AFRICAN INSTITUTE FOR CLIMATE,
TRADE AND ECONOMIC MODELLING

CLIMATE STATUS REPORT

Africa Synthesis

An integrated assessment of African countries climate position, emissions profile, and the economic effects of adaptation and mitigation options to 2050.

AICTEM CLIMATE STATUS REPORT

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Models: CDCGE (GTAP 11 multi-region CGE) + DICE climate

Key datasets: GTAP and EMERGING

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Abstract. This report synthesises the climate position, emissions profile and the economics of adaptation and mitigation across Africa to 2050, drawing on the individual AICTEM country assessments. It combines documentary climate and emissions evidence with the CSTATUS land-use carbon module and the CD-CGE computable general equilibrium model coupled to a DICE-type climate module. The continent-wide findings are consistent: unmanaged warming damage falls hardest on rural livelihoods and food security; planned, water- and infrastructure-led adaptation recovers most of that loss; carbon pricing cuts energy emissions at a modest, revenue-recyclable cost along a convex abatement curve; and unilateral pricing leaks abroad, so border carbon adjustment helps sustain ambition. Computation of the least-cost way to attain the NDC targets is well grounded, using an optimisation methodology across the various adaptation and mitigation levers. Across economies, both agendas reduce to redirecting investment toward resilient, low-carbon capital; model results are structural and relative, not calendar-dated forecasts.

Contents

Executive summary

Africa faces a double bind: it has contributed least to global warming yet is among the most exposed to its consequences, and it confronts both an adaptation and a mitigation finance gap of a scale its own budgets cannot close. This report synthesises the AICTEM Climate Status Reports for 51 African economies, together with a continental CDCGE computable-general-equilibrium and CSTATUS CO_2 footprint diagnostic, grouping the continent into **seven climate-challenge regions** (Figure 1) defined by shared hazard and emissions structure rather than by political bloc. Its findings are directional — the trustworthy content is the ranking, regional pattern and approximate magnitude of effects — but they are consistent and policy-relevant.

The physical challenge is real and unevenly distributed. Africa is warming faster than the global mean in several sub-regions, and the binding hazard differs by geography: drought and desertification across the Sahel and the Horn; drought, cyclones and "Day-Zero" water stress in Southern Africa; coastal flooding and erosion along the Gulf of Guinea; forest-carbon stewardship in the Congo Basin; acute heat and water scarcity in North Africa; and sea-level rise for the island states. These rainfall and aridity geographies, more than national borders, organise where the report's risks bind hardest.

Adaptation pays, and the same package works everywhere. Unmanaged climate damage lowers rural incomes by roughly 8–13% by 2050 across the modelled economies. The single most robust and transferable result in the report is that a **planned, water- and infrastructure-led disaster-risk-reduction (DRR) package roughly halves that loss in every region** (Table 1, Figures 3 and 2), compressing the residual to about 3.4–3.8% outside North Africa. But these are public goods the market under-provides, so adaptation must be *publicly financed and front-loaded*: protection bought early is worth far more than the same protection bought late.

Mitigation is low-cost in GDP terms, but carbon pricing reaches only part of the pledge. With carbon revenue recycled, the general-equilibrium GDP cost of meeting the *energy* component of the NDC is small — between roughly zero and one percent of GDP, and mildly positive in several regions. The continent splits sharply by emissions structure: fossil-grid economies (North and Southern Africa, oil and gas exporters) raise large carbon revenue (about 6% of GDP in North Africa) and can largely self-finance their energy NDC, while hydro- and biomass-reliant economies (much of East Africa, median carbon revenue ∼1.5% of GDP) have a thin base to tax. The no-regret tonnes — efficiency, renewable support, fossil-subsidy and gas-flaring reform — should be exhausted before the expensive last tonnes (Section 5).

Most African NDCs lie beyond the reach of energy carbon pricing. African pledges are ambitious — a mean conditional target of about **37% below business-as-usual** — and overwhelmingly conditional on international support. Yet **only a minority of conditional NDCs are attainable within a $200/t energy carbon price** (Figure 5); the remainder are dominated by land-use and forestry abatement that no domestic energy price can deliver, so they require REDD+, agriculture and forest-protection finance rather than carbon pricing. The median energy carbon price required is high (∼$122/t), but the residual conditional financing gap, after domestic revenue is recycled, is modest in GDP terms (∼0.5% of GDP per year) — concentrated in the thin-revenue drylands and small-island states (Section 6, Table 4, Figure 10). A least-cost *pathway* optimiser run across the full energy-lever set — a carbon-price ladder together with renewables, electrification and a border adjustment — sharpens the picture (Section 7): **17 of 51 pledges are fully deliverable on energy instruments and 34 are energy-limited**, the deepest (forest) pledges least of all; but the deliverable share is **largely no-regret** — in 36 of 51 economies renewables or electrification cut emissions while *raising* GDP. The implied sequencing rule is uniform: exhaust the win-win energy tonnes first, price carbon modestly and recycle the revenue, and route the land-use majority of the pledge through forest and agricultural finance (Table 5, Figures 12 and 13).

The policy implication is a differentiated, twin-track strategy. Adaptation should be publicly financed and front-loaded; mitigation should be sequenced and revenue-recycled where the energy base allows. The continental finance architecture must match instruments to needs: domestic carbon revenue for the self-financing energy core; grants and concessional climate finance for the land-use and adaptation measures that markets will not fund; blended private capital for bankable renewables; and Article 6 used to *fund* ambition above the core, not to sell off the cheap tonnes countries must claim for their own pledges. For an oil- or coal-anchored economy the NDC and the diversification agenda are the same problem. For the forest basins, results-based forest payments are decisive. For the islands and the Sahel, external support is the binding constraint. Africa's NDCs are deliverable, but only with a financing settlement that treats climate finance as the lever that re-tools the continent's economies, not as a cost imposed on already-strained budgets *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

1. Introduction

Africa bears the climate problem it largely did not create. The continent's 1.4 billion people have contributed only a small fraction of the cumulative greenhouse gases now warming the planet, yet they face some of the sharpest consequences: intensifying drought across the Sahel and the Horn, accelerating sea-level rise around low-lying coasts and islands, erratic monsoons that destabilise rain-fed agriculture, and heat extremes that cut into labour productivity and public health. High physical vulnerability set against low historical responsibility defines both the moral and the analytical starting point of this report. That asymmetry is compounded by a second one of capacity: the public resources, concessional finance, and institutional bandwidth available to manage climate risk are thinnest exactly where the risk is greatest. Africa faces a *double exposure* — to the physical hazard itself and to the financing burden of responding to it.

This report draws together fifty-one country-level AICTEM climate assessments into a single comparative diagnostic, and overlays them with a continental CDCGE computable-general-equilibrium and CSTATUS carbon-status analysis built from a harmonised multi-regional input–output and land-use dataset and the national NDC registry *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*. The country assessments supply the granular, locally validated picture; the continental model supplies a consistent yardstick — the same marginal-abatement logic, the same general-equilibrium accounting of carbon revenue and GDP cost, and the same damage-and-adaptation framework applied to every economy. Together, they allow questions that no single-country study can answer: how deep are Africa's mitigation pledges relative to what carbon pricing can actually deliver; how large is the residual financing gap once domestic instruments are exhausted; and how much of the projected damage to rural livelihoods a disciplined adaptation package can avert.

1.1 A region-based reading of the continent

Africa is not one climate problem but several. To make the synthesis analytically honest we group the fifty-one economies into seven climate-challenge regions that share hazard profiles, emission structures, and adaptation needs: North Africa (5 economies); the Sahel and West African drylands (7); the Gulf of Guinea coastal and forest belt (9); Central Africa and the Congo Basin forest (6); the Horn and East Africa (9); Southern Africa (10); and the island and small-island states (5). These groupings cut across the conventional sub-regional blocs deliberately, because the binding climate constraint — dryland desiccation, coastal inundation, forest-carbon stewardship, or fossil-grid lock-in — travels with geography and economic structure more faithfully than with political boundaries. The regional medians reported throughout, summarised in Table 4 and Table 1, are deliberately robust to outliers, so that a single large or atypical economy does not distort the continental story.

1.2 Report structure

The continental climate profile and physical-risk landscape in Sections 2 and 3 establish the hazard baseline. Section 4 quantifies the damage to rural incomes under an unmitigated trajectory and the residual once a DRR adaptation package is deployed (Figure 3). Section 5 examines the depth and reachability of conditional NDC pledges, the carbon price needed to meet them, and the general-equilibrium GDP cost once carbon revenue is recycled (Figures 6 and 7). Section 6 sizes the conditional financing gap by region (Figure 11). Sections 7 and 8 distil the continental key messages and a forward-looking policy conclusion.

1.3 Methods and limits

The continental model is a directional diagnostic, not a forecast. Its value lies in comparability and the consistent accounting of trade-offs across fifty-one economies, not in point precision for any one of them; readers seeking calibrated national projections should consult the underlying country assessments. Three limits matter. First, the carbon-pricing results cover *energy* CO_2 only. A large share of African mitigation potential, and of several countries' headline pledges, resides in land use, land-use change and forestry — the Congo Basin above all — which a domestic energy carbon price cannot reach. Where a conditional NDC is dominated by land-use abatement, it will appear here as unreachable within any plausible energy carbon price; that reflects the instrument's coverage, not a judgement on the pledge *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*. Second, the general-equilibrium results assume carbon revenue is recycled domestically; without recycling, the GDP costs would be materially larger. Third, where individual country-period solves did not converge, those periods are masked rather than imputed, and the reported statistics are medians across the converged set. Two economies are excluded: Comoros, whose emissions are anchored to a bloc aggregate with no per-country marginal-abatement curve, and Libya, which has no quantified NDC *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*. These boundaries are stated plainly so that the strength of the synthesis — a like-for-like comparison across an entire continent — is not confused with a precision it does not claim.

2. Climate profile of Africa

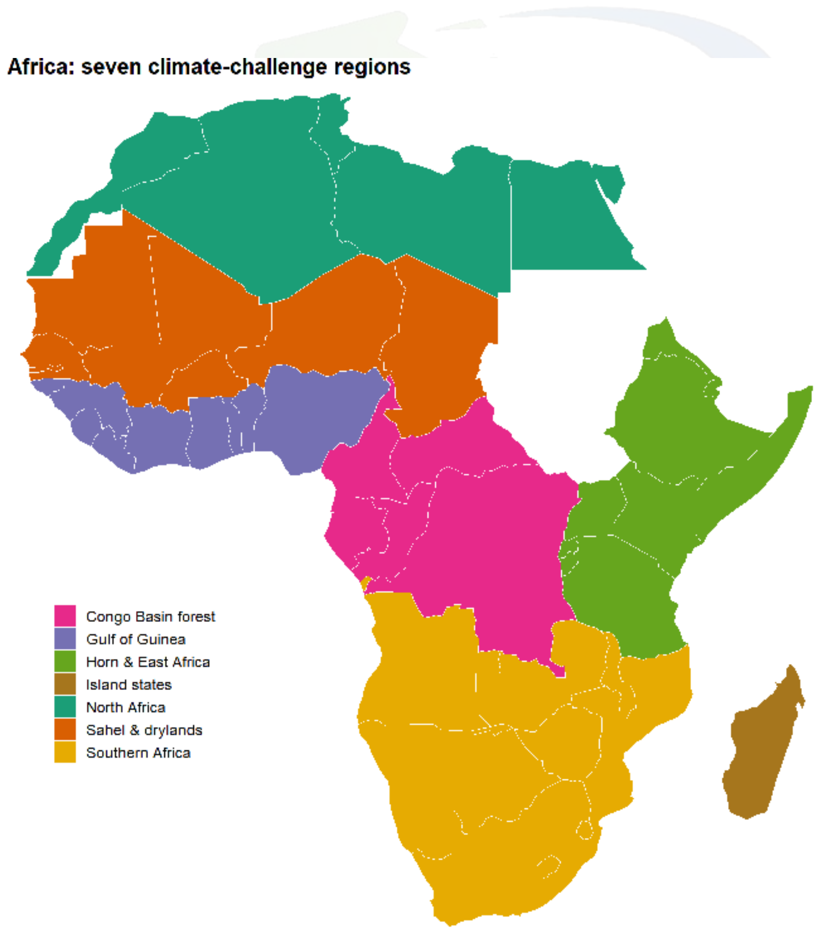

Figure 1: The seven climate-challenge regions used throughout this report, grouping the continent's economies by shared hazard profile and emissions structure rather than by political bloc. The small-island states (Cabo Verde, Comoros, Mauritius, Sao Tome and Principe, Seychelles) are not rendered at this scale *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

Africa spans roughly 70 degrees of latitude, from the Mediterranean shore at Cap Blanc to the cold-temperate tip of the Cape, straddling the equator almost symmetrically. That reach gives the continent one of the most varied physical-climate geographies on Earth: humid rainforest at the centre, flanked by savannas, then the great deserts, and finally narrow temperate margins north and south. Beneath this diversity runs a single unifying dynamic — the seasonal migration of the Inter-Tropical Convergence Zone (ITCZ) — and a sobering common trend: several sub-regions are warming faster than the global mean, even though Africa has contributed least to the problem. This section sets out the physical baseline against which the hazard, adaptation and mitigation analyses of the report are read, organised around the seven climate-challenge regions used throughout.

2.1 The major climate zones

Under the Köppen-Geiger classification, Africa is dominated by just three primary climate types — arid (B), tropical (A) and temperate (C) — with arid covering the largest share of land area, followed by tropical and then a thin temperate fringe (Peel et al., 2007). The spatial logic is best read against the Köppen-Geiger map of Africa (Beck et al., 2018) and the IPCC AR6 WGI reference-region map (IPCC, 2021), which together frame the regional discussion below.

