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Technical Brief

ENERGY

Climate Resilient Solar PV in Africa

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SOLAR PV INVESTMENTS IN AFRICA ARE GROWING AND FINANCIAL RETURNS ARE AT RISK THE RATIONALE FOR CLIMATE-RESILIENT SOLAR PV PROJECTS

Africa faces a significant energy gap, as nearly 600 million people in Sub-Saharan Africa lack electricity access (World Bank, 2025). As the population on the continent grows, and African economies expand, the demand for electricity is rising rapidly. Solar PV offers strong potential to close this gap. Global and local private investors have taken notice that solar PV is now the least-cost source of power in many African countries, due to declining technology costs. As a result, in 2023, clean energy investments in Africa grew 12% to \$36.6 billion, with solar PV accounting for a growing share (IEA, 2023). Further, the ambition for Africa is to connect more than 300 million people to electricity by 2030 and solar plays a pivotal role in reaching this ambition (Mission 300, World Bank and African Development Bank, 2025).

Solar PV projects have a strong business case. Commercial and industrial customers and local businesses seek reliable sources of power and can realise significant long-term savings on electricity costs when shifting to solar. Investors are attracted by the high potential return on investment in solar PV projects – ranging between 10% and 12% (Industry, 2024)– but in Africa, they experience new challenges to recoup their returns. Some of these challenges are higher capital costs than in developed markets, due to currency volatility and political instability, and long project development times due to project complexities and due diligence requirements.

The strength of the business case is further threatened by climate-related risks. Across Africa, climate hazards are increasingly shaping the operational environment for energy and infrastructure systems. Rising temperatures drive more frequent and prolonged heat extremes, with several regions already experiencing warming of about 1°C and projected increases of 2-3°C in the coming decades. Coastal areas face additional risks from sea level rise – projected at 10 to 36 cm by 2050 – which heightens the exposure of low-lying zones to flooding and storm surges. These hazards pose direct threats to the durability, efficiency, and safety of critical systems, and compound socio-economic vulnerabilities, especially in rural and coastal communities that rely heavily on resilient energy access and infrastructure.

Climate resilient solar PV projects present a clear opportunity to de-risk investments while delivering wider economic and social benefits. Upfront integration of adaptation measures – such as siting projects outside flood-prone zones, elevating infrastructure, using temperature-resistant modules, and applying slope stabilisation or drainage systems –can significantly reduce exposure to climate hazards like flooding, extreme heat, or landslides. Although these measures may increase initial project costs by 15–30%, they are shown to yield strong benefit-cost ratios (up to 20:1 in some cases), by avoiding damage, minimising downtime, and preserving revenue streams. Beyond asset protection, resilient projects lower operational risks, reduce insurance premiums, and improve bankability by providing investors and lenders with greater confidence in long-term cash flows. Climate resilient solar PV projects also generate significant benefits for communities, as health clinics and small businesses can benefit from stable electricity during climate shocks, safeguarding millions of jobs and protecting lives and livelihoods.



MAIN CLIMATE HAZARDS AFFECTING SOLAR PV PROJECTS IN AFRICA

Africa has some of the world’s highest solar irradiance levels, with over 85% of land receiving more than 2,000 kWh/m² annually. However, solar PV investments in Africa face a wide spectrum of climate hazards that undermine performance, raise costs, and increase financial risks:

HEAT STRESS



- Module efficiency drops 0.4-0.5% for every degree Celsius rise in temperature above 25°C. This means on a scorching 35°C day, the panels could be operating at approximately 3-5% lower efficiency than their rating suggests.
- Heatwaves with ambient temperatures >40°C can reduce the service life of conductors by up to 40% (GCA, Mozambique, 2025).
- Heatwaves is projected to be from severe to very severe on every analyzed country in the RCP 8.5 scenario, leading to revenue reduction up to 10-20% for solar technologies.
- In the Sahel, these losses translate to \$87,000–\$122,000 annually for a 10 MW plant, which over a 20-year PPA equates to several million in foregone revenues.

