



Adaptation and Resilience in the Face of Climate Disasters in Mozambique: The Role of Off-Grid Solar and Energy Access



Climate and Energy Insecurity in Mozambique

Introduction

Today, 675 million people across the developing world are living without electricity access, while over a billion more globally have unreliable access to the grid.^{1,2} The majority of those living in energy poverty are living in areas most prone to climate hazards.³ One of the countries where the twin-issue of energy poverty and climate vulnerability is devastatingly present is Mozambique. Cyclones, floods, and droughts have become an almost annual phenomena, and their impacts are intensifying. According to the NGO GermanWatch, which releases the annual Global Climate Risk Index, Mozambique ranked first on the list of countries most vulnerable to climate change in 2021.⁴ At the same time, the national electrification rate in the country is only 31% and almost three-quarters of the population live at, or under, the poverty line of \$2.15 a day.⁵ Of the hundreds of millions of people lacking energy access globally, 22 million are living in Mozambique.⁶

Climate hazards in Mozambique

Being comparatively low in elevation and hosting a coastline of over 2500 kms, Mozambique's main climatic threat is from cyclones and their resultant flooding. Three of the most disastrous cyclones to date have happened in the last five years, claiming the lives of thousands of people, and leaving millions more homeless, displaced, or destitute.⁷

Cyclones and storm surges: 60% of the country's population live in coastal regions particularly susceptible to cyclones, storm surges and flooding.⁸ Much of Mozambique's coastal regions are also rural and poor, lacking adequate housing and infrastructure exacerbating people's vulnerability

and their ability to adapt to extreme weather events.

Extreme weather and the impacts on food security: Agriculture remains the main economic activity in the country. Smallholder farmers account for the vast majority of this sector's production, with some 3.2 million smallholder farmers accounting for 95% of the country's agricultural production, and the average farm size only 1.2 hectares.^{9,10} As nearly all of the country's agriculture is rain fed and low tech in nature, it is vulnerable to weather and climate related hazards.¹¹ The country has experienced 13 drought events in the past 35 years.¹² Protecting and supporting the country's smallholder farms in the face of a changing climate – with floods on one extreme to droughts on the other – is crucial for helping to buffer the country from the worst impacts of climate change and reducing poverty.

Energy insecurity and climate vulnerability

Amid the acute climate threats, the majority of the population lack access to electricity services that can help them to mitigate and adapt to extreme weather events. Mozambique has the sixth largest energy access deficit of any country in the world.¹³ The differences between rural and urban electrification are stark. Almost two thirds of the population live in rural areas, where electrification rates are only 3.8%.¹⁴ Those most directly affected by climate hazards are amongst these rural populations.

A lack of modern energy has significant impacts on food security, water security, sanitation and healthcare – all critical inputs for resilience and welfare. For example, limited irrigation, processing

1 [Lighting Global/ESMAP, GOGLA, Efficiency For Access, Open Capital Advisors \(2022\), Off-Grid Solar Market Trends Report 2022: State of the Sector. Washington, DC: World Bank.](#)

2 [IEA, IRENA, UNSD, World Bank, WHO. 2023. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC.](#)

3 [Ibid.](#)

4 [Global Climate Risk Index. Accessed in October 2023.](#)

5 [World Bank. World Bank, Poverty and Inequality Platform. Accessed in October 2023.](#)

6 [IEA, IRENA, UNSD, World Bank, WHO. 2023. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC.](#)

7 [USAID, 2023. Mozambique – Complex Emergency and Tropical Cyclone.](#)

8 [REAP, 2020. Reap Country Case Studies – Mozambique.](#)

9 [FAO in Mozambique. Accessed in October 2023.](#)

10 [CIAT; World Bank. 2017. Climate-Smart Agriculture in Mozambique. CSA Country Profiles for Africa Series. International Center for Tropical Agriculture \(CIAT\); World Bank. Washington, D.C. 25 p.](#)

11 [Ibid.](#)

12 [USAID. 2019. Disaster Response – Mozambique.](#)

