FACTSHEET 4

# Climate Proofing Sustainable Energy Solutions

SESA
Smart Energy Solutions for Africa

Unsplash / Shravan Acharya

## About the Sustainable Energy Solutions Catalogue

The Sustainable Energy Solutions Catalogue provides an introduction to the solutions deployed during the SESA project. The catalogue targets energy practitioners, policy makers and civil society, especially at local level. In the catalogue, readers can find key facts about specific sustainable energy solutions (technologies, business models, impact areas), or learn about approaches and concepts that help ensure the viability and long-term success of sustainable energy in the African context.

**AUTHORS:**

Madeleine Raabe (WI), Elena Turienzo López (TEC), María Yetano Roche (WI)

Contributors: Edmund Teko (UEMI), Sophia Schneider (WI)

## 1 Introduction

The transition to clean and affordable energy for all in Africa will take place while the continent is adapting to the impacts of climate change. Sustainable energy solutions, such as solar mini-grids or e-mobility fleets, are cost-effective and can bring about social and economic benefits while reducing emissions. But even if they are vital to fighting against climate change, they are also vulnerable to risks resulting from it. If the solutions are not designed to withstand the new climatic conditions and variability, they will not reach their full potential. Climate-proofing sustainable energy solutions is therefore vital to the success of the energy transition in Africa. Additionally, climate-proofing has the potential to create economic opportunities and ensure energy security.

**Climate-proofing is a process that identifies risks to an asset as a result of climate change and variability, and ensures that those risks are reduced** through long-lasting and environmentally sound, economically viable, and socially acceptable adaptation measures. It involves the integration of possible risks caused by climate change into policies, project planning and design (European Commission and EEA, 2022).

This factsheet introduces key facts regarding the **climate proofing of sustainable energy solutions in the African context, focusing on the solutions that are deployed within the SESA project**. The structure of the factsheet is as follows: first, it introduces the key impacts of climate change in Africa, followed by an analysis of the specific risks relevant to the sustainable energy solutions that are being tested within SESA. It then provides general guidelines for climate-proofing implementation, as well as examples of application in the African context. Lastly, the factsheet lists tools and capacity building materials on the topic.

# 2 Climate change impacts in Africa

The African continent is one of the lowest contributors to greenhouse gas (GHG) emissions and has the lowest emissions per capita in comparison to all other regions. Though one-fifth of the world's population lives in Africa, the continent accounts for less than 4% of global energy-related carbon dioxide ($CO_2$) emissions (IEA, 2022). Nevertheless, the increase in warming is advancing faster in Africa than in the rest of the world, and Africans are disproportionately affected by climate change. Socio-economic, political and environmental factors are exacerbating the exposure and vulnerability to climate change in Africa. As a consequence of observed anthropogenic climate change, Africa is experiencing widespread loss and damage, including loss of lives, water shortages, biodiversity loss, reduced food production, and reduced economic growth, among others (IPCC, 2022; IEA, 2022).

Key impacts of climate change in Africa – both impacts that are currently observed and those projected for the future – are summed up in Table 1.

As well as the impacts listed below, climate change poses risks to infrastructure and value chains, including energy, mobility, telecommunications, and water. Climate change can be the direct cause of infrastructure damage due to, for example, extreme weather events, but it can also indirectly cause damage due to climate-related displacement or economic impacts. There are also