DUST AND DROUGHT



- Dust storms increase soiling, raising cleaning frequency and O&M costs by 20–30%, while drought-driven land degradation worsens dust exposure.
- Dust particle deposition can reduce PV panel output by 5–25%, depending on the duration and intensity of accumulation, and by up to 60% in desert regions (Hussain et al., 2017).
- In Mali, dust storms caused repeated mini-grid outages, resulting in daily revenue losses of \$50–\$100 per shop, particularly in cold-chain dependent sectors.

WILD FIRES



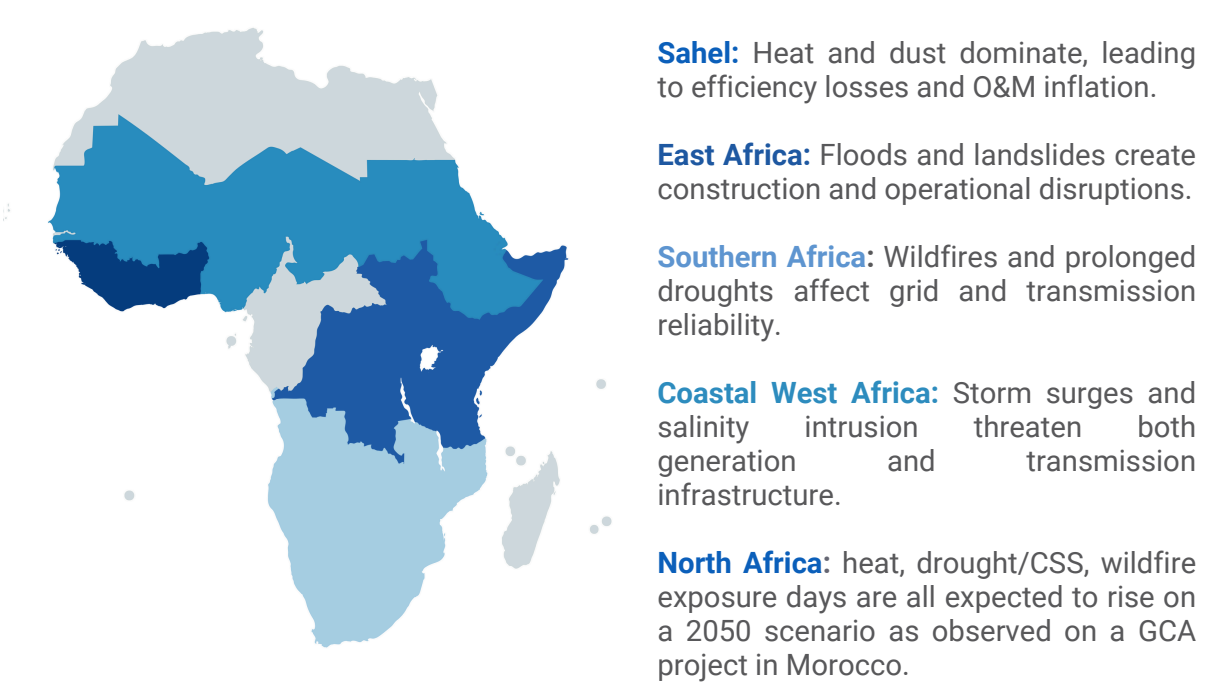
- Wildfires can either directly burn solar assets or indirectly reduce performance through smoke and ash.
- Wildfire could generate an loss between 5-10% of the revenue associated to the generation capacity.
- In Mozambique, wildfire hazards account for 94% of the replacement value at risk for transmission assets.

FLOODING AND STORMS



- Extreme rainfall, floods, and storm surges disrupt construction schedules, and cause structural damage to solar parks and transmission lines.
- Heavy precipitation and flooding can generate 10–20% revenue loss, associated to the generation capacity.
- In coastal West Africa, rising seas (10–36 cm by 2050) amplify flood risks, damaging solar assets through corrosion, short circuits, and weakened foundations, raising safety and failure risks.

MAJOR REGIONAL HAZARD DISTRIBUTION:



These effects raise financing costs, reduce leverage, and pressure debt service — making climate resilience a prerequisite for bankability and guarantee eligibility.