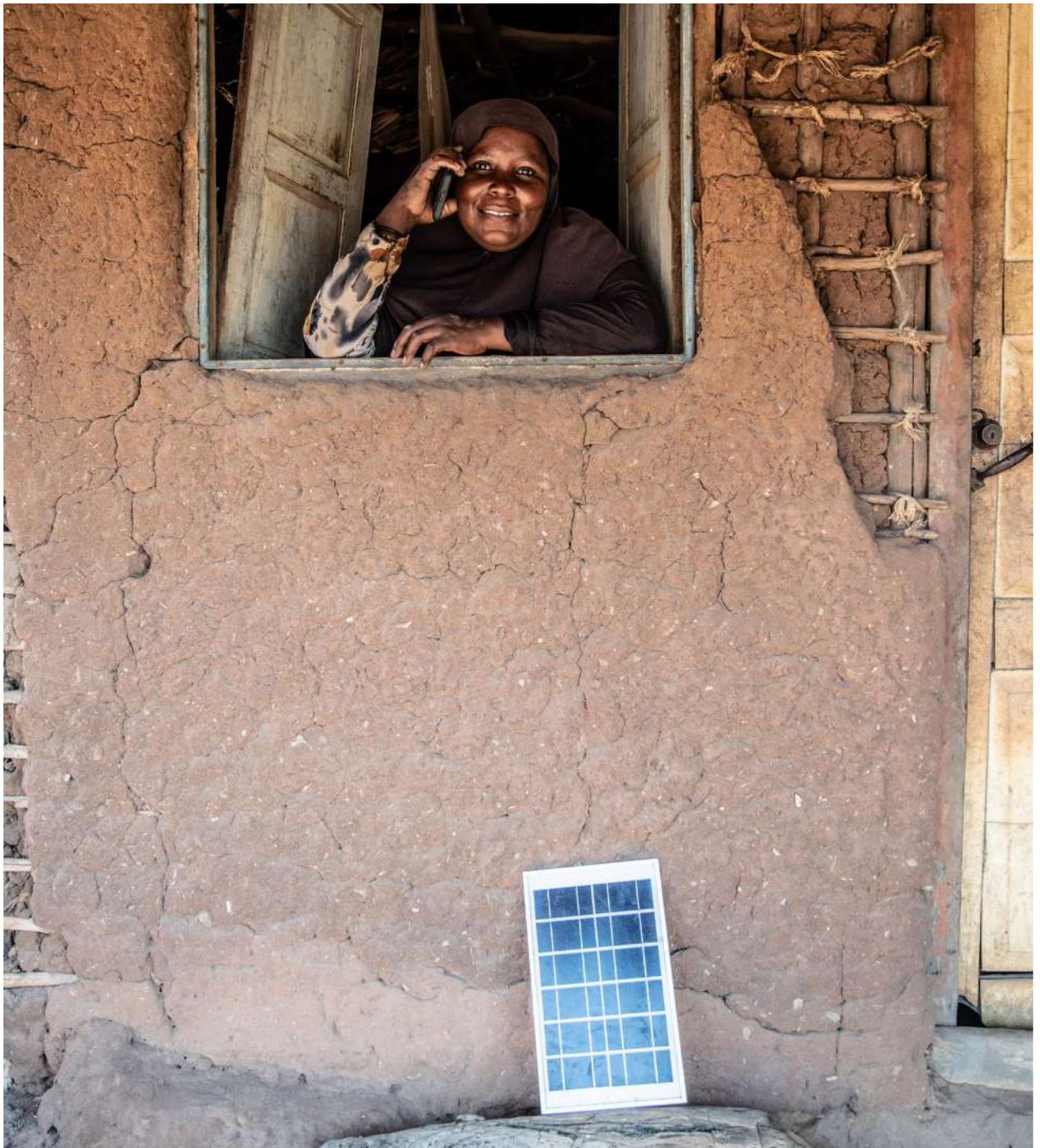
13 [IEA, IRENA, UNSD, World Bank, WHO. 2023. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC.](#)

14 [World Bank. 2023. Access to electricity, rural – Mozambique.](#)

Climate and Energy Insecurity in Mozambique

and cold storage of produce, has a significant impact on the availability of food and the long-term ability to generate crops or support livestock, especially at times of drought; while a lack of power to pump and access clean water has an immediate impact on water security. Limited electricity supply also restricts the provision of adequate healthcare, reducing the ability to store vaccines and medicines, power medical equipment and illuminate medical procedures.

