase in extent of drought Increase in wet extremes Reduction in March–May rainfall	Reduction in September–November rainfall Increase in maximum temperatures Reduction in water availability Increase in drought magnitude
	Medium	Increase in December–February rainfall	Decrease in total annual rainfall	Increase in mean annual temperatures
	Low	Increase in days with high temperature exceeding 30°C		
		Low	Medium	High
		LIKELIHOOD		

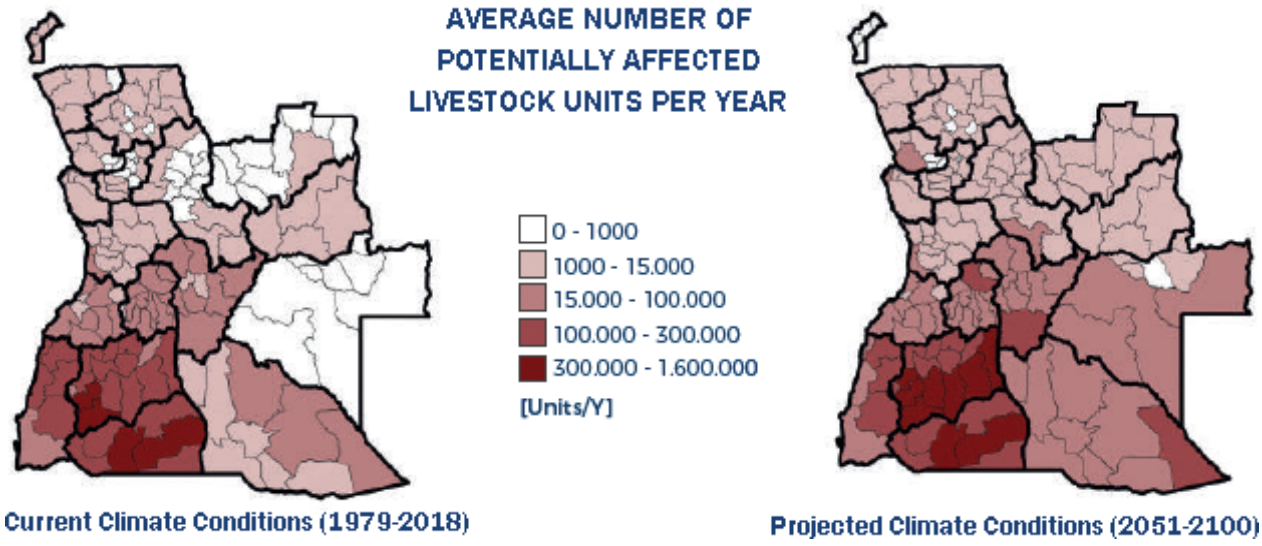
Source: Authors, synthesizing multiple sources (Hunter et al., 2020; CIMA and UNISDR, 2018; Carvalho et al., 2017).[43]

The most negatively impacted crops will be maize, bean and groundnut, all important crops for food security and nutrition in Angola. Cassava, millet, sorghum, and banana, which are more drought-tolerant crops, will be less impacted, and more climate-resilient crops like cassava will largely see an increase in suitability, especially in the central regions. Southern regions will generally become less suitable for crop production, with Namibe, Bie, Bengo and Moxico most affected.[44]

The confluence of intense rain events, water scarcity, and increased incidence of multi-year drought will increase soil degradation and reduce the arability of land. Increased evaporation, more erratic and extreme rainfall, and a projected increase in short and long dry spells will increase soil instability and cause erosion and degradation, which increases the vulnerability of farmers to floods and droughts, creating a negative, self-reinforcing cycle. Only about 10 percent of Angola's soils are highly fertile (mostly in the highlands and valleys).[45] Given the already low fertility of soils predominant in Angola, climate change conditions will likely further affect the quantity and quality of soils, increasing the loss of productive land, through loss of nutrients, and increased degradation.

Climate change could increase livestock mortality due to prolonged water distress and heat exposure, in addition to causing a general decline in milk and meat production.[46] The number of livestock affected by extreme climate conditions is expected to surpass 70 percent of total livestock populations between 2050 and 2100, up from 40 percent currently, with major losses in livestock mostly expected in the southern regions. Climate risk to livestock will likely expand from the South towards more eastern and northern parts of the country (Figure 5). The dynamics between drought, increased population pressure, and increased agricultural development of lands will put pressure on grasslands and may lead to a decline in the quality and quantity of pasturelands.

Figure 5. Average number of livestock potentially affected by drought



Source: Adapted from CIMA and UNDRR, 2019.[47]

Climate change is expected to impact fisheries in Angola, although research is limited, and models present significant levels of uncertainty. The country's coastal fisheries lie in a historically productive zone within the Benguela Current Large Marine Ecosystem (BCLME), one of the most productive ecosystems in the world. Angola's National Development Plan 2018–2022 identifies fisheries and aquaculture as a sector to grow, aiming to remobilize 10 ships and achieve average production of 303,000 tonnes of fish through industrial and semi-industrial fishing, 232,400 tonnes from artisanal fisheries, and 3,580 tonnes from aquaculture.[48] However, the combined effects of climate change on factors such as water temperature, current and nutrient circulation, and pH may substantially change the distribution and composition of fish stocks throughout the country, especially when combined with anthropogenic stressors (e.g. overfishing, habitat degradation). In a high GHG emission scenario (RCP8.5), Angola's maximum catch potential (MCP) is expected to decrease by 43.7 and 64.0 percent by 2050 and 2100, respectively.[49]

Sea-level rise is expected to have a significant impact on coastal settlements, where more than 50 percent of the country's population lives, impacting housing, roads, and industrial and commercial infrastructure. The IPCC Atlas shows the middle-of-the-road scenario for sea-level rise in west southern Africa to be 0.1 meters in the short term (2021–2040), 0.3 meters in the medium term (2041–2060) and up to 0.6 meters in the long term (2081–2100).[50] In line with recent events over the last decade, an increase in frequency and intensity of flooding is projected, especially along the coastal zone, for all seasons except June to August.[51]

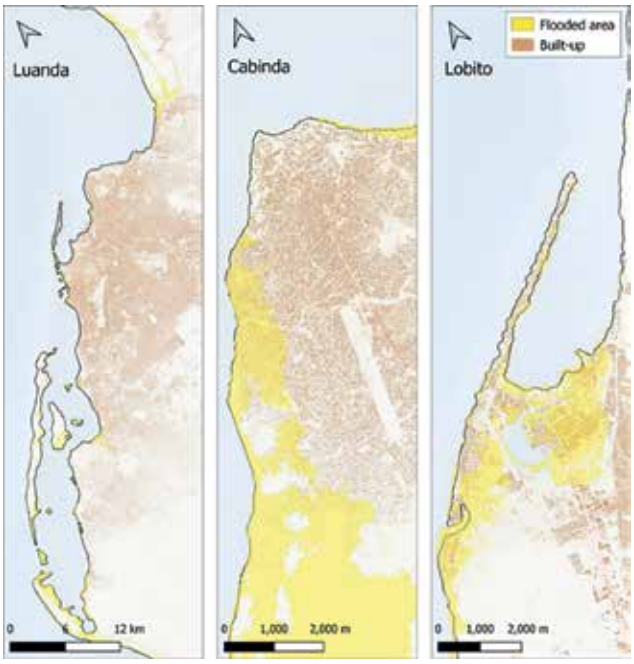
A concentration of people, infrastructure, and economic activity in Angola's urban areas makes them priorities for building climate resilience. Urban populations, especially the poorest households and those living on marginal land, are highly exposed to several climate hazards. Moreover, their well-being and livelihoods depend on urban infrastructure, supply chains, and public services that are at high risk from climate change impacts. Key concerns include:

- **Flooding** (both pluvial and fluvial as well as coastal flooding—which is projected to pose a major threat to several cities by the century's end; see Figure 6). Floods already pose very large threats to Angolan cities; flooding in Luanda in April 2021, for instance, damaged about 2,300 homes, and affected about 11,000 people.[52]

- **Droughts**, impacting urban water supply: As of 2017, some 71 percent of Angola's urban population had access to at least a basic source of drinking water, only 34 percent had access to basic hand-washing facilities with soap, and access to basic sanitation services in urban areas stood at 64 percent.[53] Limited access to improved water, sanitation, and hygiene services is detrimental to public health, as it increases the risk of waterborne diseases, for instance. Water scarcity and unreliable supply are of particular concern given that, with continued population growth, urban water demand is expected to keep growing. Globally, cities' demand for water is projected to increase by 50 to 70 percent within the next three decades, and in areas where climate change creates water scarcity, the urban poor will be particularly vulnerable.[54] While drought has the potential to affect water supplies, urban floods often damage water and sanitation infrastructure, risking disruption and pollution of water supplies. Flood mitigation measures and proper drainage will be critical in many areas.

- **Heat waves** exacerbated by the urban heat island effect: A recent study of more than 150 large African cities projects the number of people that will be exposed to dangerous heat conditions, to be 20 to 52 times higher at the end of this century than today. Among the five most exposed cities, Luanda exhibits the highest increase in relative terms compared to the historical period.[55] The 2011 African Green City Index found that Luanda has less than 1 m^2 of green space per capita, well below comparable cities like Dar es Salaam (64.1 m^2), Nairobi (37.3 m^2), and Addis Ababa (36.5 m^2), and well below the World Health Organization's recommendation of 9 square meters.[56] The heat island effect increases energy costs related to air conditioning, air pollution levels, and heat-related illness and mortality, and is anticipated to worsen due to climate change.

Figure 6. Land projected to be below a 1-in-10-year flood level in 2100



Along with impacts on food security and water stress, climate change impacts on health could include worsening epidemics of vector-borne diseases and water-associated diseases.[57] Diarrheal disease and malaria are already among the top causes of death in Angola.[58] Impacts on malaria transmission in Angola are likely to vary by region. One study projected an increase in the length of the malarial transmission season, with models showing an increase in the central highlands. The country may also face prolonged periods of standing stagnant water following increased floods, which provide breeding grounds for mosquitoes.[59]

1.2.2 Whole-of-Economy Implications of Climate Change

This CCDR examined the effects of climate change on the economy through a climate-augmented Solow growth model.[60] It begins with a standard Solow growth model with two sectors—oil and non-oil—to account for a key feature of Angola's economic structure and the focus on economic diversification away from oil. In the oil sector, oil reserves and capital are the factors of production, while capital and labor are the factors of production in the non-oil sector. Investment in the oil sector (and therefore its capital stock) is a function of oil prices, which vary depending on the climate scenario under consideration (RCP4.5 or RCP8.5)[61]. The model was augmented by adding three channels through which climate-induced damages accrue, as summarized in Table 2 below.

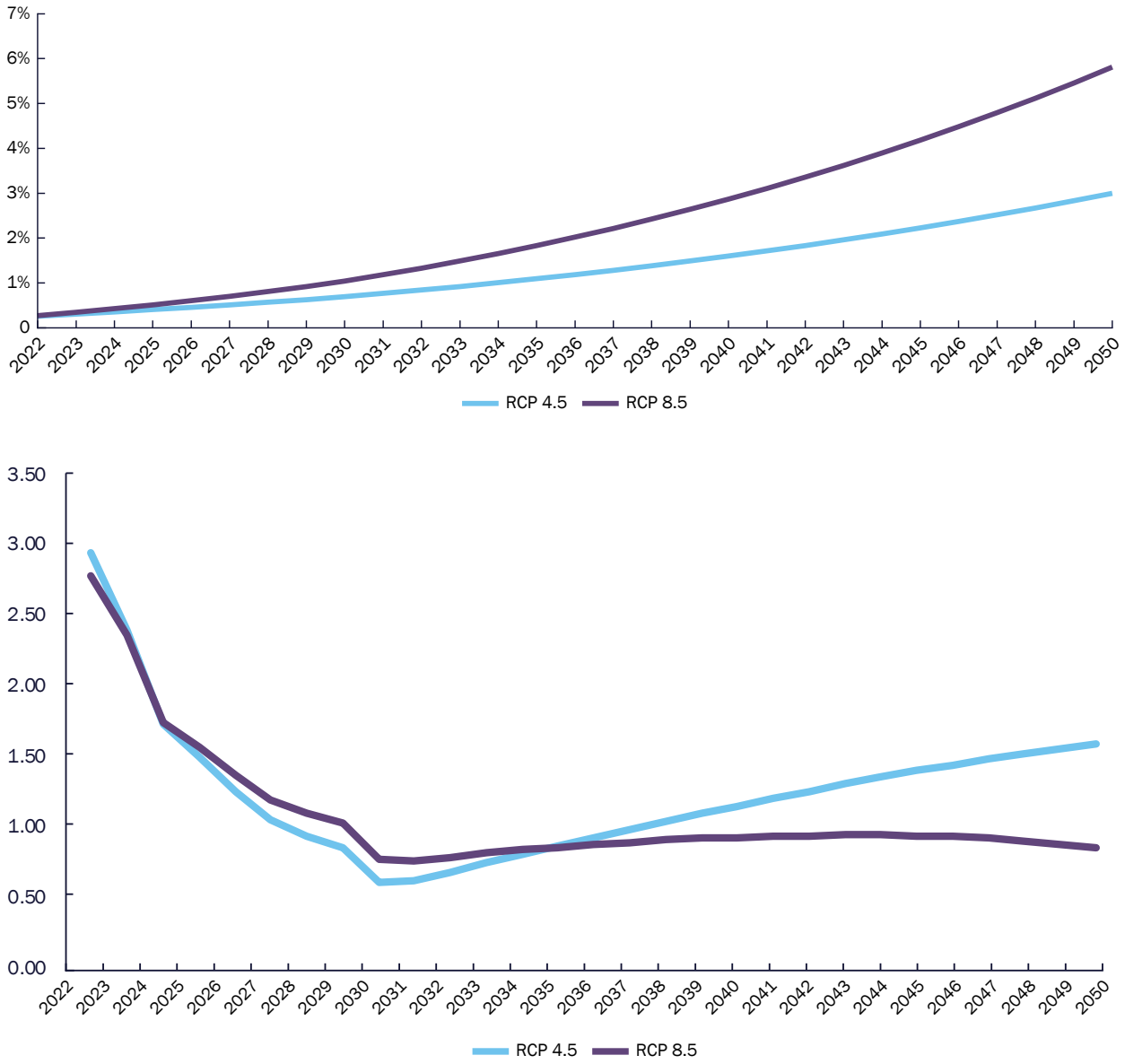
Table 2. How climate related damages were introduced into the climate-augmented Solow model

Channel	Description of economic effects and damage function
Crop yields	Reductions in agriculture value added under different climate scenarios[62]
Flooding	Depreciation of physical capital in the non-oil sector and urban sector due to infrastructure damages[63]
Heat impacts on labor	Increased costs of cooling and reduction in the availability of effective labor through the expected health damages from heat[64]

Two scenarios of economic diversification were modeled for each climate scenario: a 'business as usual' scenario continuing past trends, and an 'accelerated a diversification' scenario. The model allows for explicit choices of public investment in the oil sector or in building the resilience of other economic sectors and supporting diversification. Under a business-as-usual scenario, total factor productivity (TFP) grows at historical rates; under the accelerated diversification scenario TFP in the non-oil sector grows faster than recent historical experience and the spillovers of oil sector growth into TFP growth of the non-oil sector are smaller in the accelerated diversification scenario.

The model shows climate change reduces GDP in both climate scenarios, but losses are almost twice as great in RCP8.5, even with greater demand for oil and associated higher oil prices. Although in RCP8.5, higher oil prices would initially drive higher investment in the oil sector, boosting GDP growth, the benefits fade as oil reserves are exhausted faster and higher climate damages weigh on other sectors of the economy. In RCP4.5, climate change could reduce economic output by as much as 3 percent by 2050 relative to a scenario with no climate change, whereas in RCP8.5, losses could reach 5.8 percent of GDP (Figure 7, left panel). Projected GDP growth is thus higher in RCP8.5 until about 2030, but in the following two decades, growth is higher in RCP4.5. By 2050, real GDP levels are 5 percent higher in RCP4.5 than in RCP8.5 (Figure 7, right panel). The model shows non-oil GDP would grow on average 0.1 percentage points more slowly per year over the entire projection period in RCP8.5 compared with RCP4.5.

Figure 7. Estimated losses due to climate change as share of GDP in RCP4.5 and RCP8.5 (top) and annual GDP growth in RCP4.5 and RCP8.5, business-as-usual scenario (bottom)



The model also reinforces findings that agriculture will be hit hard and highlights the potential for climate change impacts to be mitigated through adaptation investments. In RCP8.5, the model shows agricultural productivity would be 7 percent lower by 2050 than in a scenario with no climate damages.[65] Economy-wide, the effect of higher temperatures and a higher incidence of flooding is cumulative through damages, respectively, to labor and the capital stock (such as roads, bridges, factories, and machinery). When flooding and extreme climate events occur in Angola, they destroy this capital stock, diverting scarce investments just to rebuild Angola's productive capacity. As a result, by 2050, the capital stock in the non-oil sector[66] is 3 percent lower in RCP8.5 than in RCP4.5, and 4 percent lower than in a scenario with no damages. Similarly, due to higher temperatures, effective labor input (the average amount of output one worker can produce) is 2 percent lower by 2050 in RCP8.5 than in RCP4.5, and 4 percent lower than in a scenario with no damages from climate change.

The modeling exercise emphasizes the urgency with which Angola needs to diversify its economy—in both RCP4.5 and RCP8.5. As oil production steadily declines and growth in other sectors takes time to ramp up, even under the diversification scenario, the model shows growth slowing in the coming decade. However, after 2030, growth accelerates, reaching 4.1 percent per year in RCP4.5 and 3.7 percent in RCP8.5. In the business-as-usual scenario, the economy also accelerates from 2030 in RCP4.5, but only modestly, reaching 1.5 percent annual GDP growth by 2050; in RCP8.5; growth stagnates at less than 1 percent after 2030 and starts declining towards the end of the projection period. Per-capita GDP shrinks continuously under the business-as-usual scenario, while in the diversification scenario, after a challenging period when the economy transitions from oil as the main driver of growth, per-capita income accelerates in the second half of the projection period. As a result, the model shows that income per capita by 2050 can be as much as 70 percent greater if Angola successfully diversifies its economy than in the business-as-usual scenario.