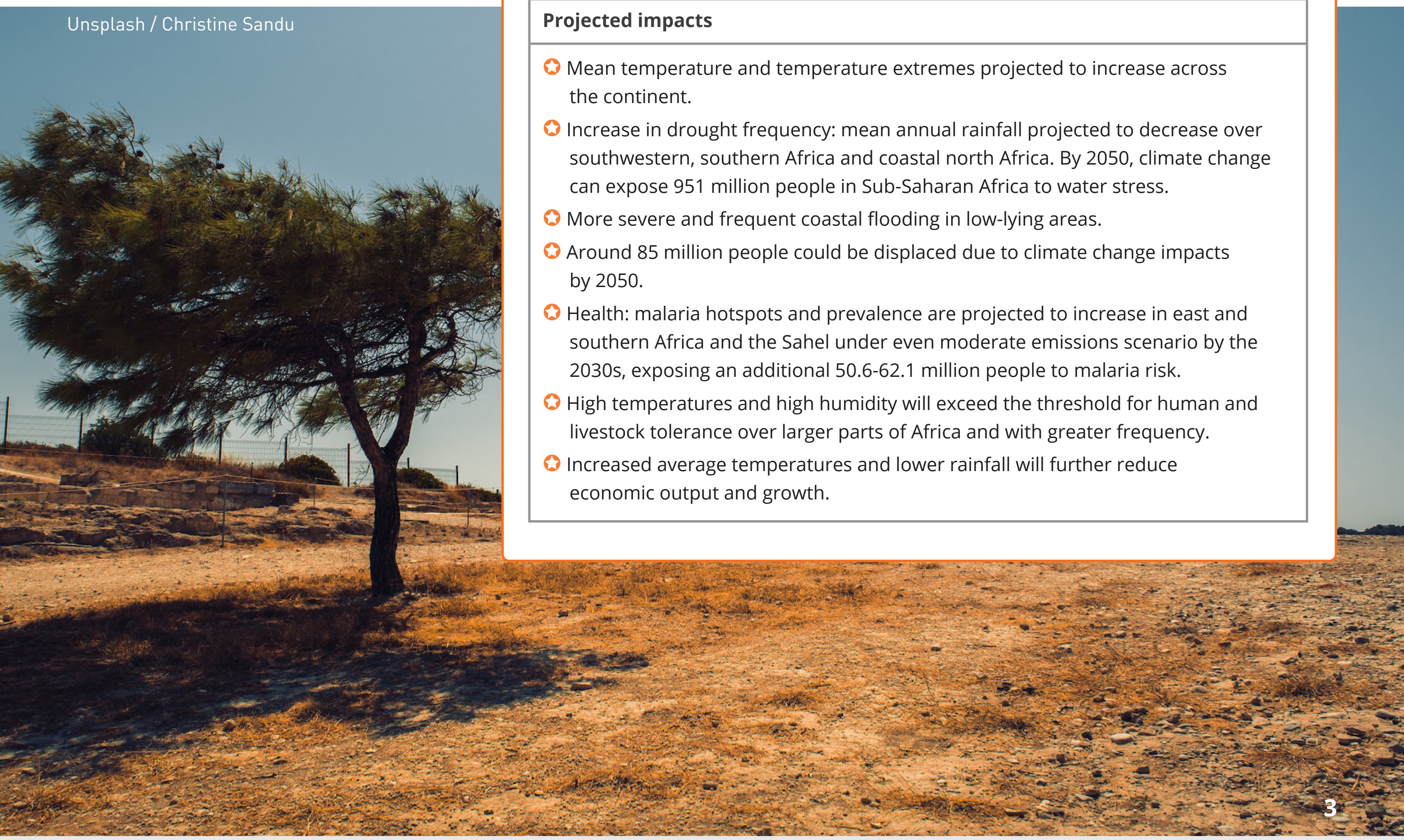
Figure 1: **Flood in rural Nkamira, North West Rwanda** (Terry J Lawrence via Getty Images)

interdependencies among different types of infrastructure, for example, between energy and water, or energy and mobility. If one infrastructural asset is negatively affected by climate change, this can lead to a cascade of impacts through the system. Therefore, resilient physical infrastructure and business models are required in a context of increasing climate variability and change.

When critical infrastructure and energy assets are climate-proofed, loss of lives, interruptions in critical services and physical damages can be reduced (UN Habitat, 2021). It is urgent to foster the climate-proofing of infrastructure in Africa, including for emerging sustainable energy solutions such as solar mini grids or e-mobility assets. The following section focuses on the risks resulting from climate change on the sustainable energy solutions that are tested within the SESA project, and also highlights the potential for climate-proofing them.