Adding to the electrification challenge is the heightened vulnerability already created by climate-induced humanitarian disasters, including damage to housing, roads and infrastructure, as well as household financial safety nets. Each new emergency compounds the negative impacts of the disasters that have come before, further reducing the capacity of the population and public services to cope.



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**How off-grid solar
combats climate hazards
and enhances resilience**

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How off-grid solar combats climate hazards and enhances resilience

Off-grid technologies are a modern solution, providing decentralised access to electricity that is more resilient to climate risks. For example, a lack of reliance on long distance cables and infrastructure makes off-grid technologies more resilient to the floods, high winds and cyclones that have previously led to grid blackouts across the country. With no fuel supply chain, when it becomes impossible to transport fuel to a region affected by disaster, off-grid systems are still able to power essential services. While the size of some products, such as solar energy kits and irrigation systems, makes them portable if extreme climate events lead to forced displacement.

They are also a climate smart alternative, enabling countries to build new clean energy infrastructure, while reducing reliance on volatile, carbon-intensive assets.

The ways in which off-grid solar technologies and services help communities respond to climate shocks and benefit from clean energy opportunities are wide ranging, including the use of solar irrigation and cold storage to improve water and food security, better disaster planning and response through solar powered communications, and the creation of clean energy jobs and green growth.

Climate Disaster Planning, Response and Support for Displaced Communities

Solar energy kits and communications appliances provide critical light, power and access to information.

For example, as profiled in the Mozambique Case Studies in this report:

- In countries with a high incidence of climate emergency, solar energy kits can be used to power phones, radios and TVs – all of which are vital for sharing disaster warnings that can help families get to safety.
- The light, power and communications provided by these kits is also key for aiding disaster response, enabling emergency workers to connect to affected communities, keep in touch with one another and light their operations.

- The distributed nature of solar energy kits also makes them rapidly deployable to support displaced communities. Hundreds of millions of off-grid solar products are being used to provide light and power in humanitarian settings, while solar water pumps are being used to provide access to drinking water.

Addressing drought and driving food and water security

Solar water pumps (SWPs) are vital for addressing drought and driving food and water security.

- SWPs and small irrigation systems are deployed as methods to enhance the production capacity of smallholder farmers. For example, Since 2018, as part of Towards sustainable energy for all in Mozambique, UNIDO has partnered with the non-governmental organisation, Ajuda de Desenvolvimento de Povo para Povo (ADPP, Development Aid From People to People) to implement a community project that uses photovoltaic irrigation systems for agricultural activities in the central provinces of Zambezia, Sofala and Tete.
- Irrigation via SWPs is helping to increase both the size of crop yields and the number of times that crops can be harvested, helping to bolster food security and create new revenues and financial safety nets for families. In a study of thousands of SWP customers in Kenya, Rwanda, Senegal, Tanzania, Uganda and Zambia, 96% reported an increase in yield and 90% an increase in income.¹⁵
- SWPs are also being used to provide clean water supplies and are profiled by UNICEF as a critical tool to achieve climate-resilient water security for all. For example, the UN agency has already installed 4600 community water pumps in Nigeria, recognising that they are cleaner and more cost effective than alternatives.¹⁶

¹⁵ 60 Decibels. 2019. *Uses and impacts of solar water pumps.*

¹⁶ UNICEF. UNICEF water pumps: a source of life, health and resilience. Accessed in October 2023.

How off-grid solar combats climate hazards and enhances resilience

Solar refrigeration systems and cold storage units are also vital for preserving food in times of climate crisis.

- In sub-Saharan Africa, an estimated 37% of food is lost unintentionally between harvest and distribution.¹⁷ Cold storage, such as walk-in cold rooms, can help to radically change this dynamic. For example, farm level walk-in cold rooms developed by SokoFresh in Kenya have helped to increase the farmers' income by up to 40% as the result of significant post-harvest loss reductions.¹⁸

Solar energy kits can also play a key role in the transfer of adaptation knowledge on climate-smart agriculture.

- Household surveys by the IMF in Ethiopia, Malawi, Mali, the Niger and Tanzania found, among other factors, that broadening access to early warning systems and to information on food prices and weather (even with simple text or voice messages to inform farmers on when to plant, irrigate or fertilise) has the potential to reduce the chance of food insecurity by 30%.¹⁹

Addressing disease and poverty via more resilient health infrastructure

Off-grid solar technologies are providing light, power and cold storage facilities that are transforming healthcare in unelectrified regions.