Luanda, Angola © Adam Reeder

2

Are Angola's Policies and Institutions Ready to Address Climate Change?

2. Are Angola's Policies and Institutions Ready to Address Climate Change?

2.1 Angola's Climate Commitments and Institutional Readiness

The Angolan government has incorporated climate action and sustainability in its high-level planning and strategies for many years. The Angola 2025 National Long Term Development Strategy,[67] adopted in 2007, cites climate change as a cross-cutting concern. The strategy includes actions to improve the quality of life of present and future generations by preserving and restoring ecosystems, enhancing biodiversity, ensuring the sustainable use of natural resources, fighting desertification, and preventing and reversing land degradation. The 2025 strategy is currently under revision to extend its time horizon to 2050.

Angola is a party to the Paris Agreement and in 2021 submitted an updated nationally determined contribution (NDC). Also in 2021, Angola submitted a detailed Second National Communication under the United Nations Framework Convention on Climate Change (UNFCCC).[68] As noted in Section 1, the NDC commits unconditionally to reducing GHG emissions by 14 percent by 2025 relative to business as usual, or about 15.4 Mt CO_2e.[69] It pledges an additional 10 percent reduction conditioned on international support and funding. The vast majority of the mitigation envisioned in the unconditional pledge involves the energy sector and the oil and gas industry. Renewable energy investments—large-scale hydropower plants, biomass-powered plants, mini-hydro, solar, and wind—would achieve about 38 percent of the reductions, while 42 percent would come from reducing gas flaring in the oil industry. Composting municipal solid waste (up to 500 tonnes per day) would contribute 13 percent of the pledged emission reductions, and reforestation of 227,000 hectares, another 6 percent.

The 2018–2022 National Development Plan (NDP) provides a framework for climate action.[70] Its priority programs include climate change adaptation and mitigation, biodiversity and conservation, marine spatial planning and ecosystem health, risk management, and environmental protection. The NDP also states that inclusive growth processes must ensure the sustainable use of natural resources by respecting their regeneration rates. It includes an emphasis on measures to combat drought and desertification, strengthen waste collection and sorting, promote environmental awareness and education, strengthen environmental monitoring, manage natural hazards, and protect populations in vulnerable areas, among other initiatives. The 2019 National Coastal Adaptation Plan also highlights key challenges for coastal resilience.

In 2021, Angola approved an updated version of its 2018–2030 National Strategy for Climate Change (ENAC).[71] The new ENAC 2020–2035 defines the country's vision for climate change as "Angola adapted to the impacts of climate change with a low-carbon development pathway that contributes to the eradication of poverty."[72] It also includes a monitoring, reporting, and verification (MRV) component, including carrying out GHG inventories and reports; developing programs and projects with measures to tackle the effects of climate change; developing technical and vocational training in areas related to climate change; fostering international cooperation, particularly in the transfer of knowledge and experience; and encouraging and develop actions involving the transfer of technology and the use of clean technologies, among others. Box 1 provides an overview of key institutions involved in climate governance in Angola, with a focus on resilience.

Box 1. What are the key institutions involved in governing climate resilience in Angola?

The **Ministry of Economy and Planning** is the World Bank counterpart in the Angola CCDR. It is charged with planning, development of policies related to economic diversification, and institutional coordination.

The **National Committee on Climate Change and Biodiversity** (NCCCB), created in 2012 under the then-Ministry of Environment, is responsible for harmonizing programs and policies for the implementation of climate and biodiversity legislation; creating the necessary conditions for the implementation of a National Climate Change Plan; creating a national plan for investments integrating climate change, biodiversity and desertification; and creating centers of excellence to carry out research on natural disasters and climate.

The **Ministry of Culture, Tourism and Environment** (MCTA) is responsible for coordinating and overseeing the implementation of measures, strategies, plans and projects on climate change, including promoting projects and programs to stabilize GHG emissions. The **Climate Change Cabinet** that operates within MCTA is the implementing agency of the National Climate Change Program. The MCTA also oversees the **Center for Tropical Ecology and Climate Change** (CETAC), created in 2012, which conducts research on tropical ecology and ecosystem management in support of environmental policies.

To address the cross-cutting nature of climate change, the **National Institute of Meteorology and Geophysics** (INAMET) established a Modernization Program in 2014 to monitor climate change impacts across sectors including agriculture, environment, fisheries, water resources, oil, industry, transport, civil construction and energy. Its implementation has lagged behind, however, and it remains underfunded. INAMET is also responsible for collecting and monitoring data and warning about potential extreme weather events and disaster risks.

Although climate change measures related to urban planning and sanitation within the NDC and National Climate Change Strategy fall within the core responsibilities of municipalities, their climate leadership is limited, as decentralization in Angola is only beginning; municipalities are still dependent on the central government for guidance, resources, and capital planning.

2.2 Strengthening Angola's Climate Policies and Institutions

Angola lacks an overarching national legal framework on climate change to guide implementation and progress tracking towards climate targets. The MCTA and other entities that are responsible for planning and implementing climate change plans require more support in terms of knowledge, governance, data, and financial resources. Increased inter-institutional coordination is needed to integrate climate priorities with national sustainable development strategies, poverty reduction plans, and public policies. It is also crucial to develop synergies between the central authorities and the provinces, to build capacity and provide support for joint implementation of plans and strategies. In order to improve Angola's legal, institutional, and fiscal architecture around climate action, this CCDR recommends prioritizing action in two key areas:

Priority Area 1: Create a strong legal and regulatory framework for climate action

- Adopt a framework climate law to establish the institutional structure, policy objectives, planning and evaluation tools for climate risk mainstreaming into sector policy and investment design, as well as national development planning, leveraging good practice economic and financial instruments in this field.

- Adopt legislation for the creation of the Angolan Fund for Climate Change, with a fundamental role in implementing the country's policy in this field, building on, and strengthening the current Environmental Fund as applicable.

- Survey ministries with responsibilities related to climate change to analyze and identify the need to adapt existing legislation or to adopt new pieces of law, and adjust the legal framework in key climate-sensitive sectors to incorporate climate objectives and policies.

- Create environmental and sectoral regulatory frameworks[73] that provide guidelines and incentivize private investment and innovation in climate resilience, and develop a legal mechanism to hold sectors accountable for reporting data to be included in GHG inventories.

- Explicitly incorporate climate priorities in the national budget, including provisions related to climate-related disasters, and increasing the budgets for INAMET's functioning and hydromet modernization, as well as for the National Water Resources Institute (INRH) and Basin Administration Offices.

Priority Area 2: Realign institutional roles and responsibilities to advance climate goals and improve coordination

- Clearly define institutional roles and responsibilities, including aligning the mandate of the National Commission on Climate Change and Biodiversity with the provisions of the ENAC 2020–2035; designating an entity in charge of collecting all data needed for GHG emissions reporting; and assigning specific powers to different entities to ensure compliance with international commitments undertaken within the scope of ratified treaties and conventions.

- Define an inter-ministerial coordination structure with specific responsibilities and timelines for line ministries engaged in implementing climate related strategies.

- Establish a competent entity for the mobilization of international green and climate finance in line with the treaties and conventions ratified.

- Create and implement programs for the training of officials working on climate change to increase awareness and strengthen the technical capacities in the field.

- Define the role and the responsibilities of local/provincial authorities in designing, implementing and financing national/local climate plans and strategies.

- Increase institutional transparency related to actions undertaken to ensure compliance with objectives and targets in the context of climate challenges.

2.3 Mainstreaming Climate-Related Disaster Risk Management

The government has recently committed to mainstream disaster risk reduction into every investment decision and development plan.[74] Several policies and regulations to reduce climate-related disaster risks were developed after the civil war, including the institutional and governance framework for disaster risk management (DRM), established in 2003 under the Civil Protection Basis Law. It created two key bodies, the National Civil Protection Commission (CNPC) and the National Civil Protection and Fire Fighting Service (SNPCB). Since then, the government has enacted multiple strategies and plans related to climate-related DRM, although challenges persist with institutional coordination, decentralization, mainstreaming, information management and priority-setting. For instance, only eight of 18 Provincial Civil Protection

Commissions had developed provincial preparedness, contingency, and recovery plans as of this writing. Overall, there is a need to move from a system focused on disaster response to a more proactive risk management system. This CCDR recommends:

Priority Area 3: Strengthen disaster and climate-related risk management capacity in Angola

- Review existing processes for capital investment planning and territorial and sectoral planning, including at the local level, to ensure that they reflect the Government's commitment to mainstream climate-related disaster risk reduction considerations. This is particularly important for hazard assessments for land use planning in urban areas, where there is a high concentration of people and assets, and a multi-sectoral approach is key.

- Scale up technical and financial resources for climate-related DRM. Collection of climate risk data, its analysis and application into infrastructural investments and planning require resources to support specialized equipment, as well as training to build technical know-how and capacity. As a start, resources can be directed toward mainstreaming climate-related DRM considerations into the preparation of the Provincial Preparedness, Contingency and Recovery Management Plans.

- Strengthen hydrometeorological monitoring, which is also crucial both for drought monitoring and response, and for disaster preparedness. INRH, INAMET, and other agencies[75] have worked to improve hydromet monitoring, but there are persistent problems with the functionality of existing stations, including vandalism. Reliable mechanisms to ensure the collection and on-site availability of hydromet data are needed.

- Set up early warning stations based on reliable climate hazard and risk data. Innovative approaches to the collection and analysis of salient, accurate and timely climate risk information are essential. An efficient hydrometeorological information system could produce the necessary and reliable data to feed into a national early warning system functioning at the local level to minimize risk to lives and property. Despite recent efforts, Angola's existing early warning system remains subpar, unable to provide reliable climate information services, and will need to be strengthened, along with efficient warning communication and early action systems able to act on received climate early warnings.

2.4 Public Financial Management

National budget processes, budget planning, public investment management, procurement practices, and intragovernmental fiscal relations have a critical role to play in meeting the challenges of climate change. Good public financial management (PFM) systems are fundamental for mitigating the economic and social impacts of intensifying climate hazards, including recovery after climate-related disasters, with fiscal responses anchored in a disaster risk financing strategy. The quality of a country's public infrastructure, meanwhile, is determined by the quality of its public investment management (PIM) system, which has also been a challenge for Angola for a long time.

A stronger PIM system would ensure that projects financed with public funds are appropriately selected, efficiently implemented, conscientiously monitored, and thoroughly evaluated. Fiscal management in Angola has been volatile for a long time, due to a lack of adherence to fiscal rules, the fragmented allocation of responsibilities for core PIM functions, and constant reshuffling and restructuring of government departments. The limited oversight power of the central PIM agency also hinders efficient management, and there has been weak budget oversight by the National Assembly and the Audit Court, Project appraisal and selection have previously been identified as areas in need of strengthening as well.[76] Angola's PIM systems, policies, and practices also have yet to mainstream climate and gender equality.

The PIM system in Angola lacks transparency, with limited infrastructure data disclosure. Angola scores well below its regional peers on the International Budget Partnership's Open Budget Index.[77] Currently, efforts to support transparency mostly rely on the National Procurement Portal, which has not yet listed any tender announcements or adjudications related to dispute resolution prior to 2018.

The Angolan government has made considerable efforts to enhance the quality of the overall PFM system, but challenges remain. In 2018, the Government adopted a package of economic reforms that were accelerated in 2020. The Public Investment Plan (PIP) was introduced to rationalize public investment, and efforts were made to systematize the processes by which projects were evaluated and selected for inclusion in the PIP. According to the forthcoming 2021 PEFA, the ongoing reforms are already yielding promising results in the field of PFM.[78] The reforms aim not only to strengthen PFM, but also to support economic diversification. However, results to date have been mixed.

Based on the analysis above, this CCDR recommends the following actions to strengthen Angola's public financial and investment management systems:

Priority Area 4: Integrate climate measures into sectoral plans, strategies, and policies, and territorial planning instruments

- Consolidate the responsibilities of the core functions of the PIM system and enhance the oversight power of the central PIM agency to achieve efficiencies. The process of formulating and implementing the Public Investment Program (PIP) must be coordinated by the National Directorate for Public Investment (NDPI), but is currently scattered across line ministries, provincial and municipal governments, and the executive branch. This process is often unmanageably complex, impairing the ability of the NDPI to effectively oversee the process and enforce compliance with its governing legislation.[79]

- Increase the availability of project-specific information to strengthen the economic impact appraisal of proposed projects and facilitate coordination among ministries and other public agencies. Absence of data creates inefficiencies and prevents coordinated planning, making it difficult to integrate complementary projects within the same investment program. While there is currently a functioning computerized system for tracking PIP projects, it is not yet integrated with the accounting and tax systems or the systems of the Court of Auditors.[80]

- Integrate climate risks, opportunities, and national climate action priorities into the medium-term fiscal strategy, sector strategies, and every stage of the policy process. This requires a systematic whole-of-government approach which encompasses the PFM cycle, including climate-informed macroeconomic analysis and planning, revenue, public investment, procurement, and expenditure management. Mechanisms for promoting institutional collaboration, discussed above, are also key.

- Design and implement a methodology that allows the government to track climate-related expenditures, such as applying markers or itemizing climate expenditures on budgets. Expenditures related to activities that run counter to climate policy should be disclosed in budget documents and in end-of-year budget execution reports.

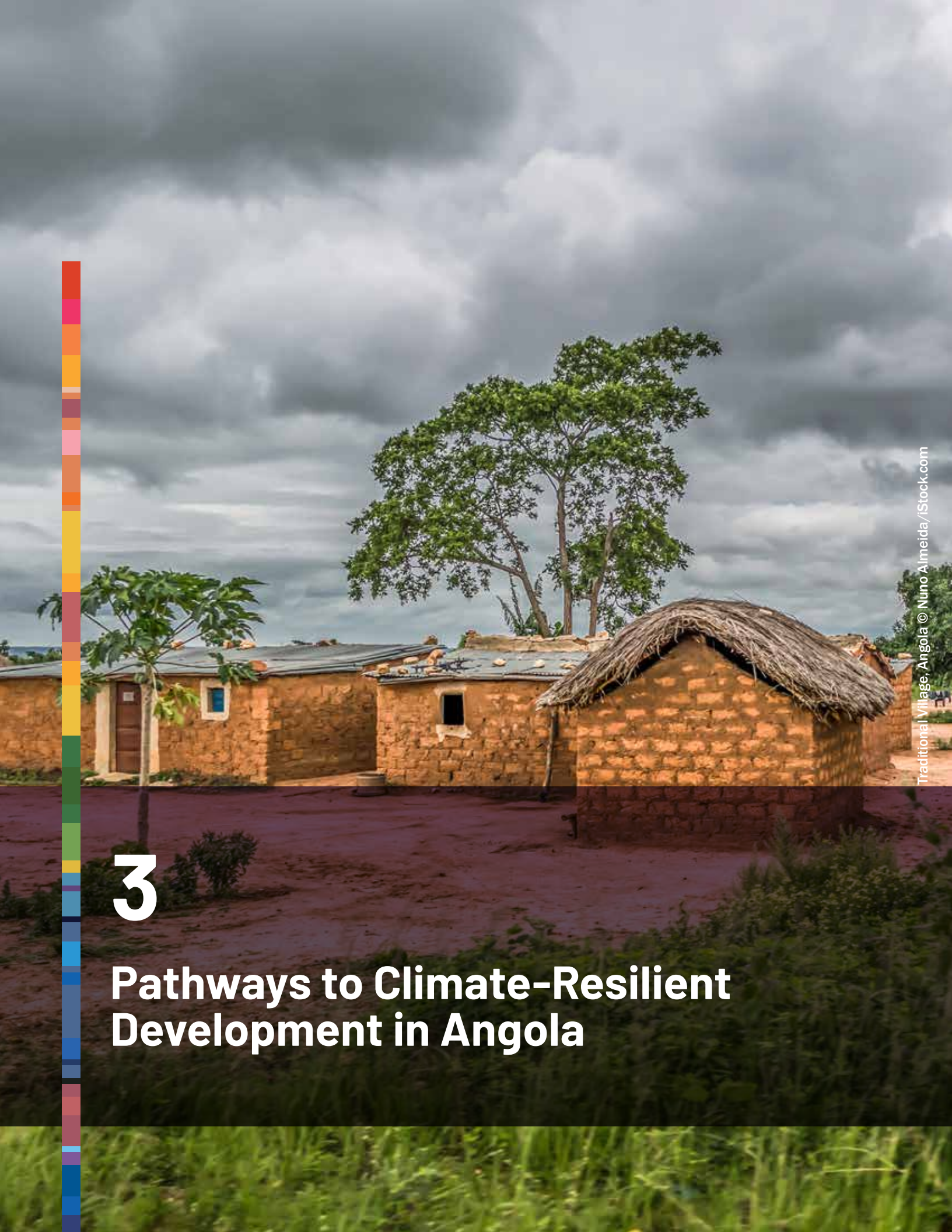
- Make PIM in Angola climate-responsive and employ mandatory assessment of new investment projects in line with national climate priorities. For this, the establishment of a standardized system for project appraisal that clearly articulates criteria for determining a project's expected return is needed. The NDPI can adopt a standard, comprehensive accounting method, including recurrent costs and key externalities, and mandate its use in all project proposals.

- Develop a credible ex-post evaluation mechanism. Maintaining an effective PIM system requires continuously working to improve the efficiency of PIM processes. Completed projects must be rigorously reported and evaluated against initial projections to gauge the accuracy of the project appraisal in general, and the methods used to calculate project costs in particular.

- Embed climate priorities in public procurement systems, using the Government's purchasing power to choose goods, services, and works with low GHG emissions and/or adaptation benefits.

- Strengthen capacity to implement tax policies aimed at reducing GHG emissions (see Sections 3.1 and 3.2 as well) and increasing climate resilience, and ensure compliance. In case of an emission-based tax, the emitters should be registered in a database linked with the taxpayer database.