Table 1: **Observed and projected impacts of climate change in Africa** (own compilation based on IPCC, 2022 and IEA, 2022)

| **Observed impacts** |
|---|
| Increase in average temperatures is faster than in any other world region. |
| Increase in annual heat wave frequency, intensity and duration. |
| Sea level rising faster than the global average, accompanied by coastal flooding and erosion. |
| Higher frequency of heavy precipitation events accompanied by floods, and extreme weather events such as cyclones. |
| More frequent multi-year droughts (e.g., 2015-2017 Cape Town drought was three times more likely due to climate change). |
| Human displacement as a consequence of disasters such as floods, or of decreased liveability of areas of human settlement. Around 1.2 million people were displaced due to climate change-related natural disasters in the East and Horn of Africa regions in 2020, representing nearly 10% of global displacements. |
| Significant increase in food insecurity due to climate variability, compounded by conflicts and exacerbated by the impacts of COVID-19 pandemic. Agricultural productivity has observed over one-third growth reduction since 1961 due to increased water stress and shortened growing season. |
| Economic impacts: African countries' Gross Domestic Product (GDP) per capita may be on average 13.6% lower since 1991 than if human-caused global warming had not occurred. |
| Human health impacts are varied, including those from exposure to non-optimal temperatures and extreme weather event,s together with increased transmission of infectious diseases. |
| **Projected impacts** |
| Mean temperature and temperature extremes projected to increase across the continent. |
| Increase in drought frequency: mean annual rainfall projected to decrease over southwestern, southern Africa and coastal north Africa. By 2050, climate change can expose 951 million people in Sub-Saharan Africa to water stress. |
| More severe and frequent coastal flooding in low-lying areas. |
| Around 85 million people could be displaced due to climate change impacts by 2050. |
| Health: malaria hotspots and prevalence are projected to increase in east and southern Africa and the Sahel under even moderate emissions scenario by the 2030s, exposing an additional 50.6-62.1 million people to malaria risk. |
| High temperatures and high humidity will exceed the threshold for human and livestock tolerance over larger parts of Africa and with greater frequency. |
| Increased average temperatures and lower rainfall will further reduce economic output and growth. |


Unsplash / Christine Sandu

# 3 Climate-proofing sustainable energy solutions

Within the SESA project, sustainable energy solutions are tested within Living Labs located throughout the African continent (Kenya, Morocco, Ghana, Malawi, Namibia, Tanzania, Rwanda, South Africa and Nigeria). Table 2 describes the potential climate change-related risks that the key sustainable energy solutions tested in SESA can encounter, and provides an overview of how to respond to the risks through climate-proofing during the design and operation phases.

Table 2: **Risks to sustainable energy solutions resulting from climate change and possibilities for climate-proofing the solutions** (own compilation, based on IPCC, 2022; IEA, 2022; Riello Elettronica, 2022; IAEA, 2019; ADB, 2013 & 2011; Johnstone, 2021)