- Solar energy kits are also providing vital light and power to health centres in several countries including Mozambique. This is especially critical in the aftermath of disasters where health infrastructure is needed to address the medical needs of those affected.

- The use of cold storage for vaccination is also critical in regions where extreme weather events can increase the risk of disease. Solar direct drive refrigeration units are now commonly used to store vaccines. For example, since 2017, the health organisation Gavi has delivered more than 40,000 solar direct drive fridges to 36 African countries; with the Head of the organisation's Health Systems and Immunisations Strengthening team crediting the off-grid equipment for achieving a 25% jump in child vaccination rates in Africa between 2010 and 2020.²⁰

Creating clean energy jobs and driving green growth

Development of new clean energy infrastructure is also a catalyst for green jobs, productivity and improvements in welfare.

- The savings generated by off-grid solar customers who have switched from using kerosene, candles or torches to light from a solar lantern or small solar home system, are \$150 per year for the average family.²¹
- Globally, the off-grid industry has generated almost 400,000 jobs, the majority in rural areas where opportunities are often more limited.²²
- Solar energy kits are already being used to support more than 10 million micro- and small businesses, such as shops, restaurants and hair salons.²³
- Off-grid solar technologies are creating greater time for study, improved health and safety and better opportunities for hundreds of millions of people across South Asia and sub-Saharan Africa.

17 [FAO. 2011. Global food losses and food waste – Extent, causes and prevention. Rome.](#)

18 [Food Flow. 2022. Impact Report 2022.](#)

19 [World Meteorological Organisation. 2023. The State of the Climate in Africa 2020.](#)

20 [Reuters. 2020. Web article. Can solar fridges helping vaccinate African children work for COVID-19? Accessed in October 2023.](#)

21 [GOGLA. 2019. Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data.](#)

22 [Power for All. 2022. Powering Jobs Census 2022.](#)

23 [Lighting Global/ESMAP, GOGLA, Efficiency For Access, Open Capital Advisors \(2022\), Off-Grid Solar Market Trends Report 2022: State of the Sector. Washington, DC: World Bank.](#)

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Off-grid solar in Mozambique: The Foundations for Rapid Scale

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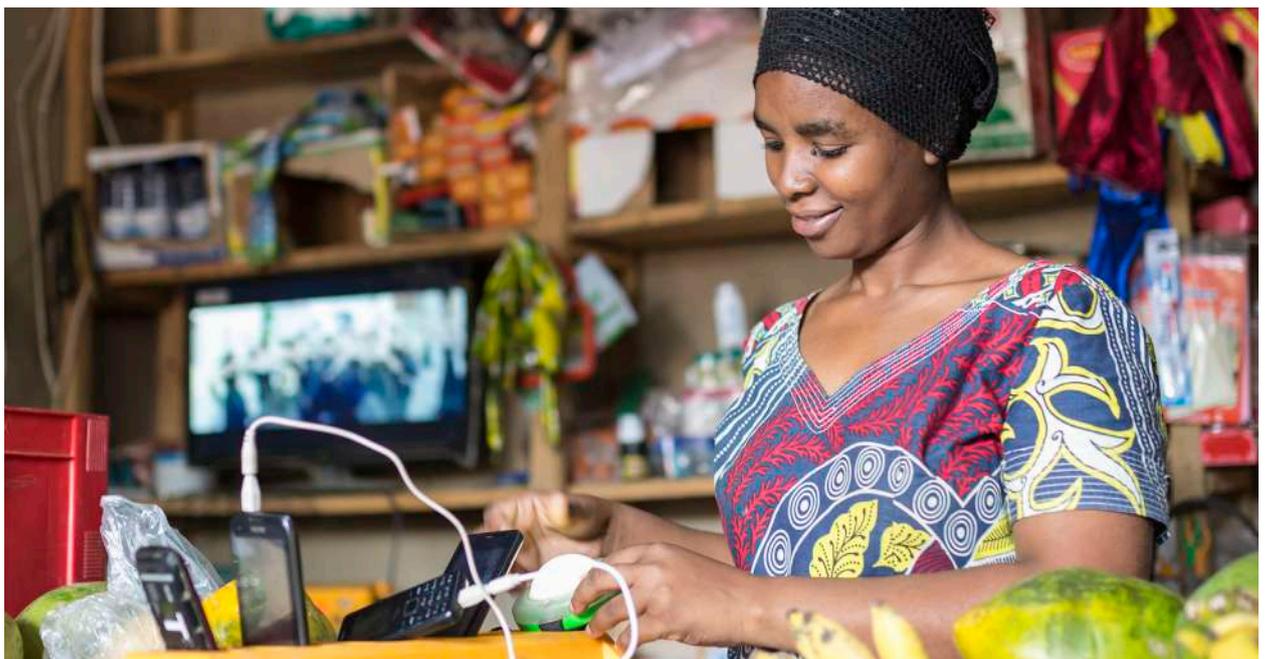
Off-grid solar in Mozambique: The Foundations for Rapid Scale