- Enable subnational governments to play larger roles in advancing climate priorities, particularly in areas they usually manage, such as urban transportation, land use, housing, and building of local infrastructure. Angola's decentralization efforts can encourage climate-friendly local initiatives by enabling subnational governments to access the necessary resources (transfers, local taxes, bonds) to do so.



Traditional Village, Angola © Nuno Almeida/iStock.com

3

Pathways to Climate-Resilient Development in Angola

3. Pathways to Climate-Resilient Development in Angola

This report identifies five pathways to achieve a vision of a future Angolan economy that is both diversified and climate-resilient, with opportunities for all.[81] Tailored to the national context, these approaches were identified in dialogue with the Government and build on Angola's abundant natural capital. Angola is not only rich in oil, gas, and diamonds; it also has abundant water resources, renewable energy potential, and fertile arable land. Through strategic investments and well-planned, effective management, Angola can turn those renewable resources into the foundation of a new, more sustainable, prosperous, resilient and inclusive economy. In order to shift away from an economy driven by oil and gas extraction and toward a sustainable and diversified economy, this CCDR recommends investing in and building the resilience of water resources, agriculture and fisheries, and renewable energy; enabling green and resilient cities with economic opportunities for all Angolans; and leveraging Angola's young population by boosting human capital, through expanded, climate-resilient access to basic services and by fostering a culture of climate preparedness.

While adaptation to climate change is the most urgent priority for Angola and remains the focus of this CCDR, critical to securing its future development under a fast-changing climate, several measures with co-benefits of reducing GHG emissions were also identified. For example, eliminating fuel subsidies would reduce inefficient use of fossil fuels but also free resources for investments in resilience. Reducing GHG and black carbon emissions in oil and gas production will not only attract more investment to the industry, but also allow Angola to monetize gas that is currently wasted. The country's vast renewable energy potential is a significant opportunity to serve as a growth driver, such that Angola can shift from being an oil country to a green energy country. And promoting compact, connected, and inclusive urban development, while also building resilience, can help Angola make the most of urbanization as a way to raise living standards and diversify the economy.

3.1 Managing Water Resources for Climate Resilience

Water is crucial to human well-being and a vital economic resource for agriculture, energy production, industry, urban development, and the environment. Sustainable water resources management is thus essential to Angola's economic diversification and to climate resilience. While Angola is rich with water resources, these are unevenly distributed, with a rainfall gradient decreasing from North to South and influenced by topography, with most rain falling on the plateau and very little across the southern lowlands and coastal fringe. In addition, seasonal and interannual rainfall variability is high and floods and droughts have been a natural cycle[82], expected to intensify with climate change and leading to a decrease in overall water availability. If Angola is to develop its productive sectors, it will need to make significant investments to strengthen its water resources governance, and manage increasing demands on limited and variable resources.

From a human development and climate resilience perspective, closing gaps in access to drinking water and sanitation services is an urgent priority. Angola has made progress in the past two decades, but as of 2020, only 57 percent of people nationwide had at least basic drinking water access, and 73 percent had access to an improved sanitation facility.[83] However, there are large disparities between urban and rural residents and across income groups; while 95 percent of urban residents in the top income quintile had at least basic drinking water access in 2020, only 14 percent of rural residents in the poorest quintile did—and clean water access has actually declined at all income levels in rural areas.[84] The lack of safe water, sanitation, and handwashing facilities is closely linked to disease outbreaks during climate-related disasters and to widespread diarrheal disease, which killed more than 10,000 Angolan children under age 5 in 2017 alone, and also exacerbates undernutrition.

Angola's water sector is undergoing a process of reform.[85] The independent Regulatory Institute for Energy and Water Services (IRSEA) has been created, and a water resources mandate has been set up through the National Water Resources Institute (INRH). The provincial water utilities, IRSEA and INRH are still maturing and face capacity challenges, only two basin administration agencies exist and no basin councils have been created. Water resources management (WRM) frameworks need to be implemented and strengthened to set the foundation for drought and flood preparedness plans. Yet institutional capacity remains weak to operationalize them at key administrative levels.

Building the resilience of Angola's water sector requires a multifaceted approach: strengthening the WRM framework, investments in water storage; ensuring the sustainable operation and maintenance of infrastructure; strengthening provincial water and sanitation utilities; and investments to expand water and sanitation access. In order to address Angola's most pressing water needs and ensure the resilience of the sector, this CCDR offers the following recommendations:

Priority Area 1: Strengthen Angola's water resources management offices and frameworks as a key step toward building adaptive capacity

- Strengthen hydrometeorological monitoring, which is crucial for water management and planning: INRH, INAMET, and GABHIC have worked to improve hydromet monitoring, but problems persist with the functionality of existing stations and data collection. All water utilities should start to systematically measure and record their water resources (aquifer, production springs, river levels), to understand variability and detect impacts, also from other users.

- Strengthen licensing and registration of users: INRH is making progress on this with bulk water users, and with World Bank support (the PDISA2 project),[86] a nationwide cadaster of users is being developed. Understanding resource use and demand dynamics through this cadaster will provide important data for water resources planning, allocation, and management.

- Implement the bulk water abstraction tariff ("regime jurídico da taxa de captação de água do domínio hídrico") within the broader Financial and Economic Regime on the Use of Water Resources. Approval of this tariff will help promote the rational use of water resources. It doesn't apply to traditional and livelihood uses, so it will not burden poor households. PDISA2 will support pilot implementation in the Kwanza River basin, and the new RECLIMA project[87] will do the same in the southern basins under GABHIC's administration.

- Develop technical capacity for modeling water resources and allocation dynamics: The systematic use of data to balance water allocation across competing demands will enable more sustainable use of water resources and will be crucial to shaping efficient responses to scarcity.

- Enhance the capacities of the Basin Administration Offices and support the creation of Basin Councils as stakeholder participation platforms: In 2021, the Government mandated GABHIC with managing all three southern river basins, but GABHIC still lacks the capacity to fully implement its mandate, and Angola's other Basin Administration Offices are still to be created.

- Clearly recognize the role of water in achieving key development goals in Angola: As a first step, this CCDR included an analysis of dynamics at the water-energy-agriculture nexus (Box 2).

Priority Area 2: Adopt a comprehensive strategy for water storage at the basin level, integrating watershed storage, groundwater, and surface storage to maximize climate resilience.

- Promote the adoption of nature-based solutions (NBS) such as soil and water conservation measures, sand dams, and managed aquifer recharge to maximize the "sponge" effect of the watershed, in order to mitigate flood risks and store water for dry periods.

- Invest in groundwater exploration and ensure that existing data are shared, managed, and used to inform projects: groundwater in Angola is poorly known, and thus poorly managed. Studies are needed of strategic aquifers in the South and nationwide. Angola also urgently needs to digitize and make use of the extensive HIDROMINA colonial archive of hydrogeology.

- Adopt a resilience-by-design approach to align surface water storage and other infrastructure investments with the unique characteristics and dynamics of each basin.[88] Groundwater recharge and storage can be used conjunctively with surface water for flood and drought mitigation purposes.

Priority Area 3: Ensure the sustainable operation and maintenance of water infrastructure, as a key element of resilience-building

- Resources need to be channeled into operationalizing and maintaining existing dams. Technical capacities need to be strengthened, and each dam needs an instrumentation and surveillance plan, an operation and maintenance plan, and an emergency preparedness plan.

- Strong support from the Ministry of Energy and Water (MINEA) is needed to strengthen coordination and management across levels of government and among agencies. Many irrigation dams are semi-abandoned and lack a designated owner or operator, in a cycle of neglect and disrepair.

Priority Area 4: Strengthen provincial water and sanitation utilities, and the regulator, to ensure that they are resilient to climate variability and shocks, and improve service coverage in urban and peri-urban areas

- Provincial utilities have a clear and sustainable business model for service delivery, and they need to be strengthened. Provincial utilities have identified six key measures to improve their climate resilience: (i) protecting and monitoring watersheds and monitoring the resource, investing in knowledge; (ii) diversifying water sources and conjunctive use of surface and groundwater, creating buffers to have options in times of scarcity; (iii) developing drought preparedness and contingency plans; (iv) reducing non-revenue water and increasing efficiency; (v) installing meters and creating customer registries; and (vi) good operation and maintenance plans.

- Government efforts to connect urban and peri-urban households to the provincial utilities' supply networks must continue. Transitioning from tanker trucks to piped and metered supply has enormous benefits for beneficiary households and can also reduce GHG emissions.

- Continued support to the Electricity and Water Services Regulation Institute (IRSEA) will ensure well-regulated pricing and a healthy sector, as IRSEA is working to reduce non-revenue water and promote an efficient and economic use of water, greater service reliability, and increased capacity to adapt to scarcity. Continue to explore public-private partnerships (PPPs) where they can work: selected urban systems with a clear business model, well-regulated service, and a reliable customer base.

Priority Area 5: Invest to expand access to water and sanitation services for rural households and build planning and operating capacity in municipalities, to reduce vulnerability to climate shocks

- Household access to clean water is a key factor in resilience to climate change and disaster risks. The household's type of access to water for drinking has significant implications for distributional impacts of climate change on health, education and livelihoods, as discussed in detail in Annex 3.

- In rural contexts where vulnerability is highest, the consolidation and strengthening of sustainable operation and maintenance models of water supply systems is a priority. Investments in small solar-powered systems and manual hand pumps have proven to be more sustainable than those using generators, representing a win-win for adaptation and mitigation.

- It is important to strengthen municipal capacity to operate and maintain water points, frame local community management efforts, and coordinate backstopping support from the provincial level, in order to increase the functionality of water points. The implementation of Municipal Water Plans will promote the integration of local water supply with local management of water resources and will improve preparedness to droughts and increase climate resilience for households.[89]

Box 2. Understanding the water-energy-agriculture nexus to optimize investments

Water is a vital, but there are growing demands for increasingly variable and limited resources in Angola. It is thus essential to understand and quantify the trade-offs between different investment for water, energy and agriculture, so Angola can make the most of its available supply.

As part of the Angola CCDR process, an analysis has was conducted of different food, energy and water "configurations"," for Angola and its river basins, including resources used and produced, for Angola and its river basins using GCAM, a market equilibrium model. GCAM has a global scope and covers the time period from 1990 to –2100 period in five-year time steps. It can be used to examine, for example, how changes in population, income, or technology cost might alter crop production, energy demand, and water withdrawals, or how changes in one region's demand for energy could affect energy, water, and land in other regions.

GCAM was developed to analyze the implications and interactions of different interventions (policies, investments). Three climate scenarios were modeled: a net-zero scenario (RCP2.6) and the two used in the climate impacts analysis in Section 1 (RCP4.5 and RCP8.5). All simulations have used SSP2 for socioeconomics input to include adaptation pathways. Results for these 3 scenarios were generated for the 3 sectors (water, energy, food) as time series of projected sectoral variables. The modeling approach and results are detailed in the GCAM paper in Annex 10. Some key results are noteworthy:

- In RCP2.6 and RCP4.5, improved efficiency reduces overall energy demand, and there is a marked shift from fossil fuels to low-carbon sources, particularly biofuels and solar energy. Notably, even in RCP8.5, a large share of electricity generation comes from renewables, including hydro.
- The water demand analysis in the mitigation scenarios shows increased water use in irrigation after mid-century, due to larger crop production; usage in the electricity sector could also increase if carbon capture and storage (CCS) were implemented.
- Land use shows some increase in bioenergy feedstock cultivation (consistent with the energy results), with some increases in total agricultural production, as well as increases in commodity prices, in the mitigation scenarios. The model shows that increased bioenergy crop cultivation could drive deforestation, which would increase GHG emissions from land use.

Next steps in the modeling analysis include scenario refinement and evaluation consistent with potential investment packages aligned with the new National Development Plan to be drafted in 2022–2023. A summary of proposed development strategies and investment options can be derived through discussions with in-country specialists across sectors. Questions that may be explored in next steps include: (i) impacts across the sectors of a longer and more severe dry season by 2040; (ii) basin storage needs to be able to cover water demands in a 10, 30 or 50-year drought as per GCM projections; (iii) impacts on water, energy and agriculture sectors if Angola would reduce 50 percent its GHG emissions by 2040 and achieve net zero emissions by 2060; (iv) impacts on the sectors if fossil fuels would not be available for power generation by 2060; and many others.

Several investment strategies and development scenarios at the water-energy-agriculture nexus will be considered with the Government after the CCDR, with special attention to informing and supporting the development of the new National Development Plan.

3.2 Ensuring a Green and Climate-Resilient Power Supply

Angola's power generation capacity has grown rapidly, mainly through large-scale hydropower—but there is even broader renewable energy potential. As noted earlier, Angola is blessed with abundant hydropower resources, and its solar and wind potential is also very strong.[90] This means Angola could generate large amounts of clean electricity. Exploration of new hydrogen fuel made entirely with renewable energy—a key resource in a low-carbon future—is also underway.[91] Several large hydropower projects have been commissioned in recent years, more than quadrupling hydro capacity in just one decade, to reach 3,676 MW by 2021.[92] Angola has also partnered with international companies, backed by development finance, to develop solar PV in the South, starting with seven mini-grid projects launched in 2021 that will add a combined 370 MW of capacity.[93]

Relying heavily on hydropower holds down Angola's energy-related GHG emissions, but also exposes the electricity supply to the impacts of climate variability and change. In 2020, total domestic power generation in Angola was 13,991 GWh: 88.5 percent from hydropower, 11.2 percent from thermal sources, and 0.3 percent from hybrid sources; it also imported about 60 GWh of power. Nearly all generation capacity is publicly owned, operated by the state-owned company PRODEL. The energy output of hydropower plants depends on upstream flow conditions, which vary seasonally and over time and are becoming less predictable with climate change. Climate projections suggest that the South and Southeast of Angola may become dryer. This would imply lower hydropower production on the Cunene River, for example. Some river basins, on the other hand, may benefit from increased runoff. However, increased intensity of precipitation in upstream sections of rivers may result in floods and accelerate soil erosion, carrying sediment to reservoirs and reducing their storage capacity. This can reduce average annual generation and also amplify flood risks.

Ensuring that Angola has a green, climate-resilient energy supply will require targeted investments, systematic planning, and policy reforms. The following recommendations emerge from this analysis:

Priority Area 1: Improve power system operation and expansion planning, and prepare and systematically update a climate-adjusted Power Sector Master Plan

- Adopt state-of-the-art methodologies and tools for power system operation and expansion planning, which will require new software as well as capacity-building. The new methodologies and tools should properly account for hydrologic variability and the optimal management of hydropower plants with reservoirs to achieve least-cost security of supply. The use of those tools will reduce the risk of suboptimal decisions and avoid the need to use expensive generators during water-scarce years. The potential savings achieved by improving reservoir management practices under the current capacity and using best-in-class hydro-scheduling techniques are estimated at a minimum of US$11 million per year.

- The planned update of Angola's Power Sector Master Plan as part of the ongoing Electricity Sector Improvement and Access Project (ESIAP)[94] offers a unique opportunity to complete the country's first climate-adjusted Power Sector Master Plan. This requires: (i) creating scenarios of climate change impacts on hydrology and other variables; (ii) assessing a wide range of adaptation options; and (iii) using appropriate approaches for decision making in high-uncertainty conditions. The 2018 master plan does not adequately account for hydrological variability in its representation of existing and candidate hydropower plants.

- The ESIAP will also enable Angola to adopt software and equipment to collect and analyze dam safety and hydrometeorological data, allowing PRODEL to optimize hydropower production through better monitoring of rainfall and water flows in real time across basins.

Priority Area 2: Expand the transmission and distribution network

- Expanding the transmission and distribution grid is key to increasing electricity access in both urban and rural areas. A priority is to interconnect the northern-central, southern, and eastern regional systems to allow clean energy from hydropower to reach the South and East. Developing cross-border transmission lines will also allow Angola to tap into the Southern African Power Pool (SAPP) market in optimizing current system's operation.

- If generation grows to exceed domestic demand, Angola could potentially export green energy to its neighbors. Angola's vast renewable energy potential could represent a significant economic opportunity, but first it needs to address climate risks to the power system.

- To bring modern energy services to all households—as of 2020, only 47 percent of Angolans had access to electricity, and 50 percent to clean cooking[95]—the adoption of a National Electrification Strategy based on least-cost technical solutions should be prioritized. In May 2021, MINEA completed the most comprehensive geospatial electrification expansion assessment to date.[96] It found over US$3.3 billion in investments (grid and off-grid) will be needed, mostly public with concessional financing, to increase the electricity access rate to 77 percent by 2030.

Priority Area 3: Strengthen the enabling environment for private sector investment in solar and wind energy to diversify the energy mix

- Development of solar and wind power will contribute to reducing the Angolan power system's exposure to climate-related hydrological variability. The results of the climate-adjusted Power Sector Master Plan (Priority Area 1) should guide this. As noted, solar PV is already starting to be developed in Angola, including mini-grids and off-grid solutions. Wind and solar can also be integrated with hydropower systems, using reservoirs to offset the intermittency of these resources. Angola should also consider floating solar PV on reservoirs, which eliminates the need for land, can reduce evaporation, and optimizes resource use.

- Angola will need strong private sector participation—in the form of independent power producers (IPPs)—to develop non-hydro renewables. This requires creating an enabling environment, ensuring the sector is financially sustainable and bankable projects can be created. Progress on the following reforms is key:

  - Transition to cost-reflective tariffs: Despite the new tariff schedule of May 2019, which nearly doubled the average tariff, the current level of AKZ 12.09/kWh (or US¢3.5/kWh), remains one of the lowest in the world and about half the cost-recovery levels of AKZ 23.4/kWh.

  - Periodic adjustment of Annual Revenue Requirement (ARR) to address changes in cost drivers of each of its components: The ARR methodology approved in 2020 includes procedures and formulas for periodic adjustment of each component. In particular, this implies that all components of the ARR nominated in foreign currency (such as capacity and "take or pay" charges in power purchase agreements) must be adjusted to reflect exchange rate fluctuations

  - Off-taker (buyer) credit risk and liquidity: The financial health fragility of the single buyer for the system, RNT, needs to be addressed to assure investors and financiers that it will be able to pay for electricity purchased from IPPs in the long term.