| Solutions | Risks from climate change | Possibilities for climate-proofing |
|---|---|---|
| E-mobility fleets and infrastructure | • Damage to e-mobility charging infrastructure<br>• Vehicle battery premature failure and more frequent replacement needs due to high temperature<br>• Damage to roads/bridges/pavements, reducing their safety and/or reducing access to mobility | • Design of resilient re-charging infrastructure<br>• Choice of batteries that are suitable to the expected temperature ranges<br>• Vehicle operation and storage that avoids exposure to extreme heat |
| Solar mini grids | • Reduced efficiency of PV panels through excessive heat<br>• Battery premature failure and more frequent replacement needs due to high temperature<br>• Reduced efficiency of whole system due to changes in radiation and ambient temperature<br>• Physical damage due to flooding, wind, landslides, fires<br>• Disruption or reduction of the ICT services vital to mini grid viability, due to damage of telecommunications networks | • Choice of PV panels that are suitable for expected temperature variability, i.e., with small temperature coefficient, where efficiency is not greatly reduced under high temperatures<br>• Choice of batteries (including second-life Lithium-ion batteries) that are adapted to the expected temperature ranges<br>• Design of robust mini grids with components that can withstand and are more resilient to climate extremes<br>• Choice of sites that takes into account climate risks in the location<br>• Design of modular infrastructure that integrates ease of repair and replacement in case of damage (circularity principles)<br>• Design of ICT and IoT components that are resilient and adaptable |
| Clean cooking | • Availability of clean cooking fuels (e.g., LPG, biogas, fuelwood for efficient stoves) may be reduced due to the impacts of climate change on fuel production and distribution infrastructure | • Design of robust fuel supply infrastructure that considers climate variability and risk |
| PUE appliances | • Damage to PUE appliances and therefore to their productivity benefits | • Design and operation of appliances that considers climate variability and risks |
| E-waste from solar off-grid solutions | • Physical damage to e-waste collection or treatment infrastructure due to climate extremes | • Design of robust collection and treatment facilities and supply chains |
| 2nd life Li-Ion batteries | • Exposure to high temperatures can damage battery and shorten its life | • Appropriate management of the battery during the first and second life to minimise temperature exposure |

Moreover, climate proofing of sustainable energy solutions can be ensured through the application of the following general principles (for further details, refer to corresponding factsheets in this catalogue):

- **Water-Food-Energy Nexus**: when the WEF nexus approach is applied in the design of sustainable energy solutions, it can enhance resilience to climate change by reducing water stress and strengthening food security. This is the case of solar agrivoltaics, or of solar-powered irrigation systems that are carefully tailored to the crop type and designed to save water via remote sensing.
- **Energy efficiency**: when energy-intensive appliances are efficient, they consume less energy, thus requiring smaller infrastructure (e.g., smaller installed capacity of PV modules in a solar mini grid).
- **Circularity**: energy solutions that are designed to be easy to maintain and repair (e.g., modular) are more resilient to the impacts of climate change that create partial damages or outages.

# 4 Implementing climate-proofing

The first step in the climate-proofing process is the assessment of the climate risk in a specific project or business model. **Climate risk assessments** should be integrated into each project development steps: planning and strategies, feasibility studies, technical design, and operation and maintenance. A climate risk assessment starts by defining the scope, i.e., the project context, boundaries and interactions (Watkiss, 2020). The assessment must then establish the most appropriate timescale over which climate change risks are being assessed, taking into account the intended lifespan of the project in question. It is advisable to use more than one time horizon, and to keep in mind that, the longer the timespan, the greater the uncertainty. As part of the assessment, detailed climate data is collected, and potential climate hazards are identified. The assessment then maps the vulnerabilities of the project to the identified hazards and the probability of those hazards to materialize (Watkiss, 2020).

The result of this assessment is used to guide planning and design, feeding these processes with essential information to make better decisions with regard to project location, technology selection and technical specifications (such as materials selection or sizing).

The following are key considerations in the implementation of climate-proofing for sustainable energy solutions (EUFIWACC, 2016; European Commission, 2021):

- Climate proofing is more effective and less costly when it starts at an early stage, i.e., in project planning and design.
- Integrating climate-proofing into the financing and business models of sustainable energy solutions is crucial, as the process can increase the complexity of design and therefore the upfront costs and financing needs. However, not considering or delaying the consideration of climate proofing of energy solutions can lead to high costs in the long term.
- Before starting the analysis, it is important to allocate sufficient resources, create the most appropriate working team, and ensure compliance with applicable legislation and regulations.
- Robust data on climate change impacts for a specific location can be challenging to find, but some sources are suggested in the "Relevant tools" section below.

Figure 2: **Agrivoltaic systems provide shade to the crops while generating energy** (Diyana Dimitrova via Getty Images)

## 5 Scaling-up

Widespread application of climate-proofing is crucial for the success of sustainable energy solutions. Two important factors for accelerating the take up of climate proofing are the **availability of reliable climate change impact projections and risk assessments** and the availability of **financing**.