The foundations for rapid deployment of off-grid solar technologies in Mozambique have been set by a series of supporting policies and programmes across the last decade, which have led to a robust off-grid industry. In 2015, the Government of Mozambique adopted the National Development Strategy for 2015–2035, which serves as the comprehensive framework directing all development policies and decisions concerning energy-related issues.²⁴ In November 2018, President Nyalusi introduced Projecto Energia Para Todos (ProEnergia), a prominent electrification initiative. This program underscores the significance of off-grid solutions in attaining universal access to electricity by 2030. Consequently, the National Electrification Strategy envisions that 19% of the population will be served by off-grid power in 2030.²⁵ In September 2021, the government granted approval for a fresh policy aimed at overseeing electricity delivery via off-grid solutions.²⁶

Government focus on off-grid solar has been complemented by the ongoing activities of the FCDO and Sida funded SNV-BRILHO programme, which is designed to unlock and accelerate the potential of off-grid technologies. Since 2020, BRILHO has assisted over 20 private-sector companies in early and mature stages of operation

by offering technical support and various financing mechanisms. This has led to over GBP29 million in private sector investments, helping to unlock over 225,000 solar home system connections and 137,000 improved cooking solutions, benefiting 1.8 million people.²⁷ Over 26,000 micro and small businesses have gained access to energy, generating income and local economic development.²⁸ In 2022, more than 20% of new electrifications in Mozambique were facilitated by businesses supported by BRILHO.²⁹ In addition, BRILHO supports policy reform and institutional strengthening, collaborating with organisations such as ARENE, FUNAE, and MIREME to enhance sector regulation and develop a comprehensive regulatory framework for the off-grid sector.

With the right support for scaling the market, the foundations are firmly in place for off-grid solar technologies to reach 19% of the Mozambique population by 2030, with the potential to reach even more citizens with an increase in commitment. This will enhance energy security, improve resilience and drive green jobs and economic growth. As explored through the case studies included in this briefing note, it is also vital for enabling disaster planning and response and for the development of long-term climate adaptation infrastructure.



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²⁴ UN Environment Programme. 2014. National Development Strategy (2015–2035).

²⁵ FUNAE. 2019. Projecto Energia Para Todos.

²⁶ SNV. 2021. Government of Mozambique approves off grid energy regulation taking a key step towards universal access.

²⁷ Consultation with SNV.

²⁸ Ibid.

²⁹ Ibid.



Resilience in Action: Practical Approaches and Success Stories



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Resilience in Action: Practical Approaches and Success Stories

Enabling Early Warning Alerts in Namacurra

In a world where climate change brings about increasingly severe weather events, the ability to provide timely and accurate information to communities on the front line of extreme weather disasters is paramount. This is especially true for the residents of Namacurra, a community located in the Zambezia Province, as they faced Cyclone Freddy in March 2023.

ENGIE Energy Access is one of the off-grid solar providers in Mozambique dedicated to empowering communities with sustainable

electricity solutions. Its MySol solar home systems contain lights, radio, and TV units, enabling illumination and information sharing. When Cyclone Freddy approached, Namacurra's MySol customers were able to receive early warnings and real-time updates about the cyclone's trajectory via their radios and TVs and were able to safely evacuate the area. Once the storm had passed, the community received instructions on when it was safe to return to their homes. The Namacurra experience provides a simple example of how solar powered communications devices can prove vital in enabling climate vulnerable communities to receive emergency warnings and life-saving disaster preparedness information.