At the centre lies the **equatorial Congo Basin rainforest**, a tropical rainforest (Af) and monsoon (Am) belt of near-perennial convective rainfall, year-round cloud cover, and minimal seasonal temperature range — the second-largest contiguous rainforest on the planet and the anchor of the report's Central Africa / Congo Basin forest region. Radiating outward, the rainforest gives way to the **Sudano-Sahelian and East African savannas** (tropical wet-and-dry, Aw), the seasonally rainy grasslands and woodlands that dominate the Sahel and West African drylands, the Gulf of Guinea hinterland, and much of the Horn and East Africa. Beyond the savannas lie the **great deserts**: the Sahara in the north — the largest hot desert on Earth and the physical core of the North Africa region — and the Kalahari and Namib in the south, the latter one of the oldest and driest coastal deserts anywhere, both hot-arid (BWh) and concentrating the continent's highest solar irradiance. The continent's only substantial **temperate margins** are the Mediterranean (Csa) littoral of the north — the wet-winter, dry-summer coasts of Morocco, Algeria, Tunisia and northern Egypt — and the climatically analogous Mediterranean Cape of South Africa, together with the humid-subtropical eastern seaboard. Cutting across this zonal scheme are the **Ethiopian and East African highlands**, where altitude overrides latitude to produce temperate Cwb and Cwa climates — cool, seasonally wet uplands that are the water towers of the Nile and the East African lakes and that host dense, climate-sensitive rural populations.

2.2 Rainfall regimes and the ITCZ

Africa's rainfall is governed first and foremost by the meridional migration of the ITCZ, the convergence band that the seasonal rainfall maximum follows from south to north and back: from Zimbabwe and central Mozambique during the austral summer to the Saharan margin near 15°N during the boreal summer (IPCC, 2021). This single dynamic produces two contrasting regimes that matter directly for agricultural risk.

The first is the **unimodal monsoon** of the Sahel and West Africa, where the ITCZ delivers a single concentrated wet season: the Sahel receives on the order of 90% of its mean annual rainfall in the June–September window as the convergence band reaches its northernmost position, leaving the rest of the year effectively dry (Nicholson, 2017). The narrowness of this window makes Sahelian and West African dryland agriculture acutely vulnerable to onset shifts and intra-seasonal dry spells. The second is the **bimodal regime** of the Horn and equatorial East Africa, where the twice-yearly passage of the ITCZ across the equator yields two distinct rainy seasons — the "long rains" of March–May and the "short rains" of October–December (Wainwright et al., 2023). The Congo Basin itself sits close enough to the equator to receive rain in most months, while Southern Africa reverts to a unimodal austral-summer regime peaking December–February. These rainfall geographies, more than national borders, define where the report's drought, flood, and rain-fed-agriculture hazards bind hardest.

2.3 Temperature and observed warming

The continent is warming, and in places faster than the world as a whole. Over 1991–2023 Africa warmed at about +0.3°C per decade, slightly above the global average, with the most rapid warming in **North Africa** at roughly +0.4°C per decade — up from +0.2°C per decade over 1961–1990 — and the slowest, around +0.2°C per decade, in Southern Africa (WMO, 2024). The year 2023 was about 0.61°C above the 1991–2020 mean and 1.23°C above the 1961–1990 baseline, and the warmest year on record in several countries including Mali, Morocco, Tanzania and Uganda. The northern margin bore the most extreme heat: Tunis reached 49.0°C and Agadir 50.4°C during the July–August heatwaves of that year (WMO, 2024). Warming is therefore not uniform: it is fastest in the already-arid North, and its compounding effect on evaporative demand intensifies the drought exposure that the report's adaptation analysis quantifies as a loss of rural income.

2.4 Key physical drivers: ENSO, the IOD, and sea-level rise

Year-to-year variability around these means is governed largely by tropical Indo-Pacific modes. The **El Nino–Southern Oscillation (ENSO)** and the **Indian Ocean Dipole (IOD)** jointly modulate African rainfall, and CMIP6 models reproduce the broad spatial structure of both modes with medium confidence (IPCC, 2021). Their teleconnections are regionally opposed: El Nino events are generally associated with suppressed rainfall and drought in Southern Africa during the austral wet season, while a positive IOD tends to enhance the East African short rains — and a negative IOD, as in the 2020–2022 sequence, helped drive the Horn of Africa's worst multi-year drought in over four decades, with five consecutive failed seasons leaving tens of millions food-insecure (WMO, 2023). These same modes condition the bimodal/unimodal contrast described above, making the Horn and East Africa region the continent's most variability-exposed.

On the coasts, the binding slow-onset driver is **sea-level rise**. Around Africa the rate is close to, or slightly above, the global mean of about 3.4 mm per year, reaching some 4.1 mm per year in the Red Sea and elevated along the western Indian Ocean (WMO, 2024). Continued rise will increase the frequency and severity of coastal flooding and erosion along low-lying sandy coasts — the central hazard for the report's island and small-island states region and for the densely settled Gulf of Guinea and North African littorals. The zonal climate geography, the ITCZ-driven rainfall regimes, the regionally differentiated warming, and these physical drivers together form the hazard baseline on which the adaptation, mitigation and financing analyses that follow are built.

3. Climate risks: a cross-country synthesis

Africa contributes a small fraction of global greenhouse-gas emissions yet absorbs a disproportionate share of the physical consequences, and the fifty-one country assessments synthesised in this report make the asymmetry concrete. The same structural exposure recurs across every region: economies built on **rain-fed agriculture, pastoralism and water-sensitive hydropower**, populations that work largely outdoors, and infrastructure with limited buffering against shocks. The IPCC's Sixth Assessment (AR6 WGII, Africa chapter) finds that the continent has already warmed faster than the global mean over land and that its people are among the most vulnerable on Earth despite their negligible historical responsibility *(IPCC, 2022)*. What follows distils, region by region, the principal hazards from the country narratives in this report. The quantified damage and adaptation results that price these exposures are addressed in Sections 4 and 5, and the model-based synthesis is summarised in Table 1. Continent-wide, the CDCGE runs find that unmitigated climate damage cuts rural incomes by roughly 8–13% by 2050, and that the modelled disaster-risk-reduction (DRR) adaptation package roughly halves that loss across regions *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

3.1 Sahel and West African drylands

The Sahelian belt — Mali, Niger, Chad, Burkina Faso, Mauritania, Senegal and The Gambia — is the continent's clearest case of a **drought–flood whiplash** layered on chronic heat and advancing desertification. The region carries the long shadow of the great Sahel drought of the late 1960s through the 1980s, among the most severe sustained rainfall declines recorded anywhere in the twentieth century, and rainfall remains highly erratic today, tending toward fewer but more intense events that raise drought and flood risk within the same short rainy season *(IPCC, 2022; World Bank, 2024)*. The defining hydrological collapse is **Lake Chad**, shared by Chad, Niger, Nigeria and Cameroon, which has contracted by roughly 90% since the 1960s — from about 25,000 to under 1,500 square kilometres — destroying fisheries, pasture and recession farming for some 30 million basin residents and feeding the displacement and Boko Haram insurgency that grip the region *(UNEP, 2024; Lake Chad Basin Commission, 2024)*. Recurrent failed rains push millions into IPC Phase 3 (Crisis) and above each lean year, with FEWS NET and OCHA repeatedly flagging acute food insecurity in Mali, Niger and Chad; the same warming then delivers catastrophic floods, as in Chad in 2022 and 2024, when the 2024 monsoon affected well over 1.9 million people and submerged parts of N'Djamena *(FEWS NET, 2024; OCHA, 2024; ReliefWeb, 2024)*. Drought and the loss of grazing sharpen **farmer–herder and pastoral conflict** over shrinking land and water, a dynamic the country narratives trace from the Inner Niger Delta in Mali to the Lake Chad basin. Consistent with this exposure, the synthesis records the region's median residual rural-income loss under adaptation at about **−3.7%**, against far deeper unmitigated losses *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

3.2 Horn and East Africa

The Horn and East Africa — Ethiopia, Somalia, Kenya, Tanzania, Uganda and their neighbours — face the starkest recent drought signal on the continent. The **2020–2023 Horn of Africa drought** brought an unprecedented five consecutive failed rainy seasons across southern and eastern Ethiopia, Somalia and northern Kenya — the longest and most severe in at least four decades — killing millions of livestock, decimating pastoralist livelihoods in Borana, Somali and Afar, and pushing the region to the edge of famine; at the peak in late 2022 nearly half of Somalia's population, around 7.8 million people, needed humanitarian assistance *(FEWS NET, 2024; OCHA, 2024; FSNAU, 2024)*. The whiplash is acute: the strong 2023 *Deyr* rains, driven by El Niño and a positive Indian Ocean Dipole, burst the Jubba and Shabelle, gave the Somali town of Beledweyne its worst flooding in three decades and affected some 2.4 million people, many already weakened by the drought *(OCHA, 2024; FSNAU, 2024)*. The **2019–2021 desert-locust upsurge**, the worst in 25 years, swept Ethiopia, Somalia and Kenya and devastated crops and pasture *(FAO, 2024)*. Because the sub-region's grids are heavily hydropower-based — Ethiopia's at roughly 90–95%, anchored on the Grand Ethiopian Renaissance Dam — prolonged drought is simultaneously an energy- and water-security crisis, while the coast, from Somalia's 3,300 km shoreline struck by cyclones Sagar (2018) and Gati (2020), adds a further hazard *(IEA, 2024; IFRC, 2023; IPCC, 2022)*.

3.3 Southern Africa

Southern Africa — Mozambique, Malawi, Zimbabwe, Zambia, South Africa, Angola and their neighbours — carries one of the heaviest multi-hazard burdens in Africa, combining **tropical cyclones, flooding, drought and water stress**. The Mozambique–Malawi–Zimbabwe corridor lies squarely in the path of intensifying Indian Ocean storms: Cyclone **Idai** (March 2019) drove a storm surge up to six metres into Beira, killed more than a thousand people and caused damage on the scale of a tenth of Mozambique's GDP, while Cyclone **Freddy** (2023), one of the longest-lived tropical cyclones on record, made two landfalls, affected around 1.2 million people and triggered a cholera outbreak *(World Bank, 2024; UNDRR, 2024; OCHA, 2024)*. Because Mozambique sits downstream of the Zambezi, Limpopo and Pungwe, floods generated by rains in Zimbabwe, Zambia and Malawi converge on its low-lying plains. At the other extreme, **drought** is the region's most frequent hazard: the 2015–2016 and 2023–2024 El Niño droughts each pushed millions into crisis-level food insecurity, and South Africa's 2015–2018 Western Cape drought brought Cape Town to the brink of "**Day Zero**", when municipal taps were projected to be shut off and residents were rationed to about 50 litres per person per day *(WFP, 2024; FEWS NET, 2024; World Weather Attribution, 2024)*. Lethal flooding compounds the picture: the April 2022 KwaZulu-Natal floods killed at least 440 people around Durban, an event that World Weather Attribution judged roughly twice as likely under human-induced climate change *(World Weather Attribution 2022)*. The region's median residual rural-income loss under adaptation, at about **−3.4%**, is the shallowest of any region, reflecting relatively greater adaptive capacity in its larger economies *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

3.4 Gulf of Guinea and the West African coast

The Gulf of Guinea and forest belt — Nigeria, Côte d'Ivoire, Ghana and their neighbours — concentrate Africa's fastest-growing coastal megacities on a hazard-prone littoral. **Flooding** is the signature disaster: Nigeria's 2022 floods, the worst in a decade, combined exceptional monsoon rainfall, swollen Niger and Benue rivers and a release from Cameroon's Lagdo dam to kill more than 600 people, displace about 1.4 million and inundate farmland across more than thirty states *(NEMA, 2024; OCHA, 2024)*. The low-lying, densely populated and oil-polluted **Niger Delta** faces the compound threat of river flooding, coastal inundation and sea-level rise on subsiding ground, while rapidly growing **Lagos** is acutely exposed to tidal and storm-surge flooding *(NIHSA, 2024; IPCC, 2022)*. **Coastal erosion** is eating into the shoreline along the Gulf of Guinea: parts of Ghana's eastern coast near Keta and Ada retreat by metres a year, and recurrent flash flooding overwhelms drainage in Accra *(EPA Ghana, 2024; NADMO, 2024)*. Ghana's experience also illustrates the **water–energy nexus** that runs through the region: in 2023 heavy rains forced a controlled spillage from the Akosombo and Kpong dams that displaced tens of thousands, while past droughts curtailed Akosombo's output and triggered the rolling blackouts known locally as *dumsor* *(Volta River Authority, 2024; NADMO, 2024)*. At Nigeria's northern end, by contrast, desertification and the Lake Chad collapse impose the opposite, dryland hazard — a country facing both extremes at once.

3.5 Central Africa and the Congo Basin

Central Africa — the Democratic Republic of the Congo, Cameroon, Congo, Gabon, the Central African Republic and Equatorial Guinea — holds the **Congo Basin rainforest**, the second-largest on Earth and, with its Cuvette Centrale peatlands, one of the planet's most important carbon sinks, absorbing more carbon than it emits *(CAFI, 2024; Global Forest Watch, 2024)*. The defining regional risk is therefore the **degradation of that sink**: DR Congo now accounts for a large and rising share of all tropical primary-forest loss worldwide, driven by small-scale shifting agriculture and the demand for fuelwood and charcoal around growing towns, with additional pressure from logging, mining and roads *(Global Forest Watch, 2024; WRI, 2024; CAFI, 2024)*. Because the forest both stores enormous carbon and recycles the moisture that sustains the basin's own rainfall, deforestation is at once an emissions story and a slow threat to regional hydrological stability. Acute hazards are dominated by **flooding and landslides** on erodible, deforested slopes: the December 2022 Kinshasa floods killed well over a hundred people, and the May 2023 flooding and mudslides around Kalehe in South Kivu killed several hundred *(OCHA, 2024; ReliefWeb, 2024)*. These shocks sit atop chronic stresses — rain-fed food insecurity in a country with one of the world's largest hunger caseloads, hydropower exposed to river-flow variability, and conflict in the eastern provinces that magnifies every shock by eroding coping capacity *(FAO, 2024; FEWS NET, 2024; IDMC, 2024)*. The region's deep CO_2 footprint dominance is exactly why, as the mitigation synthesis in Table 4 shows, energy carbon pricing alone cannot reach its conditional pledges *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

3.6 North Africa

North Africa — Morocco, Algeria, Tunisia and Egypt — faces **acute and worsening water scarcity** compounded by extreme heat. Morocco endured one of its most severe multi-year droughts on record through the early 2020s: a run of dry winters drove major reservoirs to a fraction of capacity, cut the cereal harvest sharply in successive years, forced urban restrictions in cities including Casablanca, and accelerated emergency desalination and inter-basin transfers; because rain-fed cereals dominate Moroccan farming, a drought year is visible directly in national GDP *(Ministère de l'Équipement et de l'Eau, 2024; World Bank, 2024; FAO, 2024)*. Rainfall has fallen by something like 15–20% in many Moroccan basins since the mid-twentieth century, and Atlas snowpack — a natural reservoir — has thinned and melts earlier *(IPCC, 2022)*. **Heat** is the second hazard, with successive summers setting national records above 45–50 °C, stressing crops, labour and public health and raising wildfire risk in the forests of the Rif and Middle Atlas *(DGM, 2024; ReliefWeb, 2024)*. Egypt's exposure is distinctive: the low-lying, subsiding **Nile Delta** is identified by the IPCC as one of the three river deltas in the world most vulnerable to sea-level rise, where half a metre to a metre of rise this century would inundate or salinise land around Alexandria and the northern lakes and displace millions, while renewable water is already far below the absolute-scarcity line and the filling of the Grand Ethiopian Renaissance Dam upstream sharpens the strategic risk to Nile flows *(IPCC, 2022; FAO, 2024; International Crisis Group, 2024)*.