  - Government support to IPPs: Since bankable power purchase agreements require long-term financing, investors and lenders usually seek contractual guarantees against several risks (such as changes in law, expropriation, war) to be underwritten by the government.

- Reducing system losses: Overall electricity losses are above 30 percent, and collection rates are below 75 percent. Thus, improving the distributor's (Empresa Nacional de Distribuição de Electricidade, ENDE) operation and commercial performance is critical. The World Bank and African Development Bank (AfDB) currently lead two programs to support the sector in reducing losses.

Priority Area 4: Assess strategic options for developing green hydrogen

- Angola's large renewable energy potential means it could become a producer, user, and exporter of green hydrogen, which has emerged as a promising clean energy technology, thanks to significant cost reductions and improved efficiencies. Angola has shown some interest, particularly for uses in agriculture, but neighboring Namibia has already developed an ambitious strategy to underpin its economic growth.[97] A study to assess Angola's options to develop green hydrogen for the domestic market and to export should be a priority.

3.3 Becoming a Hub of Climate-Smart and Abundant Food production

Agriculture in Angola is crucial to food security and holds tremendous potential for growth, but significant changes are needed. As Angola's NDC notes, the sector is "underdeveloped and not very productive," employing 51 percent of the population—mainly as subsistence farmers—but contributing only 9 percent to GDP.[98] Only about a third of the arable land is cultivated, and only about 2 percent of arable land benefits from machinery or even animal traction. Irrigation is also rare.[99] Of Angola's total arable land, only 100,000 out of 5 million arable hectares benefit from machinery and/or animal traction for sowing and harvesting. At the same time, unsustainable practices are common, resulting in forest loss, reduced biodiversity, and other environmental burdens. Addressing these problems will thus be crucial if agriculture is to become a pillar of Angola's economic diversification.

Climate-smart agriculture (CSA) offers a key pathway for sustainable intensification that reduces GHG emissions, increases climate resilience, and boosts productivity. This makes it a key tool for achieving Angola's domestic priorities and meeting its climate commitments. As global agri-food markets become increasingly carbon-sensitive, due both to policies and to consumer demands, CSA can also help Angolan agriculture be competitive and secure international markets. Producers in major food-exporting countries, such as South Africa and Brazil, have already been working to enhance the green credentials and sustainability of their agri-food value chains.

A closely related priority is to stop land degradation and restore soil fertility. Widespread adoption of technologies and innovation that promote soil health, conserve water, and protect grasslands is urgently needed. Leading strategies include crop rotation and intercropping, integrated soil fertility management, agroforestry, and silvopasture. These approaches replenish soils with vital nutrients and make them better able to store water, increasing drought resilience. They also increase soil carbon storage, contributing to Angola's NDC goals through a cost-effective natural solution. In the livestock sector, better manure management (to reduce GHG emissions from manure) and improved grazing practices (such as adaptive grazing) are also key.

Angola has large potential for fisheries and aquaculture, but it needs to carefully manage its resources to protect ecosystems and promote sustainable growth. Angola's NDC highlights the economic importance of the fishing sector, but notes that overfishing and changes in hydroclimatic conditions have greatly reduced the sector's potential.[100] Angola's Institute for the Development of Artisanal Fisheries (IPA) is working to develop artisanal fisheries and improve fishing communities' living standards; aquaculture is only starting to take off. Data on GHG emissions related to fisheries in Angola are sparse, but the sector's impact on overall emissions appears to be limited.[101] A priority for ensuring the sector's sustainability is to establish a network of marine protected areas (MPAs) to reduce environmental stress, which can also increase the

ability of marine organisms to adapt to climate change. It is also important to improve capture fisheries statistics and transparency, and to enhancing the productivity of commercial aquaculture while preventing environmental harm.

Building a climate-resilient, productive, sustainable, and competitive food system in Angola requires a multi-pronged approach, drawing on insights and best practices within Angola and around the world. This report makes the following recommendations:

Priority Area 1: Boost resilience to drought and water scarcity through water storage, management, and reuse strategies and expanded irrigation infrastructure

- Well-managed, sustainable water storage and irrigation systems are crucial to climate resilience (see also Section 3.2.2) and are urgently needed in large areas of Angola. Some initiatives for irrigated agriculture are already emerging, but they need to be expanded.

- Angola needs to combine the rehabilitation of old irrigation perimeters and infrastructure neglected during the civil war; drainage and flood mitigation infrastructure; and flexible, smaller decentralized water systems that use a range of technologies (such as wells and boreholes, rainwater harvesting, water reuse), such as farmer-led irrigation development (FLID). A combination of storage solutions and conjunctive surface and groundwater use will be needed. The risks of water pollution from fertilizer and pesticides must also be managed.

- For existing systems, the private sector can play an important role when it comes to rehabilitating, operating, and maintaining the infrastructure of existing government-funded irrigated perimeters, through contracted management services. The investment and operating costs for decentralized techniques will require creative financing schemes, such as subsidized loans combined with business models. The private sector could bring financing, technical and management expertise to build and manage irrigation systems through public private partnerships (PPPs), provided there is an attractive regulatory framework in place and a clear distribution of risks between the public and private sectors.

- The private sector can also be tapped to provide small-scale irrigation solutions. Community-based management structures will be needed to operate and maintain infrastructure, which requires capacity-building. Support for market development will also be needed, to enable farmers to fully benefit from higher crop yields and higher-value crop production.

Priority Area 2: Promote integrated approaches that protect and restore land, boost soil fertility, and contribute to biodiversity and climate objectives

- Boosting the productivity of Angolan agriculture starts with the soils. Integrated soil fertility management (ISFM) has been used successfully for sustainable intensification, soil restoration, and climate resilience in Sub-Saharan Africa.[102] Many relevant techniques overlap with climate-smart agriculture (CSA) and can help boost soil fertility while increasing both soil carbon storage and climate resilience.[103]

- Promoting integrated approaches to production, such as combined crop and livestock production, agroforestry, and silvopasture, would have multiple benefits for livelihoods and ecosystems. Agroforestry involves integrating trees with crops, which can improve diets and livelihoods by diversifying farm production (for instance, growing bananas or other fruit along with tubers and legumes), and also enhance biodiversity. Silvopasture, which integrates trees with pastoral systems, can diversify fodder and also provide valuable shade for livestock.

- All these approaches can help Angola rehabilitate degraded soils and landscapes, stem deforestation and biodiversity loss, and advance climate goals, while supplying diverse products for consumption and income and opening up new value chains to promote value addition and agro-processing, in line with the Government's ambitions for commercialization.

- Support through agricultural extension programs and incentives will be important to help farmers adopt new practices and encourage them to shift away from unsustainable practices. Incentives will need to be tailored to local socio-economic and environmental contexts.

Priority Area 3: Repurpose agricultural subsidies to promote climate-smart agriculture and related approaches with broad socio-economic and environmental benefits

- The Government has several programs to support the agricultural sector through subsidized credit and technology access that amounted to $1.3 billion in 2019, representing 28.5% of agricultural GDP; 94% of which was through producer support (largely in the form of market price support), while just 6% went to general agriculture public goods and services. These subsidies however mostly benefit larger farmers. They also tend to favor production of a limited set of crops, such as cassava, maize, and beans.[104] For example, a maize farmer receives almost six times more support per hectare than a banana farmer. Redirecting subsidies from traditional crops to more nutritious, high-value, and climate-resilient crops can lead to the exploration of new market opportunities to benefit farmers.

- CSA needs to be embedded in farmer input and technology support programs, with nutritional and environmental outcomes, including climate resilience, explicitly addressed. Repurposed subsidies can support incentives (cash or inputs) for farmers, with upfront payments to offset the initial high costs of adoption of more sustainable agricultural practices, followed by additional payments over time to support persistent use of CSA.

- Although repurposing of current subsidies in this manner can help achieve improved outcomes with available budgets, it is important to recognize that there will be winners and losers, and therefore safety nets may be required.

Priority Area 4: Increase investment in applied research and development (R&D) and extension services to support climate-smart agriculture

- Develop systems to produce and distribute seeds for particularly climate-resilient climate breeds, as well as for livestock breeding and selection.

- Improve weather forecasting, monitoring, and early warning systems, combined with climate services, to deliver timely information to farmers (see also Section 2).

- Develop and/or adapt technologies to increase water efficiency in both irrigation systems and use of rainwater.

- Build the capacities of the staff of agricultural extension services and members of local organizations (of farmers, water users, etc.) to support the adoption and use of CSA and soil and water conservation techniques.

- Establish soil health and soil fertility monitoring systems as well as pest and disease surveillance systems.

Priority Area 5: Protect marine ecosystems and improve fisheries management to ensure resiliency

- Establish a network of marine protected areas (MPAs) covering at least 10 percent of Angola's exclusive economic zone (EEZ).[105] This is an explicit target under Sustainable Development Goal 4. Angola is preparing to establish its first MPA in Namibe, along the coast of Iona National Park. This development has a solid technical foundation on the process of identification of Ecologically or Biologically Significant Marine Areas (EBSAs), supported by the Benguela Current Commission (BCC) and GIZ. It is also included as a priority initiative within Angola's Coastal Zone Climate Change Adaptation Plan.

- Prioritize improving transparency and statistics in the fisheries sector.[106] Angola's Monitoring, Control and Surveillance (MCS) system is relatively well developed. Enforcement of the fisheries law at sea is organized around 15 patrol vessels (19–62 meters in length) and small vessels for coastal operations. A strong presence of the MCS service in the EEZ of Angola has contributed to a drastic reduction of the amount of illegal fishing in its waters. Still, lack of transparency is known to facilitate illegal, unreported, and unregulated fishing. Undertaking a systematic review and reorganization of official fisheries data for public consumption would be beneficial to the sustainable development of the fisheries sector and enhance the effectiveness of MCS. Moreover, Angola could consider joining the Fisheries Transparency Initiative (FiTI).[107]

Priority Area 6: In developing aquaculture, take care to adopt approaches that enhance productivity and achieve nutritional benefits while minimizing environmental risks

- Embrace climate-smart aquaculture technologies, such as the use of energy-efficient pond aeration and in-pond raceway systems to increase pond stocking density and carrying capacity.

- Promote and ensure compliance with biosecurity principles to secure breeding centers, broodstock multiplication centers, and hatcheries.

- Prioritize the use of genetically improved strains to increase yield and productivity, reduce GHG emissions, reduce vulnerability to disease, improve fish feed use efficiency, and reduce environmental impacts.

- Promote diversification into different aquaculture systems and environments, such as brackish and marine waters, taking care to avoid habitat destruction, such as cutting of mangroves.

- Study consumer preferences within Angola as well as export markets to ensure that aquaculture products can satisfy multiple types of demand, from both low-value and lucrative high-value domestic, regional, and international markets.

- Strengthen research capacity to domesticate new species and resolve fish feed challenges.

3.4 Building Green and Resilient Cities

Two-thirds of Angolans live in urban areas, and that share is expected to rise to 72 percent by 2030 and 80 percent by 2050, with cities hosting three times as many residents as they do today.[108] Infrastructure, basic services, and economic opportunities are significantly better in Angola's cities than in rural areas, but urgent action is needed to make urban areas more climate-resilient and avoid locking into carbon-intensive urbanization patterns. Angola's urban growth over the past several decades has been characterized by low-density expansion of existing cities, and without deliberate policy interventions, that trend is likely to continue. Although Angola's motorization rate remains low, vehicle registrations jumped from 332,000 in 2005 to 880,000 in 2015,[109] though vehicle imports plummeted in the past five years due to economic conditions.[110]

Promoting compact, connected urban growth, with mixed-use development, high-quality public transit and walkable streets, will make Angola's cities more livable, economically efficient, and equitable.[111] It will also help hold down urban GHG emissions, which made up a third of Angola's CO_2 emissions in 2015, up from 23 percent in 1990,[112] not counting consumption-based emissions. Urban methane emissions are also on the rise, mainly due to poor waste management. Key strategies to tackle urban GHG emissions in Angola include improved urban planning that favors compact and transit-oriented urban growth; investments in infrastructure for public transit, walking, and cycling; and improved solid waste management. These strategies have multiple socio-economic and environmental benefits. For example, compact urban form reduces the cost of municipal infrastructure and service delivery and makes it easier for people to access jobs, education, and other opportunities. It also reduces urban expansion, protecting natural ecosystems, biodiversity, and food security.

It is crucial to build the resilience of Angola's cities, to safeguard economic assets and protect the most vulnerable populations, including the large share of urban residents who work in the informal sector and have no social safety net. Both the National Climate Change Strategy and the NDC highlight the important role of cities in addressing climate risks. Risk-informed urban planning and sectoral coordination are essential, because cities in Angola are increasingly exposed to floods, landslides, heat waves, and droughts, with disproportionate impacts on the poor.[113] Urban infrastructure also needs to be upgraded with resilience in mind. This requires gathering and analyzing spatial data, preparing flood and erosion risk maps, updating the land registry, conducting inventories of critical infrastructure, developing infrastructure maintenance plans, improving building codes, and reviewing construction practices to ensure they are climate-resilient.

Cities can play a central role in building a climate-resilient, low-carbon, prosperous, and inclusive future for Angola, but key policy interventions and investments are needed. This report recommends:

Priority Area 1: Realign urban policies and investments to promote compact, connected, and inclusive urban growth

- Angola is already highly urbanized, but it can still shape its cities to avoid car dependency (and associated GHG emissions, congestion, and air pollution) and ensure that residents at all income levels can fully access urban services and economic opportunities. Urban infrastructure has a decades-long lifespan, so the choices made today will affect city residents for generations.

- National policies can provide crucial guidance to cities and set standards for urban development that promote more efficient, sustainable, and inclusive growth. Budget support is equally critical, and coordination and capacity-building will be needed as well.[114]

Priority Area 2: Adopt comprehensive solid waste management to curb methane emissions, reduce urban flood risks, and improve the quality of life in cities

- Across Angola, an estimated 5.2 Mt of solid waste is produced each year, and more than 60 percent is disposed of in uncontrolled open dumps, emitting an estimated 4.6 Mt CO_2e of methane in 2020.[115] With population and income growth, waste generation is expected to rise sharply, and emissions are projected to increase by 66 percent by 2035, to 7 Mt CO_2e. However, if open dumping is cut by half, methane emissions could be reduced by 57 percent.

- Improper waste disposal can also exacerbate flood risks, as trash blocks drains and reduces the limited capacity of the drainage systems, causing stormwater to overflow during heavy rains. This makes improved waste management an adaptation priority as well.

- Angola will need to increase waste collection to achieve comprehensive coverage, work to stop open dumping and uncontrolled landfilling, manage landfill gas, and diverting organic waste from landfills.

This could be achieved along with measures to ensure integrated sector development, including waste separation, increased and improved treatment, and measures to improve sector governance.

- The availability and predictability of operational financing is a prerequisite to mobilizing private sector capital to accelerate adoption of critically needed infrastructure and equipment. Public-private partnerships could help Angola improve service delivery. Ultimately, Angola should aim to build a circular economy, minimizing waste.

Priority Area 3: Promote risk-informed urban planning and sectoral coordination to reduce exposure to flooding, heatwaves, and droughts, while helping build the resilience of vulnerable populations

- Urban adaptation measures included in the NDC and National Climate Change Strategy need financial support for implementation. Measures such as risk analyses, integration of risk maps into territorial plans, strengthening of inspection and supervision of high-risk land are key. Early warning systems for floods are also needed, particularly in coastal zones.

- To enhance the resilience of Angola's cities, coordinated planning across sectors, including transport, water and sanitation, solid waste, and housing is fundamental and requires significant institutional strengthening. Resilience planning and coordination must include existing informal settlements and balance on-site solutions with resettlements.

- Nature-based solutions, such as planting urban trees and using green spaces and wetlands to provide flood buffers, can provide both adaptation and mitigation benefits and also enhance urban biodiversity and ecosystem services.

Priority Area 4: Adopt integrated urban water management to improve and expand water, sanitation, and hygiene (WASH) infrastructure and services

- As noted in Section 3.2.1, there are large disparities in WASH service coverage in Angola, and although cities have far better infrastructure than rural areas, the poorest and most vulnerable populations still often lack this basic necessity. Expanding and improving WASH infrastructure and service delivery is thus a priority for development and climate resilience.

- As highlighted in the NDC and the National Climate Change Strategy, the expansion of resilient water services to vulnerable populations, such as informal settlements, must be coupled with utility drought preparedness and broader water resources planning. To improve health outcomes and quality of life, it is important to improve wastewater collection and treatment systems and build new systems in underserved, highly populated areas. At the same time, drainage systems and flood protection barriers need to be installed along rivers and near critical infrastructure such as wastewater treatment and waste storage systems.

- Integrated urban water management can help Angola achieve these objectives. It requires coordination across urban services (water supply, sewerage, drainage, wastewater treatment, and solid-waste management) and land use planning (ecological zoning, protected areas, and public spaces) at the metropolitan scale.

3.5 Boosting Human Capital and Creating a Culture of Climate-Preparedness

Angola's greatest asset is its people, who are young (the median age in Angola is 17) and can power climate-resilient development across sectors—but only if they are healthy and protected from poverty.

Currently, Angola's human capital index stands at 0.4, similar to the average for sub-Saharan Africa but lower than the global average of 0.57. Climate change threatens Angola with more food and nutrition insecurity and a higher incidence of vector-borne diseases, such as malaria. Therefore, investments in health and nutrition, especially the most vulnerable and food-insecure Angolans, are a first shield against rising climate shocks, and crucial to building climate resilience, reducing poverty, and supporting inclusive growth. The lack of a large and adaptive social safety net also undermines human capital development in a context of increasing frequency of extreme events. In order to raise a climate-conscious generation, it is critical to start in the early years and instill values of shared responsibility and environmental stewardship in primary education. Prioritizing programs that prepare workers for careers in adaptation and low-carbon technologies ('green jobs') is an opportunity to boost its future competitiveness. Investments in research and development capacity for climate action are also crucial.