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Resilience in Action: Practical Approaches and Success Stories

Powering Disaster Relief: The Contribution of Solar Lights and Home Systems

Solar home systems (SHS) offer more than just lighting; they can also charge mobile phones, a crucial communication tool during disasters. A reliable energy source and open communication channels facilitate better coordination of relief efforts by NGOs and aid agencies, while providing up-to-date weather and health information. For families too they provide critical connectivity, helping them to find and stay in touch with loved ones. Their portability is vital. Families can take a solar lantern or SHS with them if they are forced to flee their homes and use them as they rebuild their lives.

The importance of solar lights and SHS were seen following the devastation of Cyclone Idai in 2019. The cyclone made landfall in Mozambique and Zimbabwe, unleashing unprecedented levels of rainfall and flooding, and driving fierce winds in Malawi. Over 700 lives were lost and hundreds of thousands of people were left homeless. Relief camps were hastily set up in old structures and tents. Recognizing the urgent need for light and power, SolarWorks!, Zonful Energy, and SolarAid sprang into action across the three countries. In Mozambique, SolarWorks! collaborated with GIZ, Save the Children, Omnivoltaic and EDP Renewables to rapidly provide SHS to relief camps and shelters.³⁰



The solar systems have been a lifeline for our community, especially during cyclone Idai. They provided us with much-needed electricity for communication, lighting, and charging our devices. I have lost almost everything, the solar system allowed to carry all the time and charging with sun during the day to survive during that critical time.

Mr. António, Buzi District,
SolarWorks! customer.



As the disaster unfolded, the International Organization for Mitigation appealed for aid to meet the humanitarian needs of 1.8 million people affected by the cyclone. As part of the response, 20 tonnes of aid were brought in through the United Kingdom Air Force, including shelters, water purifiers and solar lanterns. Following Cyclone Idai, the Humanitarian Country Team and the United Resident Coordinator's Office in Mozambique, with the support of the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) revised the Humanitarian Response Plan to include fuel-efficient cookstoves and solar lamps as necessities in the aftermath of a disaster.



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Resilience in Action: Practical Approaches and Success Stories

Energizing Healthcare: The Solar-Powered Solution

With funding from USAID and GIZ, SolarWorks! also initiated a project following Cyclone Idai to electrify health clinics in the hard-hit Sofala region. To date, they have electrified 100 health clinics and aim to reach and maintain electricity to 250 clinics by the end of 2023 across Mozambique and Malawi. In total, the clinics will serve more than 1 million people. The solar electricity generated is primarily used to power lighting, phone charging, and laptops, enabling 24/7 healthcare provision. An example is Salone Health Care in Marromeu District, where the availability of light has created significant benefits for mothers giving birth at night.

This reliability of off-grid electricity supply for health centres is particularly critical in times of climate crisis. In addition to the provision of light and power, this has proven true for the provision of vaccines. For example, following Cyclone Freddy solar-direct drive (SDD) refrigeration units were rapidly deployed to affected areas of Malawi, where UNICEF was already working to scale the use of the technology. These SDD refrigeration units allowed local health workers to get vaccinations rapidly back on track; especially important given the potential for the outbreak of water borne disease and other illnesses as a result of flooding. Notably, following the cyclone, all 450

SDD fridges previously deployed in Malawi were reported as operational, indicating their relative resilience to the extreme winds experienced in the country.³¹



We had low productivity due to a lack of energy. The first birth in that facility after electrification was 100% successful and I worked without holding a torch in my mouth while helping the mother. It was possible to stitch the patient during the postpartum period. Before that, during most night deliveries it wasn't possible to do decent stitching, forcing the mothers to wait until the next day with haemorrhages. The mothers went to the health care just to see the good news, they were so grateful and happy. They also took their own cell phones to charge in the hospital while being observed. The number of visits also increased, the community spread the news, and families went to visit the facilities during nights and celebrate. It turned into a social house for women and children where they felt safe

Midwife,
Salone Health Care Centre



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31 GAVI (2023) Web article. [Sunny with a chance of cyclones: Malawi's cold chain goes solar powered](#). Accessed in August 2023.

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Outsized CO₂e
reductions

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