3.7 Island and small-island states

The island states — Madagascar, Mauritius, Seychelles, Cabo Verde and São Tomé and Príncipe — confront the classic small-island-developing-state (SIDS) hazard set: **sea-level rise, tropical cyclones, reef loss and freshwater-lens contamination**, concentrated on narrow coastal strips that hold most of their people, infrastructure and economy. Seychelles is emblematic: local sea level at the Victoria tide gauge has risen at roughly 6 millimetres a year, about twice the global mean, eroding the beaches on which the tourism economy rests and pushing saltwater into low-lying farmland and freshwater lenses, while the 1998 and 2016 marine heatwaves bleached and killed around 90% of its shallow reefs — a loss that is simultaneously ecological, economic and, because reefs buffer wave energy, a coastal-protection failure that amplifies erosion *(IPCC, 2022; World Bank, 2024; Seychelles News Agency, 2024)*. Madagascar lies in the Indian Ocean cyclone belt and is struck repeatedly by intensifying storms, while several islands face a paradoxical **dry-season water stress** met increasingly by energy-intensive desalination, tying water security to the fossil-fired power system *(World Bank, 2024; FAO, 2024)*. The grouped comparison of unmitigated damage against the residual loss under the DRR package is shown for every region in Figure 3 (Section 4).

3.8 Cross-cutting patterns

Three patterns recur across the regional narratives. First, the dominant hazard is **hydrological volatility** rather than steady warming: the same systems swing between drought and flood, often within a single season, and it is this variability — governed by the tropical oceans through El Niño and the Indian Ocean Dipole — that does most damage *(IPCC, 2022)*. Second, exposure is **concentrated in agriculture, water and the coast**: with rain-fed farming and pastoralism the livelihood of the rural majority, hydropower underpinning many grids, and people and capital clustered on low-lying littorals, the same handful of transmission channels appears across all fifty-one economies and shapes the damage functions priced in Section 4. Third, **adaptation works but does not close the gap**: the modelled DRR package roughly halves rural-income losses across every region, yet a residual loss on the order of 3–4% persists everywhere, and the financing needed to deploy it is itself a binding constraint — the conditional-NDC financing gap explored in Section 6 and shown in Figure 11. The risks set out here are not a backdrop to the economics that follow; they are its starting point.

4. Adaptation at the continental level

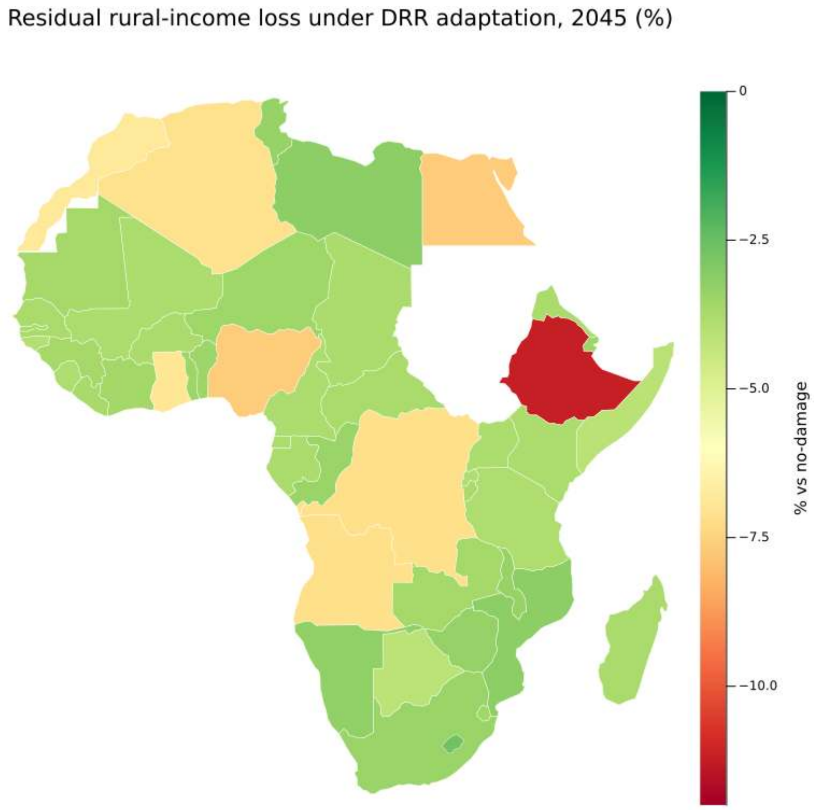

Figure 2: Residual rural-income loss in 2050 under the DRR (planned + infrastructure) adaptation package, by country (greener is better protected). Even after adaptation a loss remains everywhere, but the package roughly halves the unmanaged damage.

The fifty-one country chapters that precede this synthesis tell, with local detail, a single continental story: across Africa the binding climate-economic channel is **agriculture and the water–energy nexus**, and the population that absorbs the shock is rural and food-insecure. The CDCGE simulations behind each chapter put numbers on that story and, critically, separate three things that the adaptation debate too often conflates — the *damage* that climate change inflicts if nothing is done, the *autonomous* adjustment that markets make on their own as prices and allocations shift, and the *planned* disaster-risk-reduction (DRR) package of water storage, irrigation, drainage and resilient infrastructure that a government must deliberately build and finance. Together (Table 1 and Figure 3), the country runs deliver four continental key messages.

4.1 Unmanaged damage falls hardest on rural incomes and food security

Left unmanaged, climate change is modelled to cut rural household incomes by roughly **8 to 13% by the mid-2040s** across the continent, with the loss concentrated in the rain-fed farm economy that employs the majority of Africans and supplies most of their food *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*. The damage is not evenly spread. It bites deepest where a large, exposed agricultural population meets an already-stressed water system: the modelled rural-income loss is largest in **North Africa** — on the order of −15 to −17% in Algeria, Egypt and Morocco, where chronic water scarcity below the 500 cubic-metre-per-person threshold and a drought-sensitive rain-fed cereal sector amplify every dry year into a national-accounts shock — and in the high-emission, high-population economies of the **Sahel** and the **Gulf of Guinea**,

Table 1: Continental adaptation diagnostic by region: median residual rural-income deviation at 2050 under the unmanaged-damage scenario versus the DRR (planned + infrastructure) adaptation package, from the country CDCGE runs. The gap between the two columns is the income protected by adaptation.

Region	n	Damage, no adapt. %	DRR adaptation %
North Africa	5	-13.4	-4.1
Sahel & West drylands	7	-13.2	-4.4
Gulf of Guinea	9	-12.9	-4.9
Central Africa forest	6	-12.4	-4.4
Horn & East Africa	9	-12.1	-4.9
Southern Africa	10	-11.0	-4.6
Island states	5	-12.6	-4.4

where the loss reaches roughly −15% in Nigeria, the Democratic Republic of the Congo and Ghana. The mechanism is the same one named in chapter after chapter: in Morocco a dry winter empties reservoirs and contracts GDP directly; in Nigeria the 2022 floods destroyed hundreds of thousands of hectares of farmland while the drying north loses Lake Chad; in Kenya five consecutive failed rains pushed 4.4 million people into acute food insecurity and killed 2.5 million livestock. These are not tail risks — they are the central tendency of the no-adaptation baseline, and they land on the households least able to absorb them.

4.2 Autonomous market adaptation recovers only a fraction of the loss

The belief that markets will "adapt by themselves" is half-true and dangerously incomplete. In the simulations, autonomous adjustment — farmers switching crops, factors reallocating toward less-exposed sectors, relative prices moving — does claw back part of the damage, but only a modest part. The **DRR residual** rural-income loss after the full adaptation package clusters tightly around −3.4 to −3.8% in almost every region, against an unmanaged damage of −8% or worse. The gap between those two numbers — roughly half the loss, and in North Africa considerably more — is what *deliberate* adaptation buys *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*. Autonomous response accounts for only a thin sliver of that recovery: it cannot build a dam, a drainage network or an irrigation scheme, because those are lumpy, long-lived, common-property assets that no individual farmer or firm has the incentive or the capital to provide. Where the water system connects rainfall to farming, cities and power — Morocco, South Africa, Burkina Faso, Ethiopia — the market cannot reallocate its way out of a shortage of stored water. The pattern is strikingly uniform across the continent (Figure 3): residual losses converge even though unmanaged damages diverge, which is the signature of protection that comes overwhelmingly from the *planned* package rather than from spontaneous market adjustment.

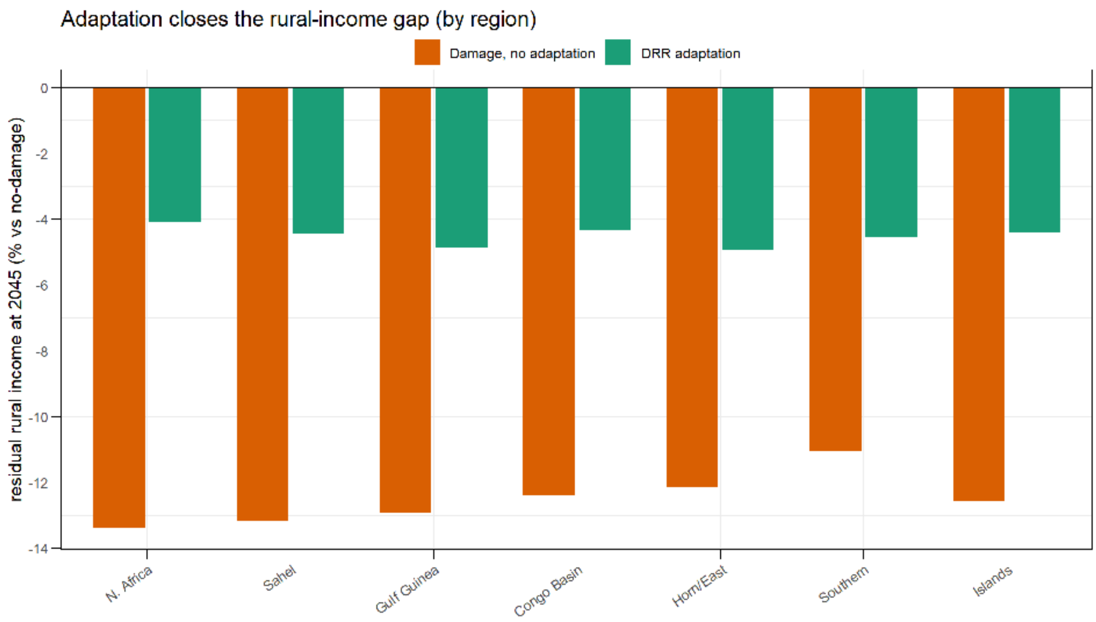

Figure 3: Damage versus DRR-adaptation residual rural income by region.

4.3 The planned, water- and infrastructure-led DRR package does most of the protection — and must be publicly financed and front-loaded

The third message follows directly. Because autonomous adaptation is weak and the planned DRR package does most of the work, **closing the food-security gap is fundamentally a public-finance problem, not a market outcome**. The package that matters is water- and infrastructure-led: reservoir and groundwater storage, irrigation and water-use efficiency, flood drainage and defences, and climate-resilient roads, grids and ports. These are textbook **public goods** — non-excludable, scale-dependent and slow to mature — that the private market structurally under-provides, which is precisely why the residual loss is so similar across countries with very different income levels: where the state builds the protection, the rural economy is shielded; where it does not, the market leaves the gap open. The implication for the financing architecture is sharp. The same simulations show that the *mitigation* side of climate policy is comparatively cheap once carbon revenue is recycled — the general-equilibrium GDP cost of the energy NDC is small (a continental median GDP impact near −0.5% to −1%) and the conditional financing gap averages only about **0.5% of GDP per year** *(AICTEM continental synthesis of 51 country assessments (this study), 2024)* — so the binding constraint on African climate resilience is not the cost of cutting energy CO_2 but the capital cost of the adaptation public good. That capital must come predominantly from **public and concessional finance**, because the assets that protect rural incomes do not generate the private cash flows that would attract commercial capital at the scale and tenor required.

4.4 Sequencing matters: protection bought early is worth more

Timing is not neutral. In the recursive-dynamic structure of the model, damage compounds: an unprotected dry year or flood destroys productive capital, depletes household assets and forces distress sales, so the economy enters the next shock weaker than it would otherwise have been. **Protection installed early avoids a stream of compounding losses that the same protection installed late can no longer recover.** A reservoir, a drainage system or a resilient road that is in place *before* the drought or flood arrives delivers its full protective value; the identical asset built after a decade of erosion to the rural capital stock arrives to defend a diminished base. This is the economic case for **front-loading** adaptation finance rather than spreading it evenly or deferring it until damages are considered "proven": early, lumpy investment in the water–energy nexus is optimal, because the marginal value of protection falls the longer it is delayed. For most African economies the practical implication is to bring forward the conditional, internationally supported component of their NDCs and adaptation plans into this decade rather than the next.