Investments in the health and well-being of the people, especially the most vulnerable and food-insecure, are crucial to building climate resilience, reducing poverty, and promoting inclusive growth. As of 2018, almost one-third of Angolans were below the national poverty line, and half lived on less than US$1.90 per day.[116] As noted in Section 1.1, the 2020 Human Development Index found not only widespread poverty in Angola, but also deep inequality, multidimensional poverty, insecure employment, and limited access to health care and education, among other factors.[117]

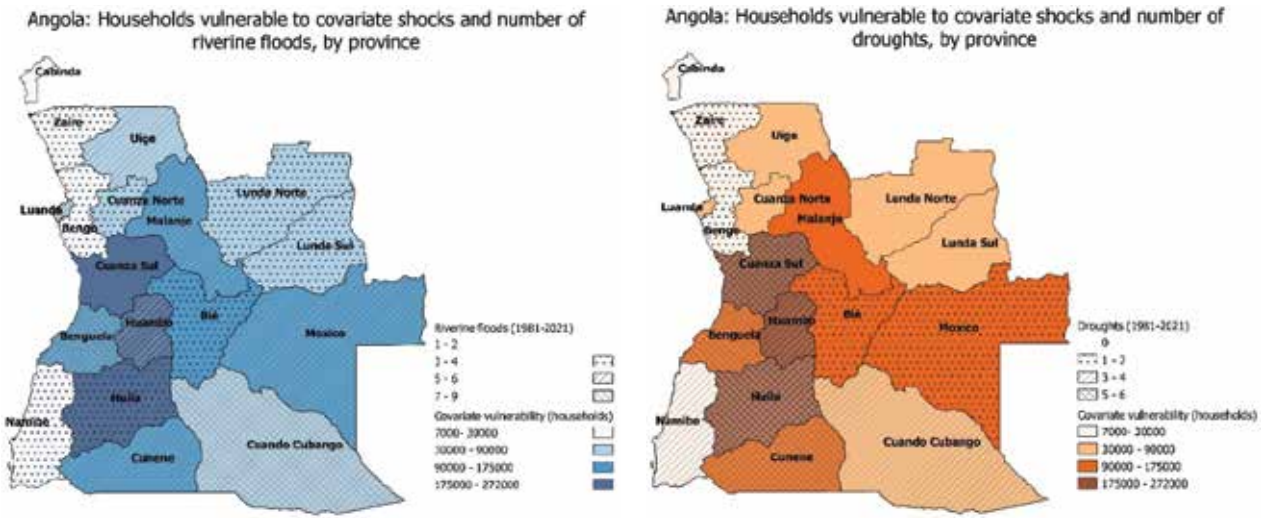
Climate vulnerability, poverty, malnutrition, and public health crises are closely intertwined. Poverty is particularly severe in rural areas, where subsistence agriculture is the main livelihood and food source. The historic drought in the southern provinces has shown how in a context of poverty and vulnerability, climate shocks can lead to hunger crises. Between October 2021 and March 2022, an estimated 1.58 million people in Angola's South—three-fifths of the analyzed population—experienced high levels of acute food insecurity.[118] Nationwide, malnutrition has been identified as top risk factor driving death and disability.[119] Droughts and floods alike can also lead to disease outbreaks linked to unsafe water. By expanding access to basic services, enhancing safety nets, and investing in public health, Angola can make its people more resilient to climate change and economic shocks alike.

3.5.1 Social Protection

Social protection plays a crucial role in helping vulnerable populations withstand shocks and preventing those shocks from reversing development gains. Not only are large shares of Angola's population living in poverty, especially in rural areas, but many others are vulnerable to falling into poverty in the event of a local shock, such as an extreme weather event.[120] Preliminary results of statistical simulations for the forthcoming Angola Disaster Risk Finance Diagnostic[121] shows that based on historical data, severe droughts such as the one experienced by southern Angola in 2018–2019 occur, on average, once every five years. This type of event, which affects a large share of the local population, is called a covariate shock. Such shocks are less likely to be insured through informal risk-sharing schemes *within* communities, or even by mutual insurance schemes *across* communities.

In Angola, exposure to climate risks overlaps to a great extent with social vulnerability, particularly among farmers. A simple approach used in this CCDR is to overlay the location of climate risks with poverty maps to help identify "hotpots" of acute vulnerability to both climate shocks and poverty (Figure 8). Cunene, Huila, Bie, Moxico, Cuanza Sul, Huambo, and Malanje provinces show the greatest overlap. Except for Malanje, these provinces are also the ones most affected by droughts over the period 1981–2021, with large numbers of households engaged in agriculture. A distributional lens is then added to the estimates of the impact of climate change on human capital by considering income differences. Without targeted interventions to help socially vulnerable populations adapt their livelihoods to be less susceptible to climate change—and cope with unavoidable shocks—escalating climate change impacts could cause humanitarian crises and push entire communities into deep, persistent poverty.

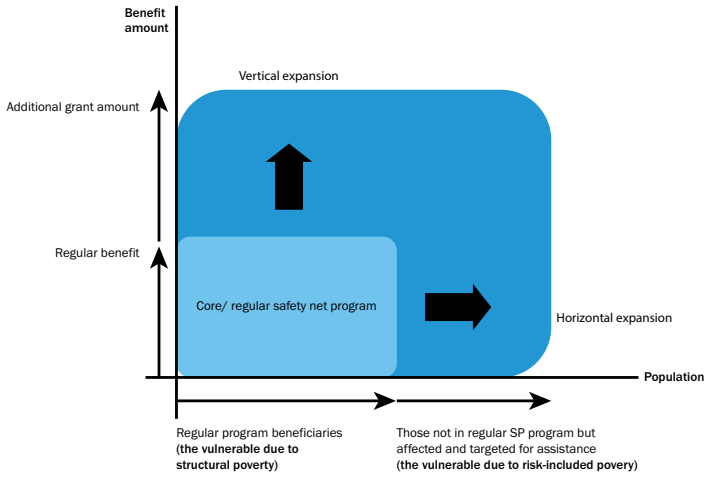
Figure 8. Vulnerability to major climate-related shocks in Angola and number of events, 1981–2021: Riverine floods (left) and droughts (right)



Source: World Bank.

Effective social protection responses to covariate shocks will require substantial expenditures. In a hypothetical scenario using 2018–2019 conditions, we find the monetary losses from a climate shock would range between US$50 million and $75 million, depending on the intensity of the shock. Kwenda, Angola's flagship unconditional cash transfer program, offers a good platform to support poor households in regular times and could be expanded to provide additional assistance when climate-related shocks occur. As illustrated in Figure 9, in order to fully restore welfare to pre-shock levels, additional assistance could be provided to existing Kwenda beneficiaries, and temporary assistance could also be provided to households that are non-beneficiaries, but are vulnerable to poverty due to covariate shocks. Planning for these contingencies, in terms of programmatic design and financing, is critical to be able to respond effectively.

Figure 9. Vertical and horizontal expansions of social safety net programs.



Source: Adapted from Bowen et al., 2020.

Social protection can also contribute to Angola's transition to a low-carbon and climate-resilient economy, by enhancing households' capacity to adapt to both climate change and climate policies. Support could be provided through the Kwenda system to offset the impact of fossil fuel subsidy reforms, for example (see Section 4.2). Households could also use the extra cash to make small, but important investments in adaptation, such as diversifying crop seeds and animal husbandry for drought risk hedging, or building a courtyard cistern to store water when feasible. Farmers might be able to afford more education for themselves or their children, in order to pursue livelihoods that are less susceptible to climate shocks, while workers who lose their jobs in a shrinking oil and gas sector could get trained to work in renewable energy, and not fear that their family will go hungry during the transition.

In order to deploy social protection towards building climate resilience, this report recommends:

Priority Area 1: Expand Kwenda to support all the poorest households, and expand it both vertically and horizontally to help protect household welfare in the event of shocks

- Kwenda's targeting criteria and scale implies that a large proportion of households that are vulnerable, particularly to covariate shocks, will already be enrolled to receive cash transfers. Estimates using data for 2018–2019, and assuming perfect targeting, show that of the 1.51 million households that are vulnerable to poverty from covariate shocks in Angola, around 0.97 million (65 percent) will be Kwenda beneficiaries when the program is fully rolled out.

- Kwenda could be used to respond to shocks by expanding vertically (providing top-ups in addition to regular Kwenda cash benefits) and horizontally (providing transfers to non-Kwenda beneficiaries affected by a shock).[122] Both types of expansion are important, because covariate shocks increase the risk of impoverishment across large swaths of a community.

Priority Area 2: Invest in jobs and economic inclusion programs to help workers transition to a green economy and build resilience

- **Education and training programs** can enhance workers' skills in their existing occupation or reskill them to enable them to transition to a new occupation;

- **Employment orientation services** can help workers identify potential new occupations and learn about job opportunities and how to pursue them;

- **Micro and small business support** can help business owners transition into new markets, or to help displaced workers or climate-vulnerable farmers start a small business;

- **Employer incentives and subsidies** can encourage employers who would otherwise shed labor due to a shock to keep their workers—for example, wage subsidies or tax waivers in exchange for continued employment (this is not a viable long-term solution, however);

- **Climate-smart public works programs** can provide employment that also makes communities greener and more climate-resilient, thereby enhancing productive outcomes. This could align with interventions to promote the adoption of climate-smart agriculture.

Priority Area 3: Develop insurance programs, especially weather index insurance, to help protect farmers from adverse climate-related shocks

- Insurance can provide a crucial buffer from climate shocks and may also enable households to make larger—and thus slightly riskier—investments in adaptation. However, there are various operational and design issues that have hindered the development of such programs in Angola.[123] They include a lack of reliable data on household characteristics, historical weather events, and crop yields; regulatory environments that are not conducive to ensuring the enforcement of contracts; and lack of efficient distribution channels and aggregators to improve access to households.

- In Angola, the weather index insurance market is relatively nascent, but Kwenda's social registry, the Cadastro Social Único, could provide a potential entry point in terms of getting reliable data on a sizable number of households.

3.5.2 Health

Climate shocks are already affecting public health in Angola, undermining the significant gains made in the past three decades. The life expectancies of both men and women in Angola increased by a third from 1990 to 2017, to 62 and 67 years, respectively.[124] Yet, as described in Section 1, the severe droughts in the South have caused widespread, acute food insecurity, and lack of safe water after extreme events has led to high levels of diarrheal disease and mortality among children. Future climate conditions are likely to bring even greater risks of vector- and water-borne diseases. However, like poverty risks, the health impacts of climate change are unequally distributed across in Angola. The same is true intergenerationally, as discussed in Section 1.2: A major study found that in a scenario consistent with current climate pledges, Angolan children born in 2020 would be exposed to about 10 times as many heat waves, five times as many crop failures, and three times as many extreme events overall as someone born in 1960.[125]

Health facilities in Angola fall short of what the population needs, especially in rural areas, and they are at risk from climate change. Health services provided by the National Health System are free of charge and delivered through a three-level system: 700 health centers and 2,120 health posts, nursing stations and doctors' offices; 145 municipal hospitals and 46 provincial hospitals; and a top tier of 12 central hospitals

and specialized hospitals. The ratio of health facilities to population was estimated at 0.5 per 10,000 people in 2010, with disparities between urban and rural areas: 24 percent of the rural population had access to a public health center or clinic within a two km radius, compared with 63 percent of the urban population. A national health network mapping exercise in 2007–2011 found about 79 percent of current public health facilities were functional. Given how critical these facilities are, particularly during crises triggered by climate change impacts, it is essential to invest in upgrades to provide better overall coverage and ensure climate resilience.

Recommendations to enhance the health system and make it more resilient to climate change are organized around key components of the World Health Organization's Operational Framework for Building Climate Resilient Health Systems:[126]

Priority Area 1: Close knowledge gaps about existing and projected climate change impacts on public health in Angola, as well as the health co-benefits of climate action

- This report has highlighted some known and expected impacts, but significant knowledge gaps remain. It is important to deepen understanding of the implications of climate change for malaria transmission, malnutrition and diarrheal diseases among children and adults, and other health concerns, including hotspots of risk. At the same time, many measures to reduce GHG emissions—from improving public transit, to reducing gas flaring—would also reduce air pollution. Quantifying the health benefits can help strengthen the case for those measures. Careful monitoring of health data will be needed to inform policies and programming.

Priority Area 2: Systematically integrate climate change in health sector plans, budgets, and programs

- Incorporate climate-related health considerations in health sector plans and provincial health plans. Create cross-sectoral coordination for climate action with ministries of agriculture, planning, social action, family and women, and water, among others, and develop national and subnational mechanisms for action on climate-related health impacts.

- Develop an investment strategy for climate and health actions, and allocate funding for adaptation and mitigation measures within the health sector budget. Establish strategic partnerships for climate-smart health financing across sectors and with external actors, including donors and the private sector.

- Existing and new health programs and services should increasingly be designed and implemented to respond to climate-sensitive health risks and vector-borne diseases. High-quality primary health care is the basis for many climate-informed health programs (including through existing programs such as communicable and vector-borne disease prevention and treatment, non-communicable disease prevention, and maternal and child health). These programs can be made more climate-sensitive by using information on current and projected climate conditions to identify gaps and inform strategic planning. It is also necessary to strengthen or create other departments and programs, such as mental health, nutrition, food safety, disasters and emergency management, and facilities management, to respond to current needs and projected climate-sensitive health risks.

- This and future analyses of climate change impacts on health should be used to inform planning for human resources for health, including strategies for creating a new health workforce to fill in gaps areas, and skills-building and training opportunities for existing staff—potentially in collaboration with the private sector.

Priority Area 3: Enhance the health system's capacity to identify climate-related health risks and reliably provide care even during extreme events

- Invest in climate-resilient and sustainable technologies and infrastructure. Systematically assess existing technologies and infrastructure for climate vulnerabilities, and develop cost-effective options for preventing and mitigating climate-related damage to health structures and improve energy efficiency. Off-grid solar systems, for example, can help keep health care facilities fully operational even during power outages—everyday and after a disaster.

- Develop intersectoral platforms to monitor climate-related health risks, and establish a climate-related disease early warning system that includes climate and health indicators, as well as an intersectoral response mechanism.

- Enhance contingency planning for deployment and response for acute climate shocks at all administrative levels.

3.5.3 Education

Angola's ability to build a resilient and thriving economy will depend to a great extent on the skills, technical capacities, and values of its people, backed by effective systems. Education is therefore crucial—from primary schools, to universities, as well as training programs that build the specialized skills needed for the climate transition. As of 2020, 66 percent of Angola's population was under age 25, and 46 percent, under age 15.[127] These young people will be one of Angola's most important assets in the transition to a diversified, low-carbon, climate-resilient, and socially inclusive future economy. A key first step is to start raising a climate-conscious generation with a new national cultural identity built around shared values of conservation and protection of natural resources. Over time, Angola will also need to grow its own technical and scientific expertise, using strategic partnerships with international actors and key industry players to make the necessary investments.

To achieve those goals, this report makes the following recommendations:

Priority Area 1: Nurture a national cultural identity and promote shared values of conservation and preservation of natural resources

- In order to raise a climate-conscious generation, it is critical to start in the early years and build a sense of shared responsibility. The values of environmental stewardship can be instilled in primary school, through formal lessons as well as experiential learning that allows young students to establish their personal relationships with nature. For urban schools, this often means prioritizing trips to nature, such as visiting rivers or waterfalls, and helping children learn the basic concepts of the water cycle, watersheds, and how they are threatened.

- Adolescents, in turn, can be taught and empowered to advocate for conservation and preservation of natural resources. This can take various forms, including national climate activism, or lobbying for specific changes to regulatory frameworks. A youth service initiative, such as that promoted through national youth conservation corps initiatives,[128] could be a promising way for Angola to develop the cadre of future environmental scientists, while providing short-term employment opportunities for young people. Such initiatives can also benefit from investments in eco-tourism and related activities.

Priority Area 2: Invest in research and development capacity for better monitoring, early identification, and faster response to crises

- Angola needs to improve its research capacity and build a strong research and development (R&D) sector, including higher education institutions and private sector partners, to support its economic transformation. Since 1990, less than 4 percent of global climate-related research funding has focused on Africa, while 78 percent of funding went to researchers in Europe and the United States.[129] Even when research does focus on Africa, African scientists receive less than 15 percent of the available funding. Inequitable financing perpetuates and deepens the gaps in research capacity between institutions in countries such as Angola and their counterparts in Europe and North America. Less funding to countries like Angola will mean fewer weather stations, for instance, resulting in less accurate forecasting, and less precise early warning systems. Worse, as long as researchers—who set the research questions—are so removed from the countries they study, the less those questions will be aligned to local needs.

- A vibrant local climate research industry will have many spillovers. First, it will result in weather models and early warning systems more embedded in local systems, which in turn will result in actors being alerted sooner, thus enhancing preparation and mitigating potential damages. Second, improved local R&D capacity in Angola will bring quicker adoption of policy recommendations by the public and private actors positioned to respond. Third, paired with proper communication efforts, it will help instill a national culture of climate awareness. Finally, investing in a research hub for climate adaptation and response represents good green jobs for Angola, and would strengthen the country's tertiary education institutions, with important linkages to training centers and to industry.

Priority Area 3: Develop new skills and professional training courses for the next generation

- As Angola reflects on the future strategic directions for its universities, the climate skills agenda represents an opportunity to position the country as a leader in a rapidly growing sector. Angola is currently drafting a strategic plan for the future of tertiary education (Livro Branco para o Ensino Superior—LiBES), expected to be finalized in May 2023. The LiBES will articulate a vision for the sector to 2050, including megatrends that the sector can leverage to help shape the country's future. Climate adaptation is one such megatrend, not just because of the myriad sectors that will require upskilling across the Angolan economy, but also because neighboring countries, facing the same challenges, will also be seeking out similar skillsets to respond to climate destabilization and develop the green economy.