**Easy-to-use climate impact data and risk assessments** are not only needed for policy makers to mainstream climate-proofing into policies. It is also crucial for the businesses operating in the renewable energy sector.

**Financing for climate proofing** of energy solutions is still only in its infancy and lagging behind already scarce climate adaptation funding. In 2019, USD 7.8 billion was provided by advanced economies for climate adaptation in African countries (IEA, 2022). However, it is estimated that the real cost is around USD 30-50 billion annually by 2030. Loans, grants and debt relief mechanisms, as well as blended finance (combination of public and private financing), are typical approaches for climate adaptation financing which can be tapped into by businesses aiming to climate proof energy solutions.


Unsplash / Renzo Souza

## 6 Examples of application in the African context

**1**

**Coping with Drought and Climate Change,** Kalu Woreda, Ethiopia

**The idea**: Improve the resilience of farmers and rural communities to water scarcity and drought through enhanced farming practices and use of early warning information systems. The objective is to develop and pilot a range of resilience mechanisms in the Kalu Woreda district.

**The financing**:
- Special Climate Change Fund (SCCF) project of UNDPs

**The impact**:
- Pilot sites disseminate weather/drought information to households
- Farmers outside the target area adopt/replicate best practices
- Reduction in vulnerability to climate change of the population in pilot sites
- Households adopt alternative livelihood strategies

**For further information visit**: → www.adaptation-undp.org/CCA-Africa

**2**

**Watermed 4.0,** Miliana, Algeria

**The idea**: Management of whole water cycle in agriculture through smart technologies.

**The technology**:
- Solar PV
- Decision support system based on IoT

**The financing**:
- Pilot research project (universities and research institutions involved)

**The impact**:
- Increased water use efficiency for agriculture and food processing
- Enhancement of export potential

**For further information visit**: → www.watermed-project.eu

**3**

**Saving lives and protecting agriculture-based livelihoods,** Malawi

**The idea**: Reduce vulnerability to extreme weather events caused by climate change by scaling up the use of modernized early warning systems and climate information.

**The financing**:
- UNDP and Green Climate Fund

**The impact**:
- Building the capacity of local beneficiaries (farmers and fishers), government agencies and stakeholders to adapt to the changing climate
- Expansion of platforms that generate and disseminate climate-related data
- Strengthening communities' capacities for use of early warning systems/ climate information

**For further information visit**: → www.adaptation-undp.org/CCA-Africa

# 7 Relevant tools and capacity building materials

### Climate-Proofing Toolkit: for basic urban Infrastructure with a focus on water and sanitation

The overall goal of the toolkit is to ensure that climate-related risks and impacts are factored in the design, construction, location and operation of current and future basic urban infrastructure. The toolkit outlines current capacity gaps and proposes specific actions for climate-resilient infrastructure (planning, designing, building and operating) that anticipates, prepares for and adapts to changing climate conditions.

→ https://unhabitat.org/climate-proofing-toolkit-for-basic-urban-infrastructure-with-a-focus-on-water-and-sanitation#:~:text=The%20Climate%20Proofing%20Toolkit%20is,current%20and%20future%20basic%20urban

### IPCC AR6 WG1 interactive atlas

The Interactive Atlas supports the assessment done in the IPCC 6th Assessment Report (AR6), allowing for flexible temporal and spatial analyses of trends and changes in key climate variables.

→ https://interactive-atlas.ipcc.ch
→ www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Atlas.pdf

### ThinkHazard! tool

This web-based tool assists with project planning and design, providing non-specialists with information on potential impacts of disasters on new development projects. It provides qualitative information about hazards present in a project area (at country, provincial or district level), including river, coastal and urban flooding; extreme heat; wildfire; earthquake; drought; cyclone; tsunami; volcano; and landslide. As a result, it supports the assessment of risks when planning the project together with recommendations and guidance on how to reduce them and links to additional resources (country risk assessments, best practice guidance, additional websites). It also highlights how each hazard may evolve in the future as a result of climate change.