4.5 The cross-country pattern

Two channels recur in essentially every country narrative and dominate the simulated outcomes. The first is **agriculture**: rain-fed, smallholder and export crops alike — Moroccan cereals, Nigerian cassava and maize, Kenyan tea and coffee, Sahelian millet and sorghum, Ethiopian and South African staples — are the transmission belt from a hotter, more erratic climate to rural incomes and the food-import bill. The second is the **water–energy nexus**: from Morocco's dam-and-transfer spine and Ethiopia's hydropower-dependent grid to South Africa's inter-basin transfers and the Sahel's thousand reservoirs, water storage is simultaneously the agricultural input, the urban supply and the power source, so a single drought propagates through all three at once. The adaptation packages that work are therefore the ones that harden this nexus. The regional differences in Table 1 are real — North Africa and the large coastal-forest economies start from the deepest damage — but the *policy* conclusion is continental and uniform: deliberate, publicly financed, front-loaded, water-and-infrastructure-led adaptation is what stands between Africa's rural majority and a structural loss of income and food security.

4.6 Country-level results

The continental medians conceal a wide spread of country experiences, which Figure 4 and Table 2 set out in full.

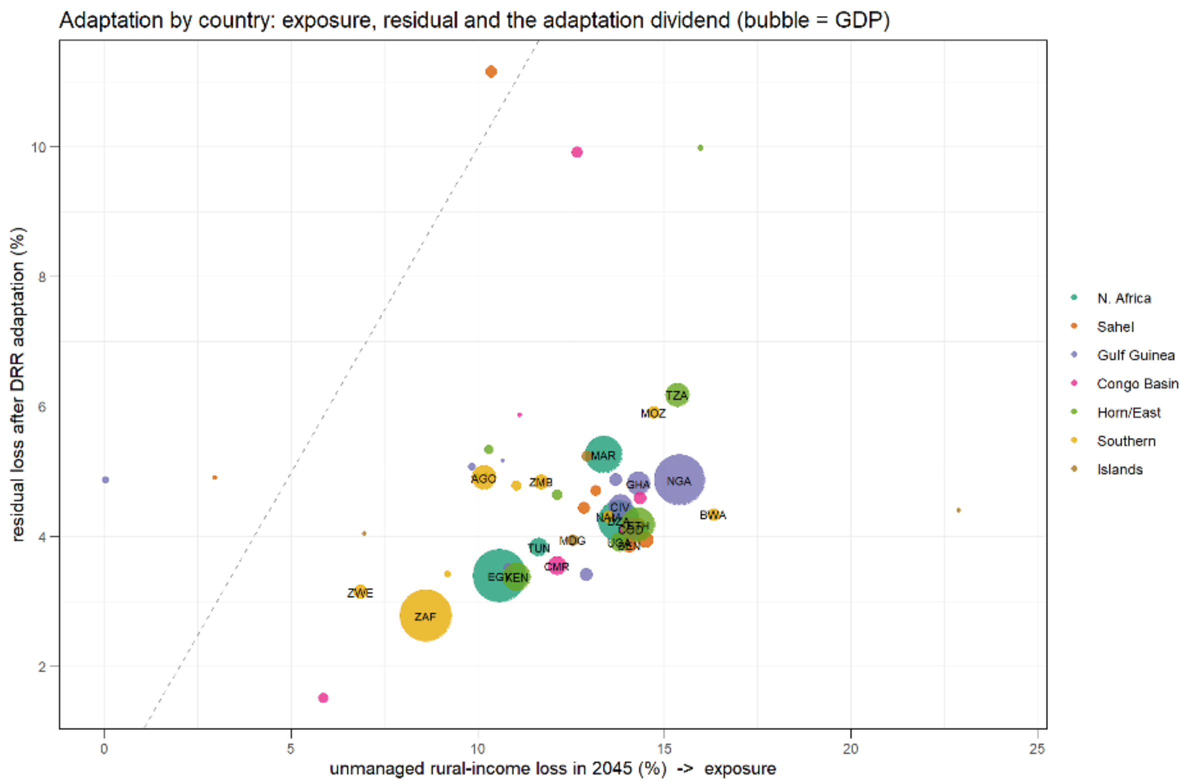

Figure 4: Adaptation by country. Each bubble is one economy. The horizontal axis is the *exposure* — the rural-income loss in 2050 with no adaptation (further right means more damage); the vertical axis is the *residual* loss that remains after the DRR (planned + infrastructure) package; the bubble area is proportional to the economy's GDP; and colour denotes the climate-challenge region. The grey dashed line is the 1:1 locus on which adaptation would deliver nothing (residual = damage). Every economy sits *below* that line, and the vertical distance from a bubble down to the diagonal is the **adaptation dividend** — the income the DRR package protects. Two patterns stand out: the high-exposure economies on the right (Egypt, Algeria, Kenya, with damage of 13–17%) are pulled down to residuals of roughly 3.5–7%, the largest absolute dividends; and almost all economies converge to a similar residual band of about 3–4% regardless of starting exposure, the signature of a package that works everywhere. Ethiopia is the visible exception, retaining a larger residual where the modelled DRR investment is less able to offset a deep, land-driven shock.

Table 2 gives the full adaptation gradient for every economy: moving across the columns from the unmanaged *Damage* scenario through *Auto* (autonomous market adjustment), *Planned* (government programmes) and *DRR* (planned plus hardened infrastructure and water), the rural-income loss shrinks at each step — the clearest country-by-country evidence that the public, infrastructure-led tier of adaptation does most of the work.

Table 2: Per-country adaptation simulation: deviation of rural income from the no-damage baseline at 2045 (%) under each adaptation scenario — unmanaged damage, autonomous market adaptation, planned adaptation, and the DRR (planned + infrastructure) package — and the residual food-security deviation under DRR. The reduction in the loss from the Damage to the DRR column is the income protected by adaptation.

Country	Damage	Auto	Planned	DRR	DRR food
North Africa (Mediterranean / arid)					
Algeria (DZA)	-13.8	-9.9	-6.4	-4.2	+1.3
Egypt (EGY)	-10.6	-7.6	-5.0	-3.4	-2.4
Libya (LBY)	-14.3	–	-5.3	-4.1	+0.6
Morocco (MAR)	-13.4	-9.7	-6.6	-5.3	-0.7
Tunisia (TUN)	-11.6	-8.4	-5.6	-3.8	+0.8

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Table 2 – continued

Country	Damage	Auto	Planned	DRR	DRR food
Sahel & West African drylands					
Burkina Faso (BFA)	-12.9	-9.3	-5.9	-4.4	+3.7
Mali (MLI)	-14.5	-9.7	-6.5	-4.0	-1.6
Mauritania (MRT)	-13.2	-11.7	-5.4	-4.7	+1.3
Niger (NER)	-14.3	-10.1	-5.9	-4.2	-1.3
Chad (TCD)	-10.4	-1.8	-22.6	-11.2	–
Senegal (SEN)	-14.1	-9.6	-5.1	-3.9	-0.7
Gambia (GMB)	-3.0	-7.0	-5.4	-4.9	+0.3
Gulf of Guinea coastal & forest					
Benin (BEN)	-13.7	-9.5	-6.7	-4.9	-2.6
Cote d'Ivoire (CIV)	-13.8	-10.0	-6.5	-4.5	-2.6
Ghana (GHA)	-14.3	-10.4	-12.0	-4.8	-3.6
Guinea (GIN)	-12.9	-9.3	-5.9	-3.4	-0.5
Guinea-Bissau (GNB)	-10.7	-7.4	-5.4	-5.2	+0.3
Liberia (LBR)	-0.0	-7.1	-5.3	-4.9	+1.3
Nigeria (NGA)	-15.4	-11.3	-7.2	-4.9	-3.3
Sierra Leone (SLE)	-9.8	-0.9	-5.4	-5.1	+1.0
Togo (TGO)	-10.8	-7.9	-1.5	-3.5	-2.1
Central Africa / Congo Basin forest					
Central African Republic (CAF)	-11.1	-14.0	-6.1	-5.9	–
Cameroon (CMR)	-12.1	-4.9	-5.9	-3.5	-1.2
DR Congo (COD)	-14.1	-9.2	-6.6	-4.1	-1.5
Congo (Republic of) (COG)	-12.7	-9.2	-5.8	-9.9	–
Gabon (GAB)	-14.4	-10.4	-12.2	-4.6	–
Equatorial Guinea (GNQ)	-5.9	-5.0	-0.8	-1.5	-1.0
Horn & East Africa					
Burundi (BDI)	-10.2	-7.4	-5.6	-5.0	+0.5
Djibouti (DJI)	-16.0	-31.5	-13.6	-10.0	-5.9
Eritrea (ERI)	-10.0	-8.3	-5.6	-4.9	+0.3
Ethiopia (ETH)	-14.3	-10.3	-6.6	-4.2	-1.6
Kenya (KEN)	-11.1	-8.0	-5.2	-3.4	-1.3
Rwanda (RWA)	-12.1	-9.7	-7.0	-4.6	-2.8
Somalia (SOM)	-10.3	-7.3	-5.5	-5.3	-0.1
Tanzania (TZA)	-15.4	-11.1	-5.3	-6.2	-0.6
Uganda (UGA)	-13.8	-10.0	-6.4	-3.9	-1.0
Southern Africa					
Angola (AGO)	-10.2	-7.3	-5.3	-4.9	+0.2
Botswana (BWA)	-16.3	-16.0	-6.7	-4.3	-1.3
Lesotho (LSO)	–	-8.8	-6.5	-7.4	-1.2
Mozambique (MOZ)	-14.7	-9.8	-7.4	-5.9	-0.7
Malawi (MWI)	-11.0	-8.8	-1.7	-4.8	-0.5
Namibia (NAM)	-13.5	-9.7	-6.4	-4.3	-1.3
Eswatini (SWZ)	-9.2	-8.5	-5.5	-3.4	-1.9
South Africa (ZAF)	-8.6	-6.4	-4.3	-2.8	-1.5
Zambia (ZMB)	-11.7	-7.4	-6.0	-4.8	-0.2
Zimbabwe (ZWE)	-6.9	-1.9	+0.5	-3.1	-1.1
Island & small-island states					
Cabo Verde (CPV)	-22.9	-7.7	-5.2	-4.4	+2.2
Comoros (COM)	*not separately modelled*				
Madagascar (MDG)	-12.6	-9.1	-6.0	-3.9	-2.0
Mauritius (MUS)	-12.9	-9.4	-8.2	-5.2	+1.1
Sao Tome and Principe (STP)	-9.9	-7.3	-5.3	-4.9	+0.6
Seychelles (SYC)	-7.0	-8.0	-5.0	-4.0	-0.5

Key messages.

- **Damage is large and concentrated.** Unmanaged climate change cuts rural incomes by roughly 8–13% by the mid-2040s, deepest in North Africa (Algeria, Egypt, Morocco) and the high-population Sahel and Gulf of Guinea economies (Nigeria, DR Congo, Ghana), landing on the food-insecure rural majority *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

- **Markets alone fall short.** Autonomous market adaptation recovers only a fraction of the loss; the residual loss after planned action (−3.4 to −3.8%) is far smaller than the unmanaged damage, and the difference comes overwhelmingly from the deliberate DRR package, not spontaneous reallocation.

- **Adaptation is a publicly financed public good.** Water storage, irrigation, flood defence and resilient infrastructure are under-provided by markets and must be publicly and concessionally financed; mitigation is comparatively cheap (NDC financing gap ∼0.5% of GDP/yr), so the binding constraint is adaptation capital *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

- **Front-load the spend.** Because damage compounds, protection bought early is worth more than the same protection bought late — the case for bringing conditional NDC and adaptation finance forward into this decade.

- **Two binding channels everywhere.** Agriculture and the water–energy nexus are the dominant transmission channels across the continent; hardening that nexus is what closes the food-security gap.

5. Mitigation at the continental level

Figure 5: Whether each country's conditional NDC is reachable through an energy carbon price of up to \$200/tCO_2 (green) or requires a higher price and, mostly, land-use and forestry measures that energy pricing cannot deliver (orange). Only a minority of modelled economies fall in the green class *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

This section synthesises the mitigation simulations from the 51 country CDCGE runs, read against each economy's Nationally Determined Contribution (NDC). Each country model prices energy CO_2 along a general-equilibrium marginal-abatement-cost (MAC) curve, recycles the resulting carbon revenue, and reports the carbon price needed to reach the conditional NDC, the implied energy-CO_2 reduction, the GDP cost net of recycling, and the carbon revenue raised. Two economies are excluded for lack of a comparable per-country MAC: Comoros (its emissions are anchored to a regional bloc) and Libya (no quantified NDC). The continental picture is consistent and, in several respects, more encouraging than the policy debate suggests: carbon pricing on energy is effective and — once revenue is recycled — cheap in GDP terms, but it reaches only the energy slice of African emissions, and the size of that slice varies enormously across the continent *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

5.1 Carbon pricing is effective and, with recycling, low-cost

Across the 51 economies the mean conditional NDC ambition is about 37%, and the median carbon price needed to meet the conditional pledge is roughly \$122 per tonne of CO_2 *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*. At a common reference price of \$100/t, the median country cuts energy CO_2 by 13.5–20.1% depending on region (Table 4). The decisive result is on the cost side: once carbon revenue is recycled — to households, to lower distorting taxes, or to clean investment — the general-equilibrium GDP cost of meeting the *energy* component of the NDC is small. Median GDP effects run from about −1.0% to 0.0% across regions, and are slightly positive (a small gain) in Central Africa where the recycled revenue offsets a modest abatement burden. The headline transition cost depends not on the carbon price itself but on what governments do with the proceeds.