- Achieving this vision will require national and foreign investments, as well as strategic partnerships with international actors and key industry players. The idea is not to emulate the practice of many universities in the world, which tend to sign dozens—sometimes hundreds—of memoranda of understanding with institutions in other countries, usually focusing on academic and student mobility. Instead, strategic partnerships between Angolan and foreign universities should involve deep relationships with a small number of carefully chosen institutions that share a common vision and similar values. The principal objective would be to undertake mutually beneficial projects spanning the entire range of academic and administrative activities in disciplines and multi-disciplinary fields linked to climate change. This could include the development of joint academic programs and/or double degrees, collaborative applied research projects, and joint services to the community.

- New curricula will also be needed, based on best practice globally in training multi-disciplinary climate experts at the nexus of climate science and societal impacts. Effective training of multi-disciplinary climate professionals will require an experiential curriculum with student-centered approaches, using advanced technologies to make the learning experience more stimulating, engaging, and

effective. Those approaches need to be supported by innovative assessment procedures and criteria that are embedded in the learning process and emphasize formative evaluations rather than summative examinations.

- Strengthening linkages with industry can make the programs even more relevant to Angola's economic transformation and improve graduating students' employment prospects. Linkages can take many forms: in-firm internships to acquire practical skills and acquire real life experience; courses given by private sector professionals intervening as visiting lecturers/instructors; in-company placements for research students and academics; participation of professionals in program and curriculum design committees; regular meetings with employers to receive feedback on the attitudes, skills, and competencies of graduates; mentorship of students by alumni; and joint applied research projects to find solutions to production or management problems faced by firms.

Talatona, Angola © Eryxson Fonseca

4

Financing Angola's Climate-Resilient Development Pathways

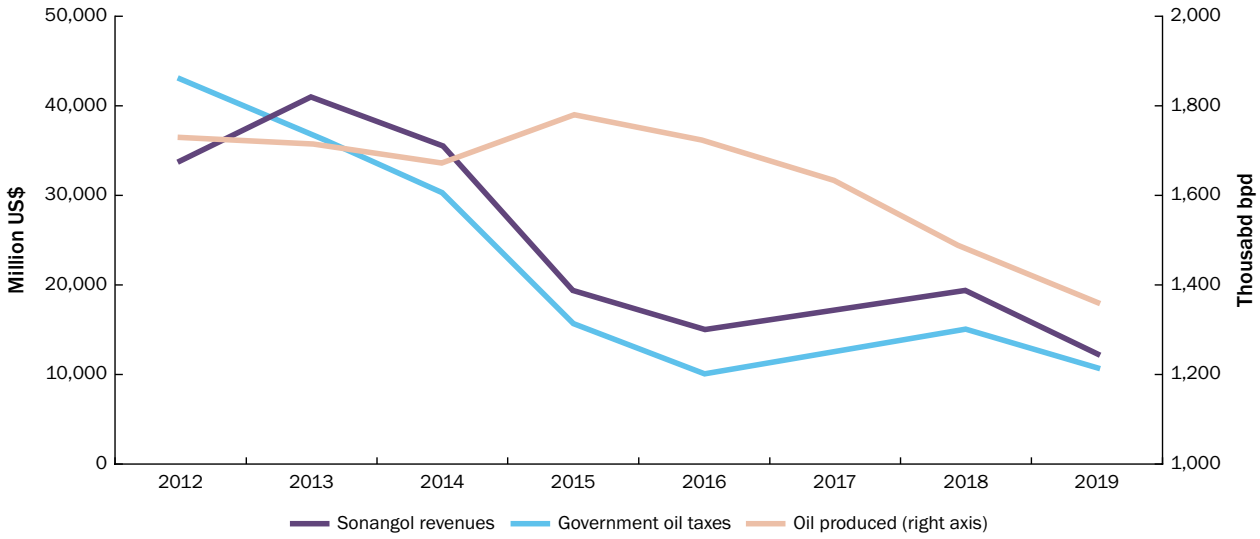
4. Financing Angola's Climate-Resilient Development Pathways

Fiscal revenues from the oil sector will remain a key source of financing for climate-resilient investments for the next decade, calling for careful management of the remaining oil wealth. Even if efforts to diversify the economy are successful and despite a gradual decline in oil production, Angola's fortunes will remain tied to oil for at least the next decade. Therefore, Angola needs to maximize the benefits from its oil wealth by boosting the sector's competitiveness through reducing emissions upstream and enhancing competition downstream. Oil revenues then need to be managed and deployed to achieve the highest impact in realizing Angola's resilient development vision.

4.1 Making the Most out of Declining Oil Revenues

Angola's fiscal fortunes will remain tied to oil revenues for at least the next decade. With oil production declining on top of, until recently, lower oil prices, Sonangol revenues and government oil taxes collapsed after 2015 (Figure 10). In response, the Government has engaged in reforms to boost non-oil revenues (most importantly by introducing a value-added tax). Non-oil revenues have grown faster than oil revenues since 2015 despite the large currency depreciation that boosts the kwanza value of oil revenues. Nevertheless, about 60 percent of total revenue still came from oil in 2021. Going forward, in the baseline RCP4.5 scenario, oil revenues are still projected to account for about half of government revenues through 2030.

Figure 10. Oil and Angola's budget: Sonangol and Government revenues, 2012–2019

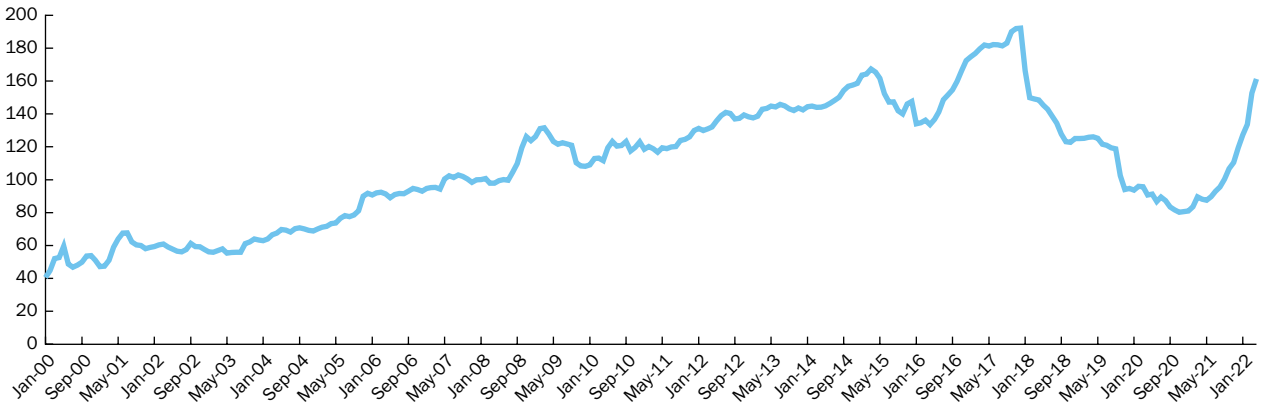


Source: Sonangol and Ministry of Finance data.

Angola's continued dependence on oil complicates macroeconomic management, as high oil prices increase revenue, but undermine the competitiveness of non-oil export sectors. In the near term, oil prices are likely to remain high due to supply constraints and geopolitical factors. This may direct resources toward the sector and exert pressure on the currency, requiring careful macroeconomic management to avoid an excessive appreciation of the real effective exchange rate (REER). Appreciation of the REER hurts the competitiveness of Angola's non-resource exporting industries and would hinder diversification efforts.

Angola's REER appreciated during the oil price rise from mid-2017 to 2020 (Figure 11). Going forward, channeling additional revenues toward debt reduction and productive public investments in human capital and infrastructure (subject to improvements in public investment management) can help mitigate the appreciation pressures.

Figure 11. Fluctuation in Angola's real effective exchange rate (May 2008 value=100)



Source: Bruegel Real Effective Exchange Rate database.[130]

Most global low-carbon transition scenarios envision oil prices declining in the coming decades. The world cannot reduce its carbon emissions without sharply reducing the use of fossil fuels, including oil and gas. The pace of the decline in oil and gas demand—and prices—may be gradual, as countries electrify their transportation sectors and switch power generation to renewable energy over time, but may also be sudden, as in the case of technological breakthroughs that quickly lead to substitution away from oil. This analysis uses projections by the International Energy Agency (IEA) and considers two scenarios: "announced pledges" (RCP4.5, the baseline scenario), which sees oil prices stabilizing at about US$65 per barrel from 2030 to 2050, and "stated policies" (RCP8.5), a scenario in which demand for oil continues to increase, leading to relatively high prices of petroleum into the future (Table 1.3). However, lower-emissions scenarios—which would result in a safer climate for Angola—cannot be ruled out; policy makers need to be prepared.

Table 3. IEA projections for crude oil prices in 2030 and 2050

			Net Zero by 2050 (like RCP 1.9)		Sustainable Development (like RCP2.6)		Announced Pledges (like RCP4.5)		Stated Policies (like RCP8.5)	
	2010	2020	2030	2050	2030	2050	2030	2050	2030	2050
Price per barrel (in 2020 USD$)	92	42	36	24	56	50	67	64	77	88

Source: IEA, 2021, with authors' notes on equivalent RCPs, highlighting the two used in this CCR.[131]

Angola needs better fiscal policies and frameworks to stabilize revenue and spending, prepare for a potentially sharp drop in oil revenue, and reduce foreign debt to manageable levels. In the baseline RCP4.5 scenario laid out in Section 1.3, successful diversification and prudent oil policies allow non-oil revenue growth to accelerate, offsetting the decline in oil revenues and leading total government revenues to expand after 2030. Economic diversification, particularly in RCP4.5, also benefits Angola by reducing exposure to climate transition risks. The model shows public debt declining meaningfully only after 2030, although this partly reflects a trade-off between debt reduction and the need to invest in resilience-building and economic diversification. At 10.8 percent of GDP per year, Angola's investment in infrastructure is already well above the average for lower-middle-income countries,[132] but this spending is often inefficient, and legal compliance is weak (see Section 2.2).

"Vertical" diversification from oil production to refining that is financially viable without any government support would require establishing a downstream petroleum sector fully exposed to international competition. Building refineries may be intuitively appealing for an oil-producing country, but the economic outlook in Angola is not necessarily favorable. The Ministry for Mineral Resources, Petroleum, and Gas (MIREMPET) has awarded a contract to build a refinery in Soyo with a capacity of 100,000 b/d, part of Angola's plan to become self-sufficient in fuel supply. The plan also includes a small refinery in Cabinda expected to come online in 2022, upgrading the existing refinery in Luanda, and a new 200,000 b/d refinery in Lobito, all involving Sonangol. However, as noted above, global demand for refined products is expected to decline in the long run, creating stranded-asset risks. There are also challenges in establishing an internationally competitive refining sector in Sub-Saharan Africa, and these challenges can be overcome only if government support, direct or indirect, is withdrawn entirely.

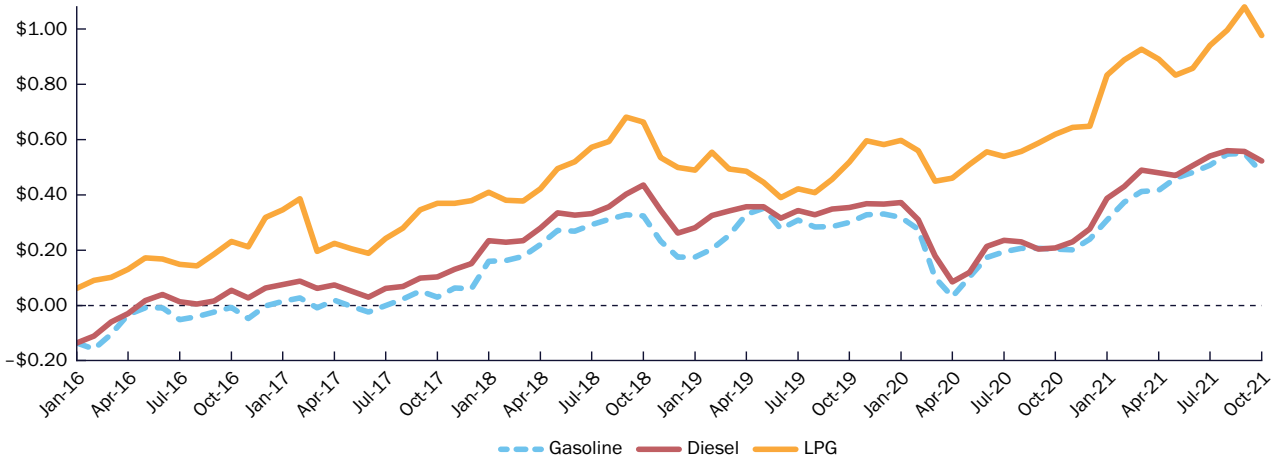
Government efforts to remove competition for domestic refineries could also be economically harmful. A recent decree establishing the legal regime for the downstream sector requires all fuel suppliers to purchase liquid fuels from domestic refineries first. This removes competition, the most effective and proven means of increasing efficiency in the sector. Domestic refineries that are efficient and competitive would not need to be shielded from competition from imports. The new decree appears intended to achieve the Government's goal of self-sufficiency in fuel supply, but likely at a significant cost. It could raise prices paid by consumers, effectively providing a producer subsidy. Revisiting the downstream strategy and exploring diversification toward renewable energy, as described in Section 3, is likely to have greater growth potential—and climate dividends.

4.2 Reforming Fuel Subsidies

Ending price subsidies for fossil fuels is good for the climate and for Government finances. Angola's universal price subsidies for petroleum products in 2021 amounted to about 2.9 percent of GDP,[133] and in the near term, costs are likely to remain high due to high oil prices. Eliminating price subsidies (and ultimately introducing carbon taxation) will promote a more rational use of fossil fuels, resulting in lower consumption and emissions. It will also free up fiscal resources that can be used to finance investments in climate resilience and sustainable economic diversification and development. A key insight from international experience is that making a clear connection between fuel subsidy reform and improved public services, infrastructure, and economic opportunities can increase public support for the reforms.

Fuel prices in Angola have been frozen for years and do not reflect economic opportunity costs. As in many other countries, the subsidies largely favor the rich, who consume more refined products and fuel-intensive goods and services than all other income groups. Against the backdrop of rising global oil prices in local currency, domestic fuel prices in Angola have been fixed in nominal terms since December 2015, imposing large costs on Sonangol, which has been reimbursed only sporadically (see Figure 12). As of November 2022, Angola's gasoline price was 24 percent of the global average, and its diesel price, 20 percent. This also encourages black markets and smuggling.[134]

Figure 12. Fuel price gap in Angola, 2016–2021 (US$ per liter for gasoline/diesel, US$ per kg for LPG)



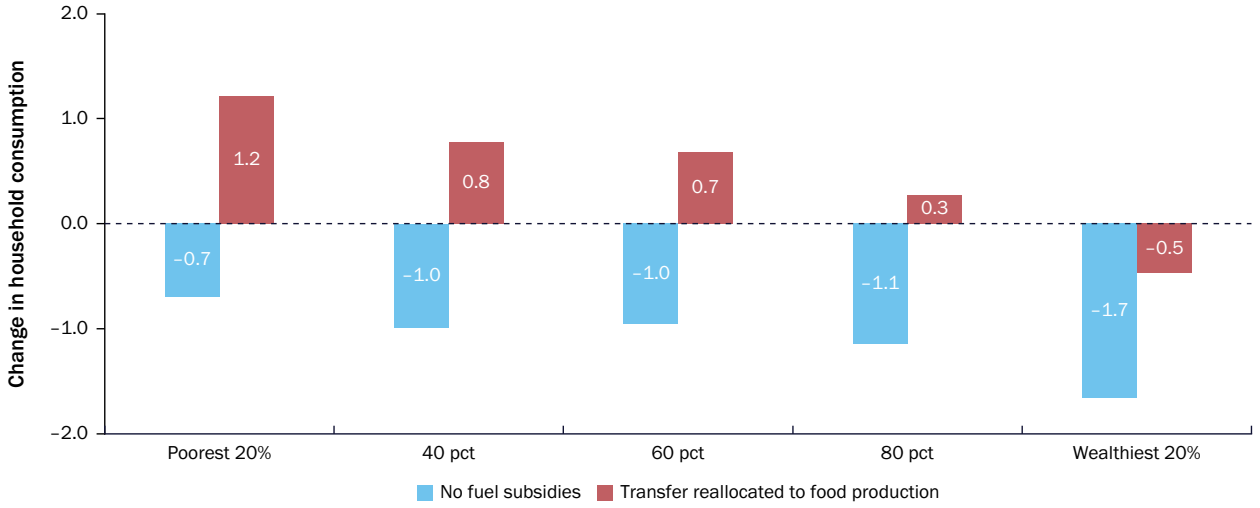
Sources: World Bank estimate (until December 2020), Ministry of Finance (January–October 2021).

Few countries that have undertaken subsidy reform have had initial price gaps as large as those in Angola. The global experience on fuel price reform is that fuel subsidy reforms are often reversed when market-based fuel prices in local currency rise (due to higher global fuel prices, currency depreciation, or both), such as from 2016 to 2019 and again in 2021 and 2022. Prices may be raised insufficiently, for instance, or even frozen, as in Angola since December 2015. A strong, long-term commitment by the Government is thus essential to adjust prices in line with market price movements until they are deregulated. Reforms can be best sustained in a competitive, deregulated fuel market with appropriate rules and health, environment, and safety standards, in which efficiency gains from competition in the market are passed on to consumers in the form of lower prices. As noted above, international experience also highlights the importance of earning the public's trust that the savings from subsidy reforms are being redirected productively to benefit society at large

Although fuel subsidies in Angola are untargeted and therefore highly regressive, the social impacts of their removal still require close attention. The most significant losses from subsidy removal will accrue to fuel smugglers and black marketers, businesses with high dependence on liquid fuels, and those households with the largest consumption of fuels and fuel-intensive goods and services, who are typically at the top of the income distribution.[135] About 80 percent of subsidized fuels purchased by households is consumed by the richest 40 percent[136] of Angolans, with only 9 percent consumed by the bottom 40 percent. Nevertheless, to the extent that the poor purchase fuels, elimination of price subsidies would have material effects. Moreover, the indirect effects of higher fuel prices on passenger and goods transportation can affect all Angolans.