ADAPTATION SOLUTIONS FOR SOLAR PV

SITE SELECTION	ENGINEERING DESIGN UPGRADES	O&M RESILIENCE	AGRIVOLTAICS AND SOLAR GRAZING
			
Avoiding floodplains and unstable slopes can reduce exposure to high-loss events. General siting measures add 5–15% to CAPEX. They could deliver very high benefit-cost ratios (BCR) of 7:1 to 20:1.	Elevated mounting, fire breaks, slope stabilization (including nature-based solutions), and high-temperature-rated equipment reduce physical damage risk. Incremental costs (10–20% CAPEX) could achieve BCR of 5:1 to 10:1.	Automated/robot-assisted dry cleaning, redundant spare part storage, and local capacity building can reduce downtime and revenue loss. O&M upgrades (5–10% of total investment) deliver BCRs of 4:1 to 8:1.	Dual-use land strategies reduce dust accumulation, extend panel life, and generate secondary income streams, strengthening project cash flow resilience.

(Hussain, A., Batra, A. & Pachauri, R. An experimental study on effect of dust on power loss in solar photovoltaic module. Renewables 4, 9 (2017). <https://doi.org/10.1186/s40807-017-0043-y>
Global Center on Adaptation. (2025, March 21). Project-level, high-granularity climate-risks assessment and adaptation measures: AfDB—Climate-resilience and adaptation options for Mozambique Songo–Matambo transmission line [Final project report]. Global Center on Adaptation.
MeteoSIM, & GlobalCAD. (2024, April 26). Downscaling report: AfDB—Climate-resilience and adaptation options for Mozambique Songo–Matambo transmission line [Technical report]. Global Center on Adaptation.

GCA CASE STUDIES



MAURITANIA (KIFFA 50 MW):

Advanced cooling and robot-assisted cleaning would have an incremental CAPEX +8–12% delivered BCR 5–7.



MOZAMBIQUE (TRANSMISSION):

Fire breaks and slope revegetation would mitigate wildfire exposure, preserving insurability, and deliver a BCR of 4.1.



MALI (MINI-GRIDS):

Robot-assisted dry cleaning would stabilize tariff recovery, and it would have an O&M cost increase +5–8% yielded BCR 1.2–2.2.

RELEVANCE FOR PRIVATE INVESTORS

Guarantee agencies, underwriters, and lenders increasingly link coverage and financing eligibility to climate risk management. Climate resilient solar PV project design provide:



Protects Revenues and Cashflows

Mitigates variability from heat, dust, and outages, stabilizing cashflows and reducing refinancing risk and covenant breaches.



Lowers Financing Costs and Unlocks Capital

Helps meet eligibility criteria for guarantees and MDB financing. Increasingly, underwriters and lenders require climate risk assessments and resilience measures, ensuring access to guarantees and concessional funding.



Extends Asset Life and Reduces O&M Volatility

High-temperature equipment and Nature-based Solutions can extend conductor and panel life by up to 40%, improving the Internal Rate of Return.



Strengthens Market Position and Community Support

Resilient developers gain a competitive edge in tenders and PPP. Agrivoltaics and solar grazing provide co-benefits (food security, livelihoods) that reduce social risk while enhancing ESG ratings, in line with investor disclosure frameworks (TCFD, ISSB, EU Taxonomy).

CONCLUSION AND RECOMMENDATIONS

Solar projects that integrate climate adaptation solutions are more likely to achieve financial close, attract commercial lenders, and sustain long-term performance.

Guarantee agencies can catalyse resilient investment by: requiring climate risk assessments and adaptation integration at feasibility stage, linking guarantee eligibility to minimum resilience standards, mobilising blended finance to cover incremental CAPEX, and stress-testing financial models under climate scenarios to safeguard debt service.

Development financial institutions and commercial banks can catalyse resilient investment by: integrating climate risk screening into credit appraisal processes, requiring borrowers to embed adaptation measures in project design, tying concessional lending or favourable terms to resilience performance, structuring blended finance facilities to de-risk adaptation components, and incorporating climate scenario analysis into loan covenants to ensure portfolio stability and protect repayment capacity.

For private investors, the climate resilience of physical assets is integral to bankability, making adaptation measures not just an environmental imperative, but a financial one.

Global Center on Adaptation. (2023). *Technical guidelines for climate-resilient solar assets in the Sahel: Country brief—Mali* [Project report].

Global Center on Adaptation. (2023). *Technical guidelines for climate-resilient solar assets in the Sahel: Country brief—Mauritania* [Project report].