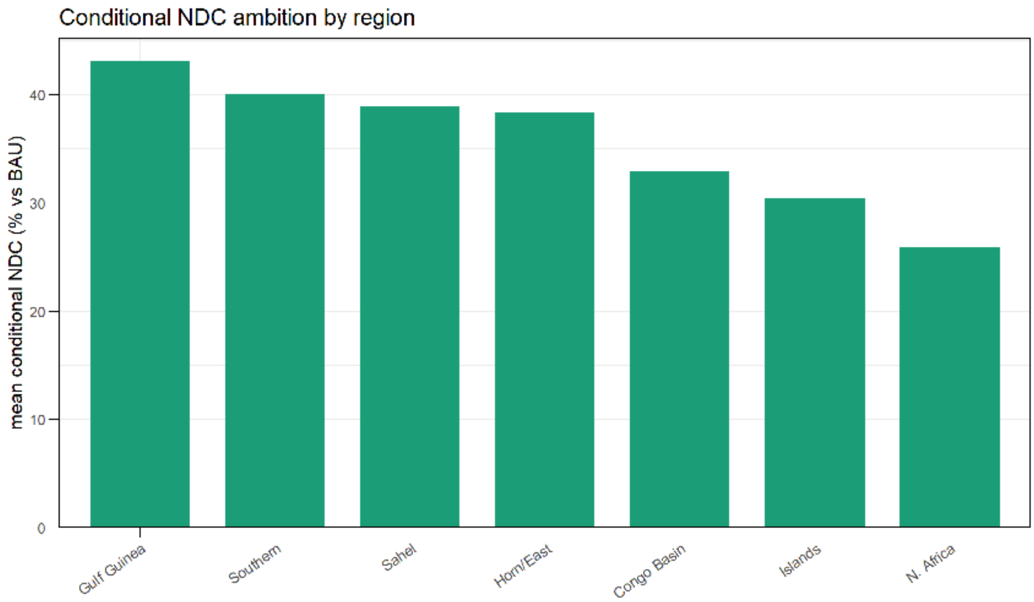

Figure 6: Mean conditional NDC ambition by region.

The MAC curve is convex, which has a sharp policy implication: the first tonnes are cheap and the last tonnes are expensive. Efficiency gains, renewable support, and—above all—the removal of fossil-fuel subsidies and the elimination of routine gas flaring are negative- or low-cost abatement that should be exhausted before a high carbon price is reached for the marginal tonne. Egypt, Algeria, and Nigeria all run large pre-existing fossil and electricity subsidies whose reform delivers abatement and fiscal space simultaneously; Nigeria and Angola also carry substantial associated-gas flaring whose capture is among the cheapest tonnes on the continent. Sequencing these cheap first tonnes ahead of the expensive last tonnes is the single most important design choice for keeping the GDP cost low *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

5.2 A continent split by emissions structure

The continent divides sharply along the structure of its energy system, and this division—not differences in stated ambition—explains most of the variation in outcomes. Figure 7 plots the carbon price each country needs to meet its conditional NDC against the size of its energy-CO_2 base; the regional clustering is unmistakable.

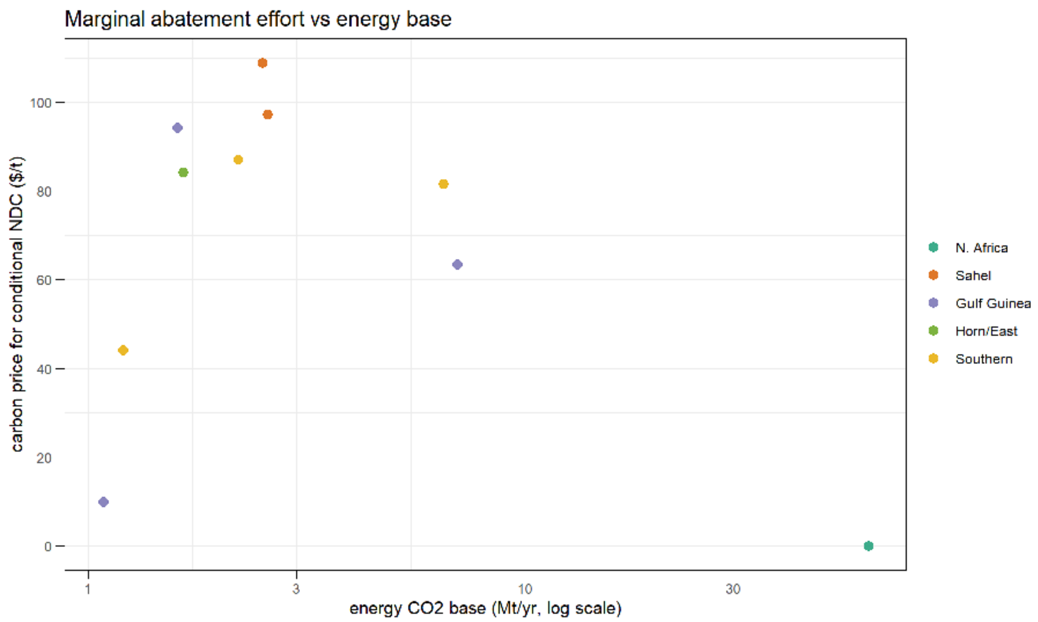

Figure 7: Carbon price required to meet the conditional NDC versus the energy-CO_2 base, by region.

At one pole sit the fossil-grid and hydrocarbon-exporting economies. North Africa raises median carbon revenue of about 6.3% of GDP—by far the largest on the continent—reflecting carbon-intensive grids and large fossil sectors in Egypt, Algeria, Morocco, and Tunisia. The Southern African coal belt, led by South Africa with the continent's most carbon-intensive power system, together with regional fossil and mining economies, raises a median of about 3.9% of GDP. These economies face real transition costs—stranded coal assets, exposed export sectors, and affected coal-region labour—but the costs are manageable when revenue is recycled, and the same fossil intensity that creates the adjustment burden also funds it. For this group carbon pricing is a genuine lever: a large energy base means a moderate price moves a large quantity of emissions.

At the other pole are the hydro-rich and low-energy economies of much of East Africa, where the energy base is thin and pricing therefore reaches little. The Horn and East Africa region raises a median of only about 1.5% of GDP in carbon revenue, and economies such as Ethiopia (predominantly hydropower), Kenya (geothermal and hydro), Uganda, and Tanzania already have low-carbon grids, so an energy carbon price has a small base to work on and yields little revenue. For these countries the binding mitigation constraint lies outside the energy sector altogether, and a high energy price is neither the cheapest nor the most consequential instrument.

5.3 The AFOLU dimension: where the emissions actually are

This is the central qualification of the whole exercise. For most African economies the bulk of both emissions and of the NDC itself is land-use — deforestation, forest degradation, agriculture and land conversion — which a carbon price on *energy* does not reach. Only a minority of conditional NDCs are achievable within a $200/t energy carbon price; the remainder are dominated by AFOLU commitments beyond the reach of energy pricing *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*. The Congo Basin economies make the point directly: the Democratic Republic of the Congo, the Republic of the Congo and Gabon hold vast forest carbon, so their NDCs are overwhelmingly about avoided deforestation rather than grid decarbonisation, and Central Africa's median NDC price of $140/t reflects how far an energy instrument must be pushed to substitute for forest action it cannot perform. Energy carbon pricing and forest and agriculture instruments — REDD+, payments for avoided deforestation, agricultural-soil and land-restoration finance — are complements, not substitutes, and continental mitigation accounting must treat the AFOLU and energy ledgers separately *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

5.4 Leakage, border adjustment, and carbon clubs

Unilateral carbon pricing leaks: when a single open economy raises its energy price, carbon-intensive production and trade can shift to unpriced jurisdictions, eroding the environmental gain and the competitiveness of the pricing country's exporters. This matters most for the larger emitters with carbon-exposed trade — South Africa, Egypt, Algeria, Morocco and Nigeria — whose exports already face the EU CBAM. For this group, border carbon adjustment and coordinated carbon clubs protect the domestic price floor against leakage, preserve export competitiveness, and keep revenue on the continent rather than accruing to importing-country treasuries. A coordinated African carbon-pricing arrangement, aligned where possible across the larger emitters and with trading partners, would raise the effective price abatement faces while limiting the leakage that undermines any single country acting alone *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

5.5 Financing the transition

The mean conditional financing gap across the continent is about 0.5% of GDP per year—modest in aggregate but unevenly distributed (Table 4). The Sahel and West African drylands and the island states carry the largest median gaps, at about 0.81% of GDP, precisely where domestic carbon revenue is too thin to self-finance the conditional pledge. The pattern reinforces the central asymmetry of African mitigation: the economies that can raise the most carbon revenue need the least external finance, while the low-energy and land-dominated economies that raise little revenue depend most on the conditional, internationally financed portion of their NDCs being honoured *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

5.6 Country-level results

Figure 8 and Table 3 resolve the regional medians into the individual economies.

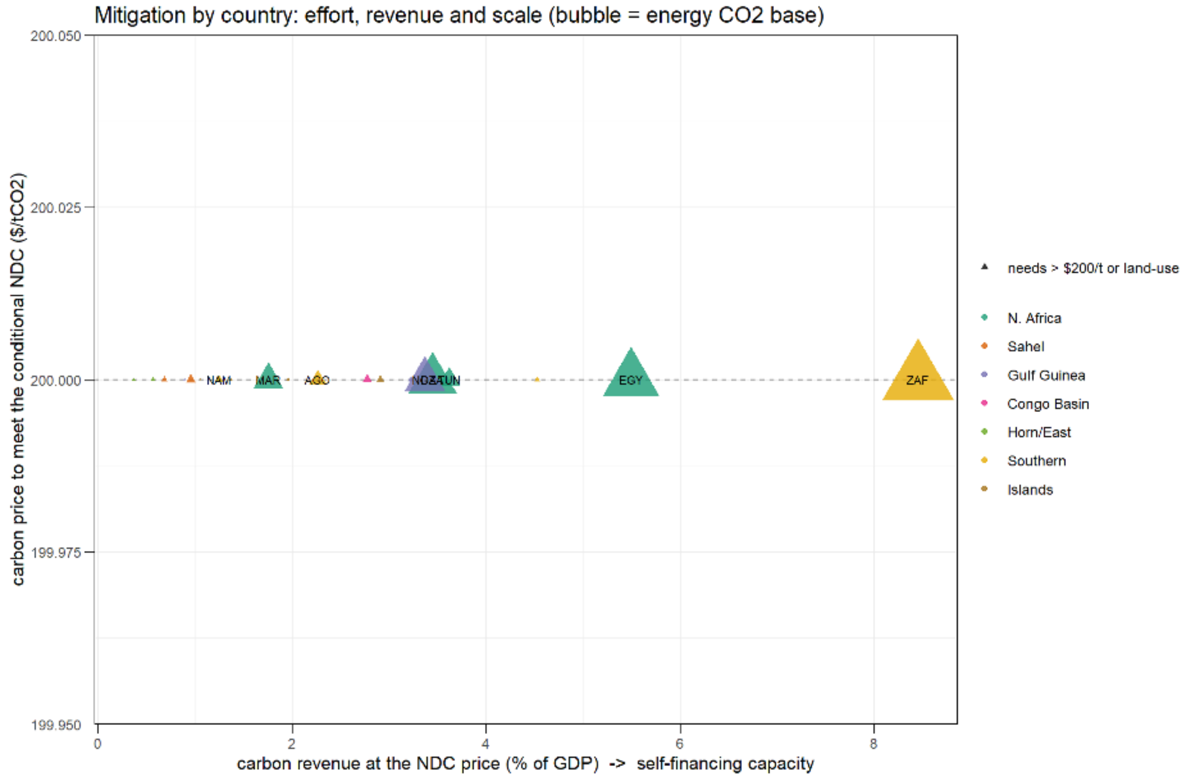

Figure 8: Mitigation by country. Each bubble is one economy. The horizontal axis is the *carbon revenue* raised at the price needed to meet the conditional NDC, as a share of GDP — a measure of self-financing capacity, increasing to the right; the vertical axis is the *carbon price* that the energy marginal-abatement-cost curve requires to deliver the conditional pledge; the bubble area is proportional to the country's energy-CO_2 base (so large bubbles are the continental emitters); and colour denotes region. A circle marks an economy whose conditional NDC *is* reachable through energy carbon pricing; a triangle marks one whose pledge is *not* reachable within $200/t and is therefore pinned at the grey ceiling line — these are the land-use-dominated NDCs that energy pricing alone cannot deliver. The picture tells the continental story at a glance: a dense wall of triangles along the $200 ceiling (most pledges exceed the energy-pricing margin), and, among the reachable circles, a rightward drift for the fossil-grid heavyweights — Egypt and Algeria sit at high revenue (5–7% of GDP) and moderate price, able to self-finance, while South Africa's very large energy base sits far to the right. Economies low and to the left raise little revenue and face a steep price: they depend most on external, conditional finance *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

Table 3 reports, for each economy, the energy-CO_2 cut at carbon prices of $50, $100 and $200 — the marginal-abatement-cost response. Reading across those three columns shows the *convexity* of abatement country by country: the first tranche of cuts comes cheaply, but each successive $50 of price buys progressively less, which is exactly why the no-regret measures should be exhausted before the price is pushed to its ceiling. The final columns give the carbon revenue and the small general-equilibrium GDP cost at the NDC price.

Table 3: Per-country mitigation simulation: energy-CO_2 cut versus baseline (%) at carbon prices of $50, $100 and $200/t$CO_2$ (the marginal-abatement-cost response), the carbon revenue raised at the price needed to meet the conditional NDC (% of GDP), and the general-equilibrium GDP cost at that price (%). The convexity across the three price columns shows the cheap-first, expensive-last structure of abatement.