Reform should be accompanied by measures to shield the poor and compensate some losses from subsidy removal. Cash transfers or other measures can be used, ideally through a comprehensive, integrated social protection program to meet the basic needs of the poor and vulnerable; one option is to adapt and expand the Kwenda program (see also Section 3.4). For example, taking the price gaps in 2018 to model subsidy elimination, if the public spending on the fuel subsidy received by households in 2018 had been reallocated toward policies that directly served to increase food production and reduce food prices, the average Angolan family in the poorest 40 percent would have seen an increase in its well-being equivalent to an income boost of 1 percent (Figure 14).

Figure 13. Impact on welfare of households of fuel subsidy removal and repurpose toward increasing food production, by income quintile



Source: World Bank estimates based on AngoSim, IDREA 2018–2019.

4.3 Pricing GHG emissions in Oil and Gas Production

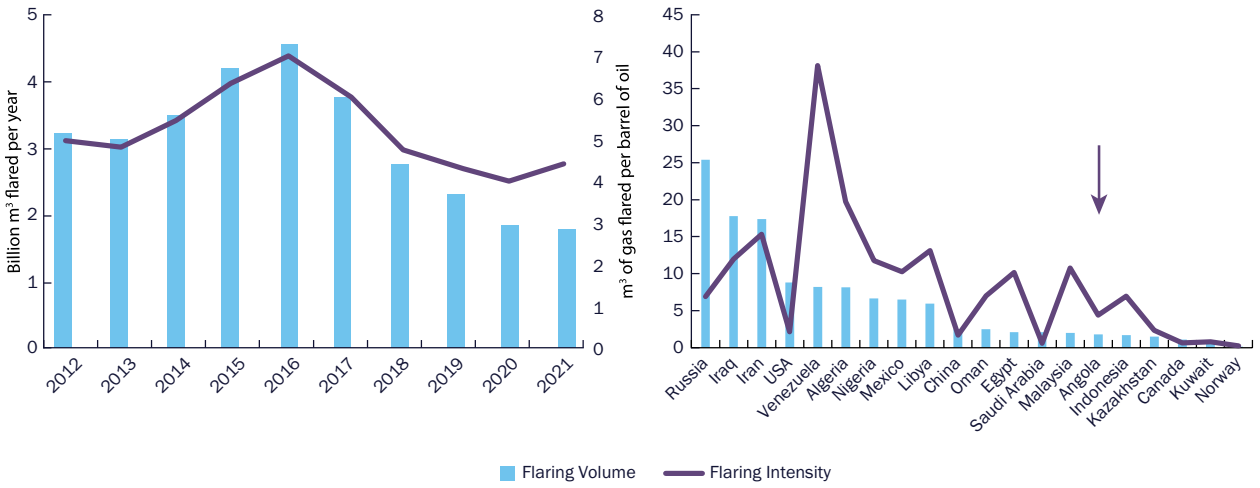
As the world transitions to a low-carbon pathway, Angola needs to reduce its oil and gas sector's carbon footprint to keep it competitive, avoid wasteful investments, and channel revenues into economic diversification. Given Sonangol's limited technical and financial capacity, investments by international oil companies remain the main drivers of production. Those companies are increasingly focused on the climate transition—including minimizing the risk of their assets being stranded and seeking oil and gas production with as low an intensity of GHG emissions as possible. This means the criteria for final investment decisions are likely to become increasingly stringent over time, but there are also new opportunities for Angola.

Angola needs medium- and long-term strategies for its energy sector to cope with a potentially sharp drop in global oil and gas demand. Angola remains Sub-Saharan Africa's second-largest oil producer, after Nigeria but, as discussed in Section 1.1, production has declined in the past decade.[137] Diversifying away from oil and gas would require retraining and redeploying highly skilled workers from oil and gas to future growth sectors—such as wind and solar and hydrogen production from electrolysis of water using renewable energy (see Section 3.2.2). Where feasible, existing oil and gas facilities such as pipelines and platforms can also be repurposed for renewable energy and fuel production or transportation of low-carbon fuels. "Vertical" diversification from oil production to refining, on the other hand, is risky on multiple levels and calls all the more for significant reform of the downstream petroleum sector (see Section 4.1).

Growing interest in oil and gas with low upstream emissions presents opportunities for Angola—if it can bring its levels of gas flaring, venting, and fugitive emissions close to the world's best performers. Recent geopolitical developments have led to a fundamental reconsideration of where oil and gas are sourced, and European governments in particular are seeking new suppliers. However, the European Union has also prioritized reducing GHG emissions along the oil and gas supply chain. World Bank data show that Angola in 2021 flared 4.4 cubic meters (m^3) of associated gas[138] per barrel of oil produced, while Norway flared 0.2 m^3

and Saudi Arabia, 0.6 m^3 (Figure 14). The volume of gas flared in Angola ranked 15th globally in 2021, with the burning of 1.8 billion m^3 of gas producing 4.8 Mt CO2—not including products of incomplete combustion, such as black carbon and unburned methane. Sharply reducing emissions in both oil and gas production would not only help Angola achieve its mitigation objectives and avoid wasting valuable gas, but is in fact crucial to ensuring the competitiveness of Angolan oil and gas and maximizing revenue.

Figure 14. Gas flaring volume (billion m^3) and flaring intensity (m^3/barrel) in Angola, left, and compared with other major oil producers, right.



Source: World Bank Global Gas Flaring Tracker.[139]

Angola has taken steps to reduce emissions in oil production, but more action is needed. The updated NDC specifically mentions flaring,[140] and Article 73 of the 2004 Petroleum Activities Law [141] expressly forbids natural gas flaring, except for short periods for testing or other operating reasons. Oil development plans must provide for use of associated gas, except where oil deposits are marginal or small, in which case MIREMPET may authorize flaring, possibly charging a fee. The law does not mention gas venting or fugitive methane emissions. The volume of gas flared annually has fallen by about 60 percent since 2016 (Figure 12), thanks to Angola LNG (liquefied natural gas) in Soyo, which uses associated gas. However, key oil-producing fields in Angola are offshore, where about 90 percent of gas flaring by volume occurs, and it is much more difficult to commercialize associated gas in offshore than in onshore fields.

GHG emissions can be further reduced by minimizing methane leaks and improving combustion efficiency during non-routine flaring. Not all flaring or venting can be eliminated, because some is needed for safety and other essential operational purposes. Still, it is important to minimize the release of methane during production, transportation, and flaring, as methane has about 30 times the global warming potential of CO_2 over 100 years; incomplete combustion also produces black carbon, a powerful short-lived greenhouse gas. A key action item in the near term is to assess how flaring, venting, and fugitive emissions during oil and gas production can all be minimized, and how gas flows to the LNG facility and the domestic market can be increased without further fugitive emissions. To that end, the regulator can enhance its efforts to enforce the regulatory requirement that oil development and production plans include provisions for utilizing associated gas.

New policy interventions will be needed to realign incentives. Based on the analysis above, this report offers the following recommendations:

Priority Area 1: Strengthen the regulatory framework by introducing a fee for flaring and venting and, over time, for fugitive methane emissions

- The flaring and venting fee needs to be set high enough to incentivize companies to develop and deploy solutions to discontinue both practices and instead capture the gas for productive use, but not so high as to make oil production uneconomic. A gradual ramp-up could help the regulator determine the necessary fee level, while giving oil and gas producers time to adjust.

- Any fee for flaring and venting should be applied equally to all producers, regardless of origin and ownership, to create a level playing field and facilitate sector-wide buy-in.

- Over time, a fee or a tax should be levied on CO_2 and volatile hydrocarbons, covering producers and transporters of both oil and gas.

Priority Area 2: Strengthen enforcement and monitoring capabilities to ensure fees are determined accurately and collected in full and on time, and to explore the creation of other economic incentives

- More can be done to enforce existing regulations banning routine gas flaring and venting in most circumstances and requiring oil development and production plans to use associated gas.

- The regulator in charge of determining and collecting the fees for flaring, venting, and fugitive emissions will need to be adequately resourced and trained to be able to enforce the adjusted regulatory framework in a non-discriminatory manner (see also Section 2.3).

- Freedom from external intervention is a key requirement to ensure impartial enforcement. In particular, no distinction should be made between national and international companies.

Over the medium term, it is important to remove economic distortions and explore where it may be economic to deliver natural gas to the domestic market, targeting replacement of diesel in electricity generation. In this context, it is crucial to instill discipline to ensure full and timely payments by domestic gas purchasers, including power generation companies, and to take care to avoid introducing economic distortions.

4.4 Tapping into Green, Blue, and ESG Debt Opportunities

Growing global demand for financial instruments that meet environmental, social, and governance (ESG) standards means more options for Angola to finance its climate-related investments. Even if Angola can increase Government revenue and free up resources through subsidy reforms (especially on fossil fuels, but also agricultural subsidies, as discussed in Section 3.2.3), it will still need to secure significant amounts of new finance. It also needs to refinance existing debt. Particularly for investments in adaptation and low-carbon development, the Government may wish to explore this still-untapped market segment. ESG integration in emerging markets' bond markets is accelerating, with total ESG debt issuance across all sectors (including sovereign and corporate) exceeding US$230 billion in 2021.[142] The share of ESG bonds in the Emerging Market Eurobond market jumped from 5 percent in 2019 to 16 percent in 2021. ESG Eurobond issuance has skyrocketed, from US$0.8 billion in 2017 to $23 billion in 2021. Costs may not be lower in the short term, but over time there is likely to be an increase in demand for ESG sovereign issuances, and Angola can broaden its investor base with ESG debt issuance.

A first step would be to build Angola's ESG credentials through improved tracking and reporting of social, environmental and governance targets, and to issue some green and/or blue bonds. Green bonds support climate-related or environmental projects, while blue bonds, a subset of green bonds, support projects that contribute to healthy oceans and marine ecosystems. Investors are increasingly focused on the ESG credentials of issuers, who must provide comprehensive reports on the ESG quality of their debt portfolios. Investors typically have a specific mandate to integrate ESG factors in their risk assessment. Angola will thus need to build a pool of eligible projects with measurable key performance indicators (KPIs), and clearly show that the proceeds of any green or blue bonds have been used for the stated purposes. Failing to do that could trigger financial penalties. Within this portfolio, Angola could include projects in renewable energy, water management, reduction of deforestation, climate-smart agriculture, and agroforestry, for example, as well as projects under Angola's Blue Economy Strategy.

Box 3. A changing ecosphere for thematic bonds

The field of sustainable investments has grown greatly since 2015—the year the Paris Agreement and the 2030 Agenda were approved. On the supply side, sovereign issuers have explored thematic bonds and loans and have sought to receive an ESG rating by specialized agencies. These firms provide ESG data and composite ESG indexes that are used by asset managers to construct funds and other investable options. On the demand side, institutional investors have increasingly sought out ESG-rated investments.

The "E" part of ESG investing is the least developed and arguably the most challenging, because there are many standards, codes, data sources, and methodologies necessary to enable green investment, related to GHG emissions, pollution, resource efficiency, and biodiversity, among others.

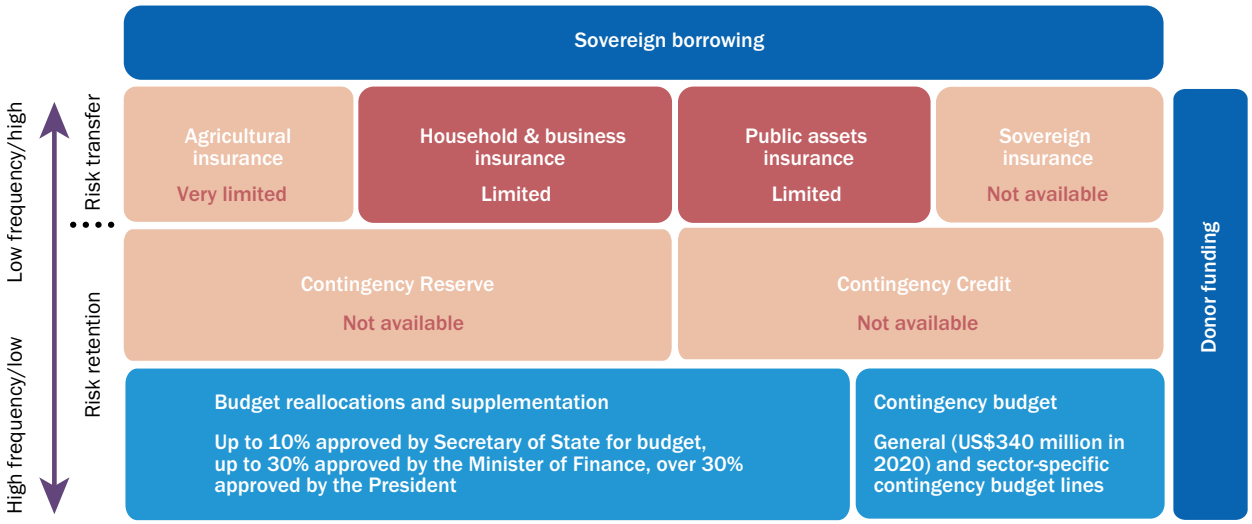
Sovereign debt managers have the opportunity to shape the debate on ESG. There are three key ESG debt management activities: (I) assess the costs and benefits of ESG-related borrowing instruments and their fit with overall debt management strategies; (II) increase ESG engagement through enhanced transparency and accountability; and (III) specialization of activities, formalizing ESG strategies.

Tapping the ESG demand can be complementary to a broader official agenda and helps to send the "signal" to the market. There are many ways for sovereign issuers to work on ESG issues. Building an ESG framework is helpful for nascent markets because ESG aspects can be incorporated in the financing plan, increased transparency for the public, institutional reforms, builds the base for labelled issuance/private sector engagement. Sovereign green bonds is one avenue, but not the only one.

4.5 Developing Climate-Related Disaster Risk Financing

The large and growing scale of economic losses associated with climate-related disasters in Angola calls for a more systematic approach to disaster risk finance. As discussed in Section 3.4, the cost of enhancing social protection—through Kwenda or otherwise—to support communities affected by a climate shock such as a drought can easily reach US$50 million, and is likely to be higher after more severe shocks. Some disasters, such as floods and landslides, may also cause significant damage to infrastructure. Currently, the overwhelming majority of these costs are borne by the Government, as few losses are insured. Donor funding has been low; emergency official development assistance covered only 8 percent of the total cost of disaster relief between 2011 and 2020.[143]

Figure 15. Status of disaster risk finance instruments in Angola



Source: World Bank analysis.

Disaster-related contingent liabilities are not yet explicitly considered within current fiscal risk analysis practices, though the Government recognizes the importance of doing so moving forward. The Macro-Fiscal Programming Unit within the Ministry of Finance (MinFin), which is the unit responsible for monitoring risks to the budget, fiscal targets, and debt sustainability, does not yet have a framework to explicitly address the risk from disaster-related contingent liabilities. Figure 15 shows the disaster risk finance (DRF) instruments that are now available, and to what extent. It is expected that the current fiscal risk management practices will be strengthened as part of ongoing public financial management reforms (see Section 2). Streamlining climate-related fiscal risk assessments as part of these efforts would help increase the public sector's resilience to shocks.

Currently, post-disaster interventions in Angola are mainly financed through risk retention budgetary instruments after disasters occur. However, the annual budget is often insufficient to meet disaster response needs. The Government mainly relies on budget reallocations and supplementation with extraordinary credits. In the last five years, the Government has presented three revised budgets (2015, 2016, and 2019). Between 2015 and 2020, AoA 27.3 billion was approved for disaster response, but only AoA 6.8 billion was paid. Similarly, AoA 6.3 billion was approved for support to people affected by disasters, but only AoA 1.2 billion was paid. Total expenditures for disaster response represent 0.01 percent of GDP, on average.[144] The Treasury also operates a contingency budget for unforeseen expenditures, including those arising from climate shocks. Contingent credit instruments and multi-year disaster reserves are not in place. The Sovereign Wealth Fund, established in 2012, does not have a mandate to finance post-disaster interventions, but in 2020, US$1.5 billion was withdrawn to support the Treasury in the response to the COVID-19 pandemic.

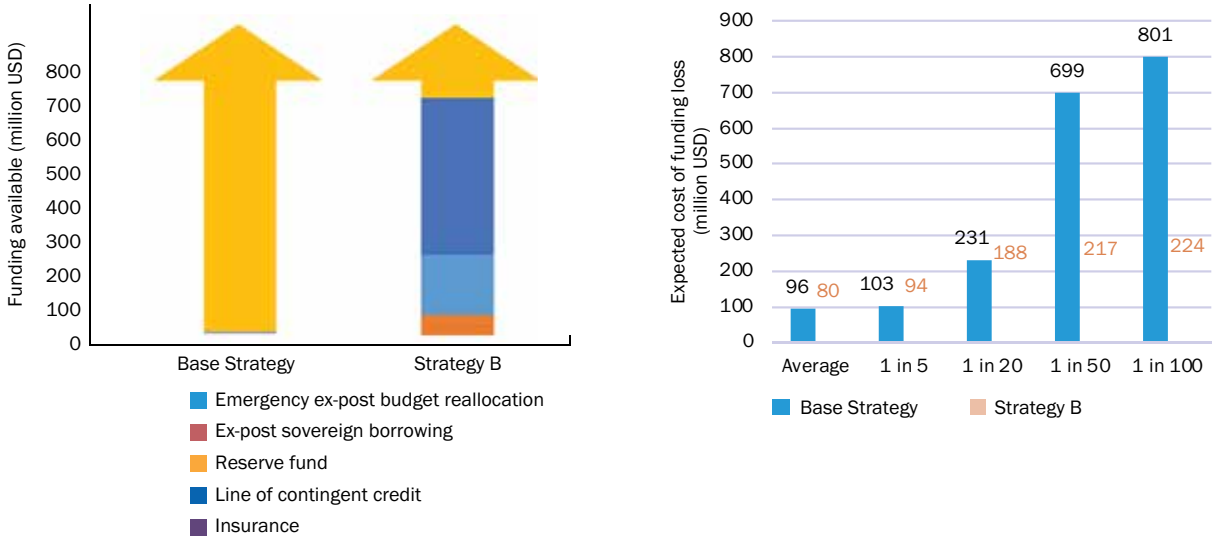
Overreliance on risk retention, with little to no use of risk transfer, does not protect Angola well from climate shocks. The current approach offers low financial protection and can work with small frequent shocks, but is ineffective with medium or large shocks. Insurance of public assets is mandatory in some sectors, and government units may allocate resources for insurance premiums using specific budget lines. However, overall, insurance penetration is low, and neither climate sovereign insurance nor other market-based instruments have been used to fund post-disaster interventions. Risk retention mechanisms tend to

be slow, and the budget is left exposed, which may compromise development plans across multiple sectors. The Ministry of Finance recognizes the need for a more comprehensive set of financing instruments, and the local insurance market has appetite and capacity to absorb more risk.[145] Opportunities for risk transfer could thus be considered as part of a comprehensive disaster risk financing strategy.