→ https://thinkhazard.org/en

### Vouwgrond / Climagon

Vouwgrond / Climagon is an easy-to-use viewer of climate change impacts created for educational use and to raise awareness about climate change.

→ https://climate.vouwgrond.nl

### Climate Change Knowledge Portal (CCKP)

This online tool provides access to comprehensive global, regional, and country data related to climate change and development. It offers global data on historical and future climate, vulnerabilities, and impacts. Country reports summarize most relevant data on climate change, disaster risk reduction, and adaptation actions and policies at the country level.

→ https://climateknowledgeportal.worldbank.org

### UNDP Climate Change Country Profiles

Country-level climate data summaries that address the climate change information gap for developing countries by making use of existing climate data to generate a series of 52 country-level studies of climate observations and multi-model projections.

→ www.undp.org/publications/undp-climate-change-country-profiles

# 8 Bibliography

ADB (2013). Guidelines for Climate Proofing Investment in the Energy Sector. ISBN 978-92-9254-109-5 (Print), 978-92-9254-110-1 (PDF)

European Commission. (2021). Commission adopts new guidance on how to climate-proof future infrastructure projects.
https://ec.europa.eu/regional_policy/en/newsroom/news/2021/07/29-07-2021-commission-adopts-new-guidance-on-how-to-climate-proof-future-infrastructure-projects#:~:text=Climate%2Dproofing%20is%20a%20process,the%20development%20of%20infrastructure%20projects

European Commission and EEA (2022). European Climate Adaptation Platform Climate-ADAPT.
https://climate-adapt.eea.europa.eu/en/knowledge/adaptation-information/adaptation-measures

EUFIWACC (2016). Integrating Climate Change Information and Adaptation in Project Development - Emerging Experience from Practitioners. European Financing Institutions Working Group on Adaptation to Climate Change.
www.eib.org/attachments/documents/integrating-climate-change-information-adaptation-in-project-development-en.pdf

IAEA, 2019. Adapting the energy sector to climate change. IAEAL 19–01258 | ISBN 978–92–0–100919–7

IEA. (2022). Africa Energy Outlook 2022 – Analysis. IEA.
www.iea.org/reports/africa-energy-outlook-2022

IPCC. (2022). Sixth Assessment Report - Regional fact sheet - Africa.
www.ipcc.ch/report/ar6/wg1/downloads/factsheets/IPCC_AR6_WGI_Regional_Fact_Sheet_Africa.pdf

Johnstone, K, 2021. Productive uses of energy for resilient livelihoods in LDCs. IIED. (Accessed Nov 15, 2022).
http://pubs.iied.org/20356IIED

Riello Elettronica. (2022). How Does Temperature Affect Batteries? (Accessed Nov 15, 2022).
www.riello-ups.co.uk/questions/28-how-does-temperature-affect-batteries

UN Habitat. (2021). Climate Proofing Toolkit: For Basic Urban Infrastructure with a Focus on Water and Sanitation | UN-Habitat.
https://unhabitat.org/climate-proofing-toolkit-for-basic-urban-infrastructure-with-a-focus-on-water-and-sanitation#:~:text=The%20Climate%20Proofing%20Toolkit%20is,current%20and%20future%20basic%20urban

Watkiss, Paul. (2020). Principles of Climate Risk Management for Climate Proofing Projects.
www.adb.org/publications/climate-risk-management-climate-proofing-projects


Unsplash / Hasanuzzaman Himel

FACTSHEET 4

# Climate Proofing Sustainable Energy Solutions

SESA
Smart Energy Solutions for Africa

**Contact:**

https://sesa-euafrica.eu
https://twitter.com/sesa_project
https://sesa-euafrica.eu/contact-us
www.facebook.com/sesaproject
www.linkedin.com/company/sesa-project

**Partners:**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.