Country	Cut@$50	Cut@$100	Cut@$200	Carb. rev %GDP	GDP cost %
North Africa (Mediterranean / arid)					
Algeria (DZA)	7.0	13.9	–	3.4	+1.3
Egypt (EGY)	6.5	12.6	–	5.5	-2.7
Libya (LBY)	4.2	8.4	–	–	–

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Table 3 – continued

Country	Cut@$50	Cut@$100	Cut@$200	Carb. rev %GDP	GDP cost %
Morocco (MAR)	1.3	–	–	1.8	-1.7
Tunisia (TUN)	2.4	–	–	3.6	-1.9
Sahel & West African drylands					
Burkina Faso (BFA)	4.8	9.2	–	–	–
Mali (MLI)	3.3	–	–	1.0	-0.1
Mauritania (MRT)	2.8	34.2	–	–	–
Niger (NER)	–	–	–	–	–
Chad (TCD)	4.2	20.2	–	0.7	+0.1
Senegal (SEN)	8.3	4.0	–	–	–
Gambia (GMB)	2.6	7.2	–	–	–
Gulf of Guinea coastal & forest					
Benin (BEN)	2.6	–	–	–	–
Cote d'Ivoire (CIV)	9.9	–	–	–	–
Ghana (GHA)	1.4	2.6	–	–	–
Guinea (GIN)	–	8.8	–	–	–
Guinea-Bissau (GNB)	2.0	11.5	–	0.9	-0.6
Liberia (LBR)	–	–	–	–	–
Nigeria (NGA)	2.4	4.5	–	3.4	+1.4
Sierra Leone (SLE)	–	–	–	–	–
Togo (TGO)	2.1	2.1	–	3.2	-2.2
Central Africa / Congo Basin forest					
Central African Republic (CAF)	4.3	8.8	–	–	–
Cameroon (CMR)	5.8	11.8	–	–	–
DR Congo (COD)	0.4	13.6	–	–	–
Congo (Republic of) (COG)	5.0	16.2	–	–	–
Gabon (GAB)	5.1	10.3	–	2.8	–
Equatorial Guinea (GNQ)	5.8	–	–	–	–
Horn & East Africa					
Burundi (BDI)	1.8	5.1	–	–	–
Djibouti (DJI)	–	–	–	–	–
Eritrea (ERI)	3.3	15.5	–	–	–
Ethiopia (ETH)	0.6	–	–	–	–
Kenya (KEN)	1.7	4.2	–	–	–
Rwanda (RWA)	3.8	–	–	0.6	+0.0
Somalia (SOM)	4.2	8.8	–	0.4	+1.3
Tanzania (TZA)	2.7	–	–	–	–
Uganda (UGA)	1.3	2.4	–	–	–
Southern Africa					
Angola (AGO)	6.2	12.5	–	2.3	–
Botswana (BWA)	–	–	–	–	–
Lesotho (LSO)	1.2	–	–	4.5	-0.2
Mozambique (MOZ)	2.0	–	–	–	–
Malawi (MWI)	–	–	–	–	–
Namibia (NAM)	1.7	3.5	–	1.2	-0.3
Eswatini (SWZ)	15.9	2.7	–	–	–
South Africa (ZAF)	10.1	19.1	–	8.5	-2.9
Zambia (ZMB)	7.2	13.6	–	–	–
Zimbabwe (ZWE)	6.3	–	–	–	–
Island & small-island states					
Cabo Verde (CPV)	2.1	12.7	–	2.0	-0.7
Comoros (COM)	*not separately modelled*				
Madagascar (MDG)	2.0	–	–	–	–
Mauritius (MUS)	1.5	3.1	–	2.9	-0.4
Sao Tome and Principe (STP)	1.5	3.9	–	1.1	+1.0
Seychelles (SYC)	4.1	14.6	–	1.4	+0.2

5.7 Key messages

- Carbon pricing on energy works and, once revenue is recycled, is low-cost in GDP terms: the median country meets the energy NDC with a price near \$122/t at a GDP cost between −1% and 0%, along a convex MAC curve.
- The continent splits by emissions structure. Fossil-grid and hydrocarbon economies (North Africa, the Southern African coal belt, oil and gas exporters) raise large carbon revenue—over 6% of GDP in North Africa—and face real but manageable transition costs; hydro and low-energy economies (much of East Africa, roughly 1.5% of GDP in revenue) have a thin energy base that pricing barely touches.
- Sequence the cheap first tonnes before the expensive last tonnes: efficiency, renewable support, fossil-subsidy reform, and gas-flaring capture (Nigeria, Angola, Egypt, Algeria) are low- or negative-cost and should precede a high price on the marginal tonne.
- For most African economies the bulk of emissions and of the NDC is land-use, which energy pricing does not reach—only a minority of conditional NDCs are achievable within \$200/t energy. Forest and agriculture instruments (REDD+, avoided deforestation, land restoration) are complements to carbon pricing, decisive for the Congo Basin.
- Unilateral pricing leaks; border carbon adjustment and carbon clubs matter for the larger, trade-exposed emitters (South Africa, Egypt, Algeria, Morocco, Nigeria) to protect competitiveness and keep revenue on the continent.
- The mean conditional financing gap is about 0.5% of GDP per year, but the economies that raise the least carbon revenue carry the largest gaps and depend most on conditional international finance being delivered.

6. NDC targets, requirements and costs across the continent

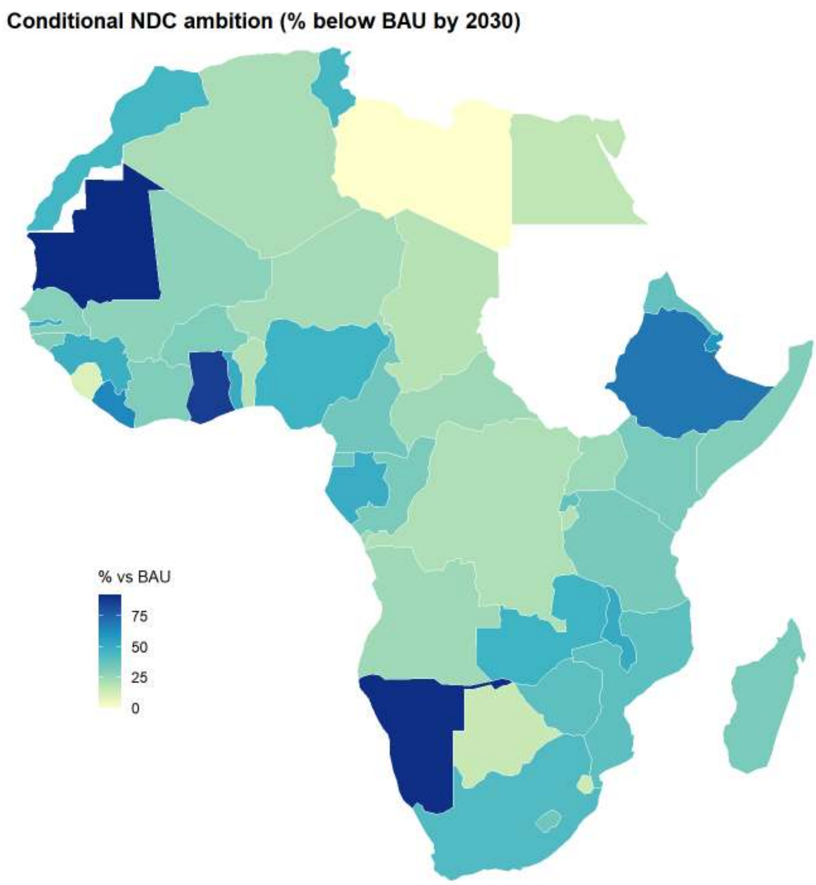

Figure 9: Conditional NDC ambition by country (% reduction below business-as-usual by 2030). Darker is more ambitious; the highest pledges cluster in the Gulf of Guinea and Southern Africa, the lowest in the fossil-anchored economies of the north *(country NDC registry, 2024; AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

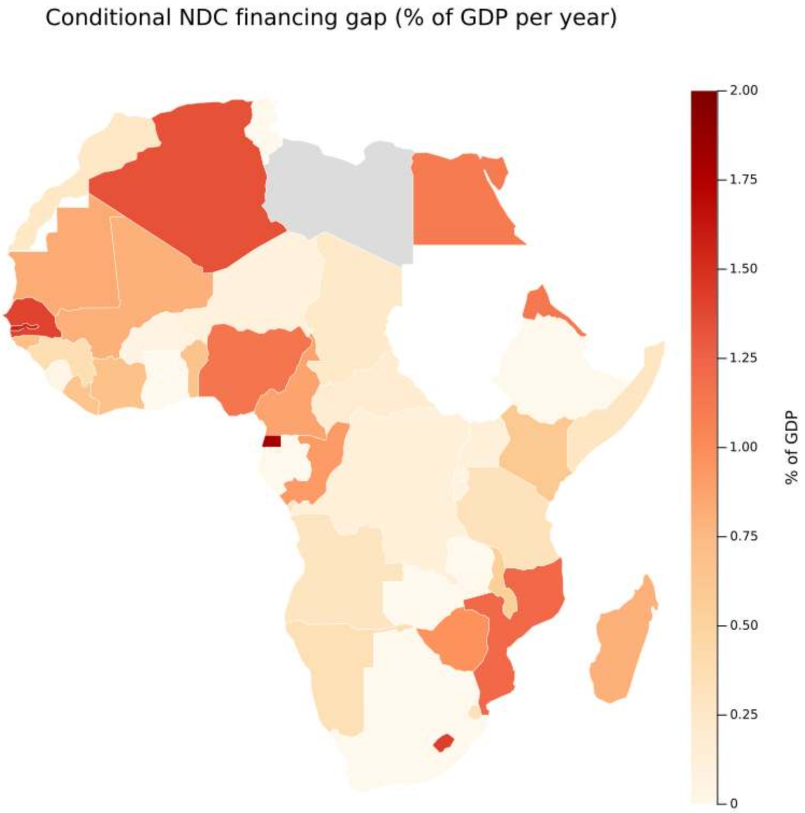

Figure 10: Conditional NDC financing gap by country (% of GDP per year) — the support needed beyond what domestic carbon revenue can self-finance. Largest in the thin-revenue drylands and small economies *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

This section is the quantitative core of the report. It draws together the 51 country CDCGE assessments developed in the per-country annex and the continental NDC registry, and asks a single question: what would it actually take, and cost, for Africa to deliver its Nationally Determined Contributions? The answer is more nuanced than either the optimistic "Africa is the cheapest place to abate" line or the pessimistic "Africa cannot afford mitigation" line. African pledges are genuinely ambitious; most of the ambition is conditional on international support; a large share lies outside the reach of any carbon price because it is land-use and forestry; and the energy share that carbon pricing can deliver is, in many economies, close to self-financing once revenue is recycled. Each of these four findings is developed below and quantified in Table 4.

Table 4: Continental mitigation & NDC diagnostic by climate-challenge region: number of economies, mean conditional NDC pledge, median modelled energy-CO_2 cut at \$100/t, median carbon price to meet the conditional pledge, median GE GDP cost and carbon revenue at that price, and median conditional financing gap. Computed across the country CDCGE runs.

Region	n	NDC cond. %	Cut@$100 %	Price $/t	GDP cost %	Carbon rev %GDP	Gap %GDP
North Africa	5	25.9	12.6	–	-1.79	3.5	0.00
Sahel & West drylands	7	38.9	9.2	–	0.01	0.8	0.03
Gulf of Guinea	9	43.1	4.5	–	-0.57	3.2	0.00
Central Africa forest	6	32.9	11.8	–	–	2.8	0.00
Horn & East Africa	9	38.3	5.1	–	0.69	0.5	0.01
Southern Africa	10	40.0	12.5	–	-0.31	3.4	0.00
Island states	5	30.5	8.3	–	-0.08	1.7	0.00

6.1 African NDCs are ambitious and overwhelmingly conditional

Across the 51 economies assessed, the mean conditional NDC implies a cut of roughly 37% below business-as-usual emissions *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*. This is not a timid set of pledges: at the regional level the mean conditional ambition ranges from 25.9% in North Africa to 43.1% in the Gulf of Guinea coastal and forest economies, with the Sahel and West African drylands (38.9%), Southern Africa (40.0%) and the Horn and East Africa (38.3%) all clustered near or above the continental mean (Table 4). The lower North African figure reflects large, fossil-anchored energy systems whose baselines are already high and whose pledges are framed against them, rather than any lack of effort; the high Gulf of Guinea and Central African (32.9%) figures are inflated by the weight of avoided deforestation in those baselines.

The defining structural feature is conditionality. The bulk of this ambition is explicitly contingent on international finance, technology transfer and capacity support; the unconditional core that countries commit to fund domestically is a fraction of the headline number *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*. This is the single most important framing fact for the cost analysis that follows: the question is not only "how much abatement," but "who pays for the conditional tranche," and the two are answered by very different instruments.

6.2 Most conditional pledges cannot be met by an energy carbon price alone

The most consequential continental finding is that only a minority of conditional NDCs are reachable within a \$200/t *energy* carbon price *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*. The majority of pledges are dominated by land-use, land-use change and forestry (LULUCF) and agriculture — avoided deforestation, peatland and wetland protection, soil carbon, livestock and rice management — which sit beyond the reach of an energy-sector carbon price no matter how high it is set. Pushing the energy price to \$200/t and beyond simply exhausts the abatement available in power, transport and industry long before it touches the forest and soil tonnes that make up the majority of the pledge in much of the continent.

The implication is direct and is the central policy message of this section: meeting the majority of Africa's conditional NDCs requires REDD+, results-based forest payments and agricultural-finance instruments, *not* carbon pricing alone. The regions where the energy carbon price is least able to deliver the full pledge are precisely the forest-rich blocs — the Central Africa / Congo Basin forest economies and the Gulf of Guinea coastal and forest states — where the pledged cut is large but the energy-CO_2 content of that cut is comparatively small (the median energy cut at \$100/t is 20.1% in Central Africa and 15.4% in the Gulf of Guinea, against a much larger headline pledge). For these economies the financing architecture must be built around land-use payments first and the energy carbon price second. By contrast, the fossil-grid economies of North and Southern Africa have a much larger energy share within their pledges, so a carbon price does most of the work there.

6.3 The required energy carbon price is high, but the GDP cost is small and the tonnes are often self-financing

For the energy share that carbon pricing *can* deliver, the median price required to meet the conditional pledge is roughly \$122/t across the continent *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*, with regional medians ranging from \$105/t in the Gulf of Guinea to \$149.9/t in the island states and \$148.9/t in the Horn and East Africa (Table 4). These are high prices by current global standards. Yet the headline cost result is reassuring: the general-equilibrium GDP cost of the energy NDC is small once carbon revenue is recycled. At the price needed to meet the energy pledge, the median GDP impact is close to zero or mildly positive in every region — ranging from −1.04% in Southern Africa and −0.92% in North Africa to essentially zero (−0.04%) in the Central African forest economies. The negative signs denote modest output *gains*: recycling carbon revenue (against distorting labour or capital taxes, or as targeted transfers) offsets and can outweigh the deadweight cost of the abatement itself.

More striking still, in the fossil-grid economies carbon revenue often exceeds the real resource cost of abatement, so the energy NDC is effectively self-financing. North Africa is the clearest case: median carbon revenue of 6.3% of GDP dwarfs the abatement bill, leaving a substantial fiscal surplus from the carbon price alone (Table 4). Southern Africa (3.9%), the Central African forest economies (3.2%), the Sahel and West African drylands (3.1%) and the Gulf of Guinea (3.0%) all raise carbon revenue of around 3–4% of GDP. The outlier on the low side is the Horn and East Africa, where median carbon revenue is just 1.5% of GDP: these economies have small fossil tax bases, so the carbon price generates little revenue to recycle and the energy NDC cannot pay for itself in the same way. The lesson is that the revenue-recycling dividend is largest exactly where the grid is most fossil-dependent, and smallest in the low-carbon, hydro- and biomass-reliant economies that have the least to tax.

6.4 The residual financing gap is modest as a share of GDP but large and uneven in absolute terms

After domestic carbon revenue is recycled and the self-financing tonnes are netted out, a residual conditional financing gap remains. In GDP terms it is modest: the continental mean conditional financing gap is about 0.5% of GDP per year *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*, with regional medians from 0.13% in the Horn and East Africa to 0.81% in both the Sahel and West drylands and the island states (Table 4; Figure 11). The gap is small relative to each economy — but it is large in absolute dollar terms when summed across 51 countries every year for two decades, and it is unevenly distributed. The regions with the highest gaps as a share of GDP are not the largest emitters but the most constrained: the drylands and small-island states, where revenue bases are thin and the pledge leans on non-revenue and land-use measures that no carbon price will fund.

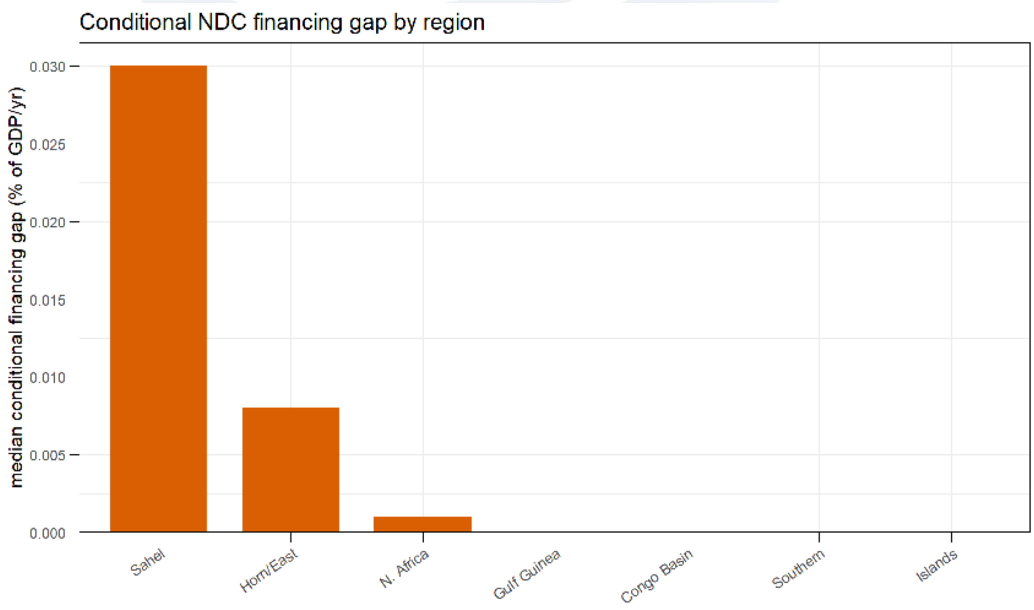

Figure 11: Conditional NDC financing gap (% of GDP per year) by region.

6.5 Financing-mode implications at continental scale

Putting the four findings together yields a coherent financing architecture in which each tranche of the NDC is matched to the instrument that can actually pay for it:

- **Domestic carbon revenue for the unconditional core.** The unconditional, energy-sector tranche that countries must deliver themselves is, in the fossil-grid economies, more than covered by the carbon price's own revenue (North Africa 6.3% of GDP; Southern Africa 3.9%). These tonnes are cheap and self-claimed; they should be financed domestically and recycled, not sold abroad.

- **Grants and concessional climate finance for the non-revenue and land-use measures.** The REDD+, peatland, soil-carbon and agricultural measures that dominate the conditional pledges in the Congo Basin and Gulf of Guinea, and the abatement in the low-revenue Horn and East Africa (1.5% of GDP carbon revenue), cannot be self-financed. These require results-based grants and concessional finance — the core of the conditional ask.

- **Private and blended finance for bankable renewables.** The energy-supply share of the pledge — utility-scale solar, wind and grid — is bankable and should be mobilised through private and blended structures, freeing scarce public and concessional finance for the measures that cannot attract commercial capital.

- **Article 6 used to fund ambition above the core, not to sell the cheap tonnes.** Cooperative approaches under Article 6 should finance ambition *beyond* the domestically fundable core, with corresponding adjustments applied carefully. The cheap, self-financing energy tonnes are precisely the ones countries must retain to meet their own NDCs; selling them abroad would hollow out the domestic pledge and leave the expensive, conditional land-use tranche unfunded.

The country contrasts sharpen the point. North Africa is a fiscal-surplus, carbon-revenue story whose challenge is recycling, not finance-raising. The Congo Basin and Gulf of Guinea are forest-finance stories whose pledges live or die on REDD+ and agricultural payments. The Horn and East Africa combine real ambition (38.3% mean conditional) with the thinnest revenue base (1.5% of GDP) and the smallest residual gap (0.13%), implying that grants, not carbon pricing, must carry their NDCs. The Sahel/West drylands and island states carry the largest financing gaps relative to GDP (0.81% each) and the least capacity to close them domestically, making them the clearest priorities for concessional support.

Key messages

- African NDCs are ambitious — a mean conditional cut of about 37% below BAU — and overwhelmingly conditional on international support.

- Only a minority of conditional pledges are reachable within a \$200/t energy carbon price; the rest are dominated by land-use and forestry and require REDD+ and agricultural finance, not carbon pricing.

- The carbon price needed to meet the energy share is high (median about \$122/t), but the recycled general-equilibrium GDP cost is small or even positive, and in fossil-grid economies carbon revenue exceeds abatement cost, making the energy NDC self-financing.

- The residual conditional financing gap is modest in GDP terms (mean about 0.5% per year) but large in absolute terms and concentrated in the low-revenue drylands, island and East African economies.

- Match the instrument to the tranche: domestic carbon revenue for the unconditional core, grants and concessional finance for land-use and non-revenue measures, private and blended capital for bankable renewables, and Article 6 to fund ambition above the core rather than to sell the cheap tonnes countries must claim themselves.

7. Least-cost NDC pathways: sequencing the full lever set

Section 6 asked whether an energy carbon price *alone* could reach each pledge. This section asks the sharper question a finance ministry actually faces: given the pledge, what is the least-cost *sequence* of *all* the energy-sector instruments — a carbon-price ladder *and* renewable-energy support, electrification and a border carbon adjustment — deployed together, and how far does that optimal mix get? It applies, across all 51 economies, the same merit-order optimiser that drives Section 8 of every country report: the country CDCGE runs supply a marginal-abatement-cost (MAC) curve, instruments are switched on cheapest-tonne-first until the pledge's glide-path is met, the carbon price is entered as *incremental* rungs so nested price scenarios are not double-counted, and the last instrument deployed sets the implied *shadow carbon price (AICTEM continental synthesis of 51 country assessments (this study), 2024)*. The result is a continental map of *how* — and how far — each country can travel toward its NDC on energy levers before land-use measures must take over.

Table 5: Least-cost NDC pathway by climate-challenge region: economies, mean conditional pledge, median share of the pledge deliverable by the full *energy*-lever set (carbon-price ladder plus renewables, electrification and a border adjustment), the number of economies whose pledge is fully reachable that way, the number with net GDP-positive (no-regret) energy levers, and the median implied shadow carbon price. Merit-order optimiser over the country CDCGE runs.

Region	n	NDC cond. %	Energy coverage %	# reachable	# no-regret	Shadow \$/t (med.)
North Africa	5	26.3	100	3	4	1018
Sahel & West drylands	7	38.9	73	3	5	12526
Gulf of Guinea	9	43.1	47	4	6	9425
Central Africa forest	6	32.9	72	0	5	5084
Horn & East Africa	9	38.3	47	2	6	54486
Southern Africa	10	40.0	84	4	8	3134
Island states	5	30.5	67	1	2	23759
Africa (all)	51	37.0	67	17	36	9425

7.1 Two regimes: pledges energy levers can finish, and pledges they cannot

The optimiser sorts the continent cleanly into two groups (Figure 12). For **17 of the 51 economies the full energy-lever set delivers the entire conditional pledge**; for the other **34 it runs out before the target**, leaving a residual that only land-use, forestry and agriculture (AFOLU) can close. This corroborates, from an independent pathway construction, the Section 6 finding that roughly a third of African pledges are reachable on energy instruments and two-thirds are land-use-dominated (there the count was 19 of 51 within a \$200/t price; here 17 of 51 under the complete lever set — the two agree to within the ambiguity of the reachability threshold). The continental median economy can cover about **67%** of its pledge with energy levers (Table 5).

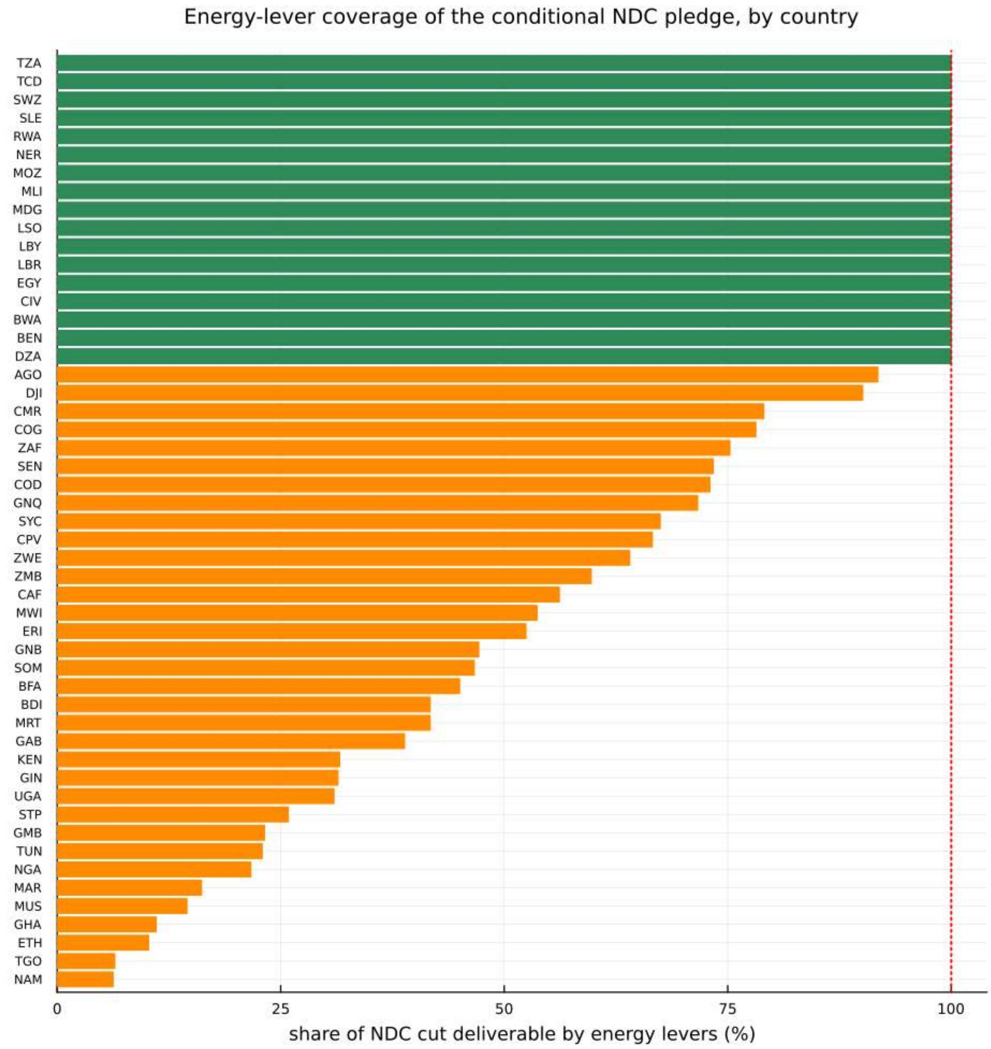

Figure 12: Share of each country's conditional NDC cut that the least-cost energy-lever mix can deliver by the target year. Green economies are fully reachable on energy instruments; orange economies are energy-limited and must rely on land-use/AFOLU measures for the residual *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

7.2 Ambition and energy-reachability are inversely related

Coverage is not a measure of effort — it is a measure of where the abatement *is*. Figure 13 plots each pledge's depth against the share energy levers can deliver, and the relationship is clearly downward-sloping: the modest pledges of the fossil-anchored economies (North Africa, several Southern African grids) are comfortably met by energy instruments and sit at the top-left, while the deepest pledges — the Gulf of Guinea and Congo Basin forest economies, where the headline number is inflated by avoided deforestation — sit at the bottom-right, energy-limited almost by construction. A high ambition figure in Africa is therefore, more often than not, a *land-use* pledge wearing an economy-wide label; the energy toolkit was never going to reach it, and the coverage chart makes that structural fact explicit country by country.

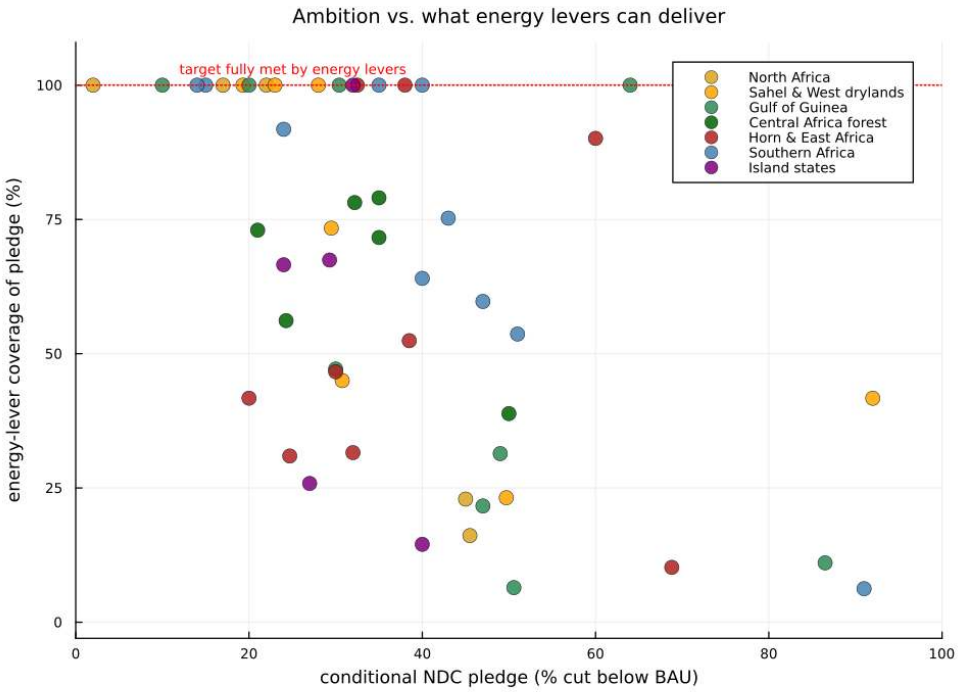

Figure 13: Conditional NDC pledge (% cut below BAU) against the share deliverable by the least-cost energy-lever mix, coloured by climate-challenge region. Points on the red line are fully met by energy levers; the downward slope shows that deeper pledges are progressively more land-use-dominated *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

7.3 The energy that *is* deliverable is largely no-regret

The most encouraging result concerns the *cost* of the deliverable share. In **36 of the 51 economies the optimiser deploys renewable support and/or electrification at *negative* cost** — they cut emissions while *raising* GDP, because across most of Africa cleaner or electrified energy displaces expensive imported fuel and under-used capacity (Table 5, "no-regret" column). These are the tonnes to buy first regardless of the pledge, and in the merit order they always are: the coverage that energy levers achieve is delivered predominantly by measures that pay for themselves, with the carbon-price rungs added only on top. Southern Africa (8 of 10 economies with a no-regret lever), the Horn and East Africa (6 of 9) and the Gulf of Guinea (6 of 9) are especially well-supplied with such win-win options.

7.4 Shadow prices: modest where the fossil base is deep, a red flag where it is thin

The implied shadow carbon price — the cost of the last tonne the mix must buy — follows the size of the fossil base, not the ambition of the pledge. Where the grid is fossil-heavy and the pledge is largely energy (North Africa, median $1,018/t; Southern Africa, $3,134/t) the shadow price is high by today's standards but finite and policy-relevant. Where the energy base is tiny and hydro- or biomass-dominated (the Horn and East Africa, median $54,486/t; several island states) the shadow price is astronomical — not a recommended tax, but the model's signal that squeezing further *energy* CO_2 out of an already-clean system is disproportionately costly, and that the pledge's real, cheap abatement lies in land use. Reading the shadow price this way turns an apparent anomaly into the section's core diagnostic: a very high number is an instruction to stop pushing the carbon price and switch to forests and soils.

Key messages

- Under the full energy-lever set, **17 of 51 African pledges are reachable on energy instruments and 34 are energy-limited** — an independent pathway confirmation of the Section 6 split, with a continental median coverage of about 67% of the pledge.

- **Ambition and energy-reachability are inversely related**: the deepest pledges are forest-and-soil pledges, structurally beyond the energy toolkit, so a low coverage score is a statement about *where* the abatement sits, not about effort.
- The deliverable energy share is **largely no-regret** — 36 of 51 economies have renewable or electrification options the optimiser deploys at negative cost, raising GDP — so the first move everywhere is to exhaust the win-win tonnes before pricing.
- **Shadow prices diagnose the strategy**: modest in the fossil-grid north and south (carbon pricing does real work), astronomical in the clean-energy Horn and islands (a signal to shift the pledge's weight to land use, not to raise the tax).
- The pathway view reinforces the financing architecture of Section 6: *sequence* no-regret energy first, price carbon modestly and recycle the revenue, and route the land-use majority of the pledge through REDD+ and results-based agricultural finance. The country-by-country pathways underlying this synthesis are in Section 8 of each national report.

8. Key messages

The following continental key messages draw on the country assessments and the continental CDCGE/CSTATUS diagnostic. Each is grounded in the regional medians of Table 4 and Table 1 and the underlying model runs *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

1. **Africa faces a double exposure: high climate risk, low historical responsibility.** The fifty-one economies assessed have contributed little to cumulative emissions yet are among the most physically exposed, with the binding hazard ranging from dryland desiccation in the Sahel and Horn to coastal and island inundation and forest-carbon stewardship in the Congo Basin.
2. **Unmitigated climate damage is large and falls hardest on rural livelihoods.** Absent adaptation, the model projects rural incomes falling by roughly 8 to 13 percent by 2050 across the continent, with North Africa most exposed at a residual rural-income loss near 6.8 percent even after adaptation.
3. **A disciplined adaptation package roughly halves the damage — everywhere.** The DRR adaptation package cuts the rural-income loss by about half across all seven regions (Figure 3), the single most robust and transferable finding in the report; outside North Africa the residual loss is compressed to between 3.4 and 3.8 percent.
4. **African mitigation ambition is real but uneven.** The mean conditional NDC across the continent is about 37 percent, ranging from a modest 25.9 percent in North Africa to 43.1 percent in the Gulf of Guinea belt (Figure 6), reflecting genuine differences in pledge depth and in what each economy can plausibly deliver.
5. **Most conditional pledges lie beyond the reach of energy carbon pricing alone.** Only a minority of conditional NDCs are achievable within a $200 per tonne energy carbon price; the remainder are dominated by land-use and forestry abatement that domestic energy pricing cannot touch (Figure 7) *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.
6. **Meeting the conditional pledge requires a high carbon price, but a modest GDP cost.** The continental median carbon price needed to meet the conditional NDC is about $122 per tonne, yet once carbon revenue is recycled the median general-equilibrium GDP

cost is small — between roughly 0.0 and 1.0 percent across regions, and in several regions a net gain.

7. **Carbon revenue is a meaningful but unevenly distributed fiscal resource.** Median carbon revenue ranges from 6.3 percent of GDP in North Africa's fossil-intensive economies down to 1.5 percent in the Horn and East Africa, making revenue recycling central in the carbon-heavy north and far less consequential where the energy base is thin.

8. **The conditional financing gap is small on average but concentrated.** The mean conditional NDC financing gap is about 0.5 percent of GDP per year, but it is far from uniform — around 0.8 percent in the Sahel and in the island states versus near 0.1 percent in the Horn (Figure 11), so a continental average masks where external support is most binding *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*.

9. **Land use, not energy, is the continent's largest mitigation lever — and its largest financing challenge.** Because so much abatement potential sits in forests and land use beyond the carbon-pricing margin, the Congo Basin and forest economies cannot self-finance their pledges through energy instruments and depend on grants, concessional finance, and results-based forest payments.

10. **The least-cost pathway is to sequence no-regret energy first, then price, then land use.** A merit-order optimiser across the full energy-lever set confirms the split — 17 of 51 pledges are fully deliverable on energy instruments, 34 are energy-limited — but shows the deliverable share is largely self-financing: in 36 of 51 economies renewables or electrification abate at negative cost, raising GDP (Section 7, Table 5). Shadow carbon prices are modest where the fossil base is deep and astronomical where it is thin, a direct signal of when to stop pricing and switch the pledge's weight to forests and soils.

11. **Adaptation and mitigation are not substitutes but a twin track.** Adaptation must be front-loaded and largely publicly financed because its returns — halved rural-income losses — accrue regardless of global mitigation, while mitigation can be sequenced and substantially self-financed through recycled carbon revenue wherever the energy base is large enough to support it.

9. Policy conclusion at the continental level

The synthesis points to one organising principle for African climate policy: a *twin-track imperative* that treats adaptation and mitigation as complementary, differently financed and differently sequenced. The two tracks share neither the same urgency profile nor the same funding logic, and conflating them — as much international climate finance still does — has left African adaptation chronically underfunded relative to its returns. The continental evidence makes the case for keeping them distinct.

9.1 The twin-track imperative

The first track is adaptation, and it must be front-loaded and predominantly publicly financed. Its returns do not depend on the success of global mitigation: the DRR package roughly halves rural-income losses in every region (Figure 3), turning a projected 8-to-13 percent unmitigated loss into a residual of 3.4 to 3.8 percent across most of the continent, and a still-severe but reduced 6.8 percent in North Africa. Because these benefits are local, near-term, and largely non-market — protected livelihoods, avoided displacement, food security — they will be undersupplied by private capital and must be carried by public budgets and concessional external finance. Adaptation is the track that cannot wait.

The second track is mitigation, and it can be sequenced and substantially self-financed where the energy base allows. The continental median carbon price needed to meet the conditional NDC is about $122 per tonne, but once revenue is recycled the general-equilibrium GDP cost is small — between roughly zero and one percent of GDP, and negative in several regions. The binding constraint on mitigation is therefore not aggregate cost but instrument coverage: with only a minority of conditional pledges reachable within a $200 per tonne energy price (Figure 7), the larger share of Africa's pledged abatement sits in land use and forestry, which no domestic energy carbon price can deliver.

9.2 A continental finance architecture

These two tracks imply four distinct financing instruments, matched to where each works.

Recycled carbon revenue is the workhorse of energy mitigation. It is largest precisely where the energy transition is hardest — 6.3 percent of GDP in North Africa's fossil-intensive economies — and recycling it into transfers, clean-energy investment, and just-transition support is what holds the GDP cost of the energy NDC near zero. Where the energy base is thin, as in the Horn at 1.5 percent of GDP, carbon revenue cannot carry the load and external instruments must.

Grants and concessional finance are indispensable for land use and adaptation, the two domains that markets will not fund. The conditional financing gap averages about 0.5 percent of GDP per year but concentrates in the Sahel and the islands at around 0.8 percent (Figure 11); closing it is a small number in global terms and a decisive one locally. Forest-rich Central Africa, whose pledges are dominated by land-use abatement beyond the pricing margin, depends on results-based forest payments and concessional capital rather than on its own fiscal space.

Blended capital and Article 6 can stretch scarce public money. Carefully governed Article 6 cooperative approaches and forest-carbon crediting can channel external mitigation finance into exactly the land-use abatement that domestic energy pricing cannot reach — provided environmental integrity and benefit-sharing are protected. *Debt-for-climate* swaps offer fiscal relief to the most debt-constrained economies, converting unsustainable obligations into adaptation and conservation spending where the financing gap and the debt burden coincide.

9.3 Regional differentiation

No single package fits the continent. The **Sahel and West African drylands** need adaptation finance above all — the largest financing gaps (around 0.8 percent of GDP) meet severe dryland damage, and carbon revenue at 3.1 percent of GDP offers only partial cover. The **fossil-grid south** — Southern Africa, with the deepest median GDP cost saving once revenue is recycled — needs a just-transition compact built around recycled carbon revenue and managed coal-to-clean reinvestment. The **island and small-island states** face the highest carbon prices to meet shallow pledges and large financing gaps relative to tiny economies; they need grant-based adaptation and loss-and-damage support, not carbon markets. The **Congo Basin and forest economies** are the continent's carbon sink and need results-based land-use finance, because their pledges are structurally unreachable through energy pricing. **North Africa**, carbon-rich and adaptation-stressed, is the clearest case for recycling large carbon revenues into both transition and adaptation simultaneously.

9.4 Africa in the global system

Africa's domestic instruments cannot close the gap alone, and the synthesis makes the international ask precise. *Loss and damage*: the residual rural-income losses that persist even after adaptation — up to 6.8 percent in North Africa — are the quantified basis for operationalised loss-and-damage support to economies that did least to cause the problem. *Fair carbon-border treatment*: as carbon-border adjustment mechanisms spread, they must credit African mitigation effort and not penalise economies whose emissions are low and whose fiscal space is thin; otherwise they become a regressive transfer from the least responsible to the most. *The development–diversification–climate nexus*: for fossil-dependent exporters, climate policy is inseparable from economic diversification, and international finance should fund the diversification that makes decarbonisation politically and fiscally survivable.

9.5 The continental case for action

The continental diagnostic delivers a clear message. Adaptation pays everywhere and must be financed now, publicly and through grants, because it halves the damage regardless of what the rest of the world does. Mitigation is affordable where the energy base supports a recycled carbon price, and unreachable through pricing where it rests on land use — so it must be sequenced and externally co-financed accordingly. The total external ask is modest by global standards: a mean conditional financing gap of about half a percent of African GDP per year, plus the concessional and results-based finance that land use and adaptation require *(AICTEM continental synthesis of 51 country assessments (this study), 2024)*. The corresponding return is the protection of hundreds of millions of rural livelihoods and the stewardship of the world's second-largest tropical forest. Africa has set out credible, differentiated pledges; the question now is whether the finance architecture — domestic carbon revenue, concessional grants, blended capital, Article 6 and debt-for-climate — is assembled at the scale and on the timetable the evidence demands. That choice belongs to the international community, not to Africa alone.

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