Funding mobilization for post-disaster interventions is centralized. Funding requests for post-disaster interventions are submitted to MinFin by central-level sectoral institutions or by a multisectoral commission. MinFin assesses the proposals, identifies funding sources, and formalizes the approved budget allocation. Budget supplementation and reallocation require approval at different executive levels depending on the amounts requested, but overall the process seems agile and can be expedited, depending on the severity of the event. On the other hand, the current institutional framework for disaster response can be strengthened by clearly defining processes and responsibilities beyond the emergency response and by institutionalizing principles of risk reduction and resilient reconstruction in the execution of disaster-related public spending.

A risk-layered financing strategy would be more cost-efficient, on average and for more extreme shock events, than Angola's current approach.[146] The Government could develop a risk financing strategy and prearrange multiple financial instruments that balance risk retention and risk transfer (risk layering). The option modeled for this approach includes a reserve fund to cover costs of mild events, and a line of contingent credit for severe events and insurance for severe to extreme events. Compared with the current financing approach (Base strategy), a risk-layered approach would yield considerable savings, particularly during uncommon, but very severe events. For example, the projected savings in a 1-in-50-year event would be about 68 percent (US$482 million on average), and in a 1-in-100-year event, 71 percent (US$577 million on average).

Figure 16. Effect of risk-layered approach on the cost of covering disaster losses



Source: World Bank modeling analysis.

Based on that analysis, this report makes two key recommendations (see also Section 3.4.1):

Priority Area 1: Strengthen financial planning and pre-arrange resources for disaster response

- Develop an integrated disaster risk financing strategy to determine priority sectors, assets and populations for financial protection, and a risk-layering strategy for financing disaster response.

- Strengthen the technical capacity of MinFin to assess contingent liability and manage climate related fiscal risk.

- Strengthen the legal and institutional frameworks for disaster risk financing.

- Develop a national database on the occurrence and impacts of climate-related disasters as an evidence base to continually refine the disaster risk financing strategy.

- Develop an expenditure tracking system for disaster and crisis response to ensure that the public financial management system accounts for post-disaster spending on an annual basis.

Priority Area 2: Develop financial markets for disaster risk financing

- Consider developing national insurance programs for agriculture and public infrastructure and a financial protection scheme for micro, small and medium-size enterprises (MSMEs).

- Deepen financial inclusion to enable household financial resilience by (i) exploring the use of simplified accounts to drive utilization of risk management products and other innovations, and (ii) increasing the penetration rate of insurance in urban areas to mitigate rising flood impacts.

- Assess the regulatory environment and required building blocks for the issuance of green and blue bonds and disaster-related financial instruments (catastrophe bonds, swaps and weather derivatives).

Miradouro da Lua, Angola © Luis Portugal/iStock.com

5

Operationalizing Climate-Resilient Development Pathways in Angola

5. Operationalizing Climate-Resilient Development Pathways in Angola

Angola faces significant challenges due to climate change, but it also has important assets that, with dedicated support from its global partners, can enable it to build a climate-resilient, sustainable, and prosperous future. Drawing on the insights and recommendations presented in the preceding sections, this section identifies a set of priority actions for operationalizing the pathways towards climate resilient development, starting with foundational, cross-cutting reforms of policies and institutions. While a number of priority investments have been identified, reforms of policies and institutions are either preconditions for, or highly conducive to, realizing investments under the pathways.

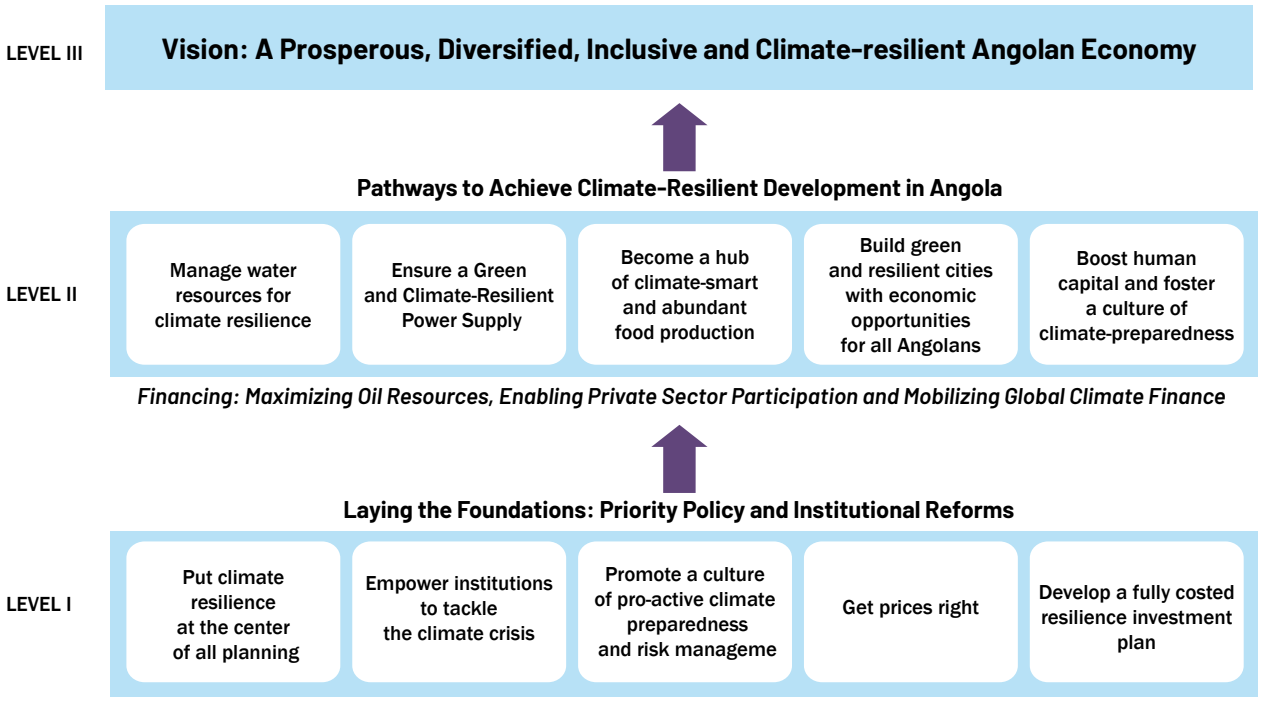
5.1 Foundations of Angola's Climate-Resilient Development

Shifting from today's oil-centered economy to a climate-resilient, diversified and inclusive economic growth model in Angola is a multi-pronged process. The first layer is to embrace a vision to embed proactive climate risk management at the heart of policy making and use it to guide strategic planning. All sector and national planning processes should start by asking, "What new climate risks and opportunities do we need to adapt to, and what do we adapt towards?" Angola will then need a systematic approach to lay a strong foundation, including institutional investments, policy reforms, and investments to achieve climate-resilience.

The Angolan government has been incorporating climate action in its high-level planning and strategies for several years. The Angola 2025 National Long Term Development Strategy, adopted in 2007, cites climate change as a cross-cutting concern, and the 2018–2022 National Development Plan (NDP) provides a framework for climate action. In 2021, Angola approved an updated version of its National Strategy for Climate Change (ENAC) that connects adaptation and mitigation with poverty eradication. However, Angola lacks an overarching national legal framework on climate change to ensure adequate implementation and track progress. Moreover, national budget processes, investment planning, and fiscal management, all of which are crucial to successful climate action, need to be strengthened and made more accountable and transparent.

The proposed framework for operationalizing climate-resilient development classifies interventions into three tiers (Figure 17). At the bottom are "foundational" activities aimed at creating an enabling environment. The report's recommendations in these areas deal with strengthening institutions and legal and regulatory frameworks in ways that are either preconditions for, or highly conducive to, investment opportunities at Level II, which focus on investments under the five pathways that will help to deliver the vision for a prosperous, diversified, inclusive, and climate-resilient future Angolan economy.

Figure 17. Framework for operationalizing climate-resilient development in Angola



Angola's vision of climate-resilient development, expressed in the ENAC, the NDC, and the upcoming NDP, will guide all actions and help sustain the momentum needed for the climate transition. This vision succeeds best when it percolates through all levels of government and into all corners of society as a shared culture of sustainability, as discussed in Section 3.5.

People will be at the heart of Angola's transformation: from cabinet-level ministers developing new sector strategies, to fiscal managers providing good stewardship of resources, to farmers adopting climate-smart agriculture techniques, to youth advocating for climate action. That is why this report repeatedly highlights capacity-building, education, and investments in human capital.

Information is crucial for effective planning and decision-making. From hydrometeorological data and models, to information on the vulnerability of key natural capital assets (fish stocks, soil health, forest cover), improved tracking of pests and diseases, GHG emissions, and climate-linked expenditures and investment, reliable and transparent data will help both public and private actors to make smarter choices and use resources more efficiently. Thus, mastery of information collection, storage, and analysis, along with a sound digital strategy, emerges as a cross-cutting success factor for many of the CCDR recommendations.

Finally, financing in its many types (debt, equity, grants, guarantees, etc.) and from all available sources, is a key enabling factor of climate-resilient development. Public financing alone will be insufficient; private sector flows will need to be mobilized at scale to finance adaptation investments where a return on investment can be derived.

5.2 Priorities for Action and Opportunities for Impact

With this framework, the report concludes with five priorities for action that Angola can implement in the next three to five years:

1. Put climate resilience at the center of all planning, integrating climate risks and adaptation measures into all sectoral plans and strategies, the medium-term fiscal strategy, and territorial planning instruments. Sectoral, national, and subnational planners need to ask, "What new climate risks/opportunities do we need to adapt to, and what can we adapt towards?" The next National Development Plan can propose an integrated package of climate resilience investments, policy reforms, and institutional changes. The Ministries of Economic and Planning and Finance play a key role and can lead an inter-ministerial coordination structure with specific responsibilities and timelines for line ministries engaged in implementing climate action. Planning is especially critical in the climate-sensitive water sector, to address competing demands amid growing variability. Finally, public investment management needs to be strengthened and made more climate-responsive, employing mandatory assessment of new investment projects in line with national climate priorities.

2. Empower key government institutions to tackle the climate crisis, ensuring adequate financial and human resources. Professional and well-trained staff and adequate resources are both critical. Across all sectors analyzed in this CCDR, existing capacities will need to be enhanced to tackle the new exigencies of climate risk management. Data are also essential, as such it will be critical to bolster the National Hydrometeorological Agency (INAMET), mandated to monitor and predict climate risks, as well as related agencies involved in early warning/early action systems.

3. Promote a culture of proactive risk management and climate preparedness. Such a shift is crucial in a world where multiple sequential and often overlapping crises are the "new normal." As basic services improve, they need to incorporate disaster preparedness plans. Mainstreaming climate-related disaster risk management, including through better early warning systems, will reduce the costs and shorten the response time when disasters hit. Finally, Angola needs to have the financing in place to deal promptly with climate-related disasters, while avoiding a large diversion of expenditures from its development priorities through financial planning and pre-arranged disaster contingency resources.

4. Get prices right to pave the way for private sector participation, improve economic efficiency, and generate additional resources for investment in climate resilience. A key example is reforming fuel pricing while providing compensation to the poor and lower middle class, which will create fiscal space, reduce waste in fuel consumption, and open the way for a competitive refining sector. Gas flaring needs to be priced (taxed) to reflect its social costs. This requires strengthening the regulatory framework for controlling gas flaring and fugitive emissions by introducing a fee for flaring and venting, and over time for fugitive methane emissions. In parallel, enforcement capabilities need to be strengthened to ensure accurate fee determination and its timely and full collection.

5. Jointly develop a fully costed resilience investment plan through collaboration between the Ministry of Finance and the Ministry of the Economy and Planning. A key next step from this CCDR is to develop a costed investment plan that identifies the full set of priority investments and financing sources. Because achieving climate resilience is a cross-cutting issue requiring coordination across the Government, these two ministries play central roles in strategically allocating limited resources. Before committing to large investments, ministries will need to fully understand the tradeoffs between investment choices and develop a comprehensive portfolio of climate resilience projects, with clear public and private financing sources identified to fund them.

Table 4 provides a summary of priority investments in specific sectors, as well as important related policy reforms. We hope that the insights and recommendations provided by this CCDR can provide a strong foundation for Angola to develop a national climate resilience investment plan and a climate-informed National Development Plan 2023–2027.

Table 4. Summary of priority investments and reforms under each pathway

Pathway	Priority investments	Priority reforms			
		Climate at the center of planning	**Strengthen institutions**	**Proactive risk management**	**Get prices right**
Water Resilience	Expand access to clean water and sanitation across rural and peri-urban areas nation-wide ($1B) Invest in Greater Luanda's resilience by implementing the Luanda Province Water and Sanitation Master Plan ($1B) Fund rehabilitation and sustainable operation and maintenance of dams and water resources infrastructure ($600M)	Prepare comprehensive strategy for water storage at basin level, integrating watershed, groundwater, and surface storage For this, invest in groundwater studies and promote nature-based solutions (NBS), such as soil and water conservation measures, sand dams, and managed aquifer recharge, to maximize "sponge" effect of watershed, mitigate flood risks and store water for dry periods	Strengthen river basin admin offices and councils, including capacity to monitor and allocate resources Enhance technical and financial capacities within the Ministry of Energy and Water (MINEA) for dam operation and maintenance Professionalize provincial water and sanitation utilities Strengthen IRSEA, the electricity and water services regulator, for a well-functioning sector	Implement municipal water plans that integrate local supply with local water management Implement drought preparedness and contingency plans for river basins and for all provincial water and sanitation utilities in Angola	Implement the bulk water abstraction tariff to help promote the rational use of water resources Electricity and water tariffs to ensure the financial sustainability of the utilities and the provision of an improved and reliable service
Renewable Energy	Expand and densify transmission and distribution grid, and interconnect the northern-central, southern, and eastern regional systems to allow clean energy from hydropower to reach South and East (~US$3 billion in transmission, $2 billion in distribution grid expansion and densification, and another US$13 billion in off-grid will be needed to increase electricity access rate to 77 percent by 2030 Develop cross-border transmission lines to tap into South African Power Pool	Complete a climate-adjusted Power Sector Master Plan Adopt a National Electrification Strategy based on least-cost technical solutions Explore green hydrogen potential	Improve the distributor's (ENDE) operation and commercial performance Strengthen enabling environment for private sector investment in solar and wind energy to diversify the energy mix	Adopt state-of-the-art methodologies and tools for power system operation and expansion planning (savings estimated at < US$11 million per year)	Electricity and water tariffs to ensure the financial sustainability of the utilities and the provision of an improved and reliable service
Climate-Smart Agriculture & Fisheries	Rehabilitate old irrigation perimeters and infrastructure and build flexible, decentralized systems for farmer-led irrigation development Build drainage and flood mitigation infrastructure Invest in climate-smart agriculture (CSA)	Scale up CSA to restore degraded landscapes, stem deforestation and biodiversity loss, and advance climate goals, while supplying diverse products for consumption and income	Strengthen agricultural extension services Establish network of marine protected areas covering >10% of Angola's exclusive economic zone Improve transparency and statistics in the fisheries sector	Facilitate farmer access to risk management tools such as insurance programs, especially weather index insurance	Repurpose agricultural subsidies to promote climate-smart agriculture
Green & Resilient Cities	Invest in comprehensive solid waste management systems to curb methane emissions, reduce flooding, and improve quality of life Implement urban resilience measures (risk analyses, risk maps integration into territorial plans, inspection and enforcement) Flood early warning systems, especially for coastal zones	Promote risk-informed urban planning and sectoral coordination, while building the resilience of vulnerable populations Adopt NBS for flood and landslide protection	Set national standards for urban development that promote more efficient, sustainable, and inclusive urban growth, with budget support, coordination and capacity-building Enhance capacities for coordinated planning across sectors to boost resilience	Support subnational governments to coordinate resilience planning across sectors	Mobilize private capital to accelerate adoption of critically needed infrastructure Public-private partnerships to improve service delivery Build a circular economy, minimizing waste
Human Capital	Expand Kwenda to reach all the poorest households and incorporate adaptive features Invest in jobs and economic inclusion programs to train workers for a green economy and build resilience Raise a climate-conscious generation, starting in the early years	Incorporate climate-considerations in health sector and provincial health plans Provide cross-ministerial coordination and develop national and subnational mechanisms for action on climate-related health impacts	Enhance capacities to identify climate-related health risks and provide care even during extreme events Improve climate research capacity and build a strong local R&D sector with a vibrant local climate research industry	Agile adaptive social safety net programs can respond quickly to crises Add climate skills agenda under the strategic plan for the future of tertiary education	Develop an investment strategy for climate and human capital actions, and allocate funding for adaptation measures within key sector budgets

Endnotes

1 See World Bank data for GDP (current US$): https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=ZG.

2 See World Bank data for GNI per capita, Atlas method (current US$): https://data.worldbank.org/indicator/NY.GNP.PCAP.CD.

3 See World Bank data for Gini index: https://data.worldbank.org/indicator/SI.POV.GINI?locations=AO. This is up from 42.7 in 2008.

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45 The probable maximum loss (PML) is the value of the largest loss that could result from a disaster in a defined return period—in this case, 10 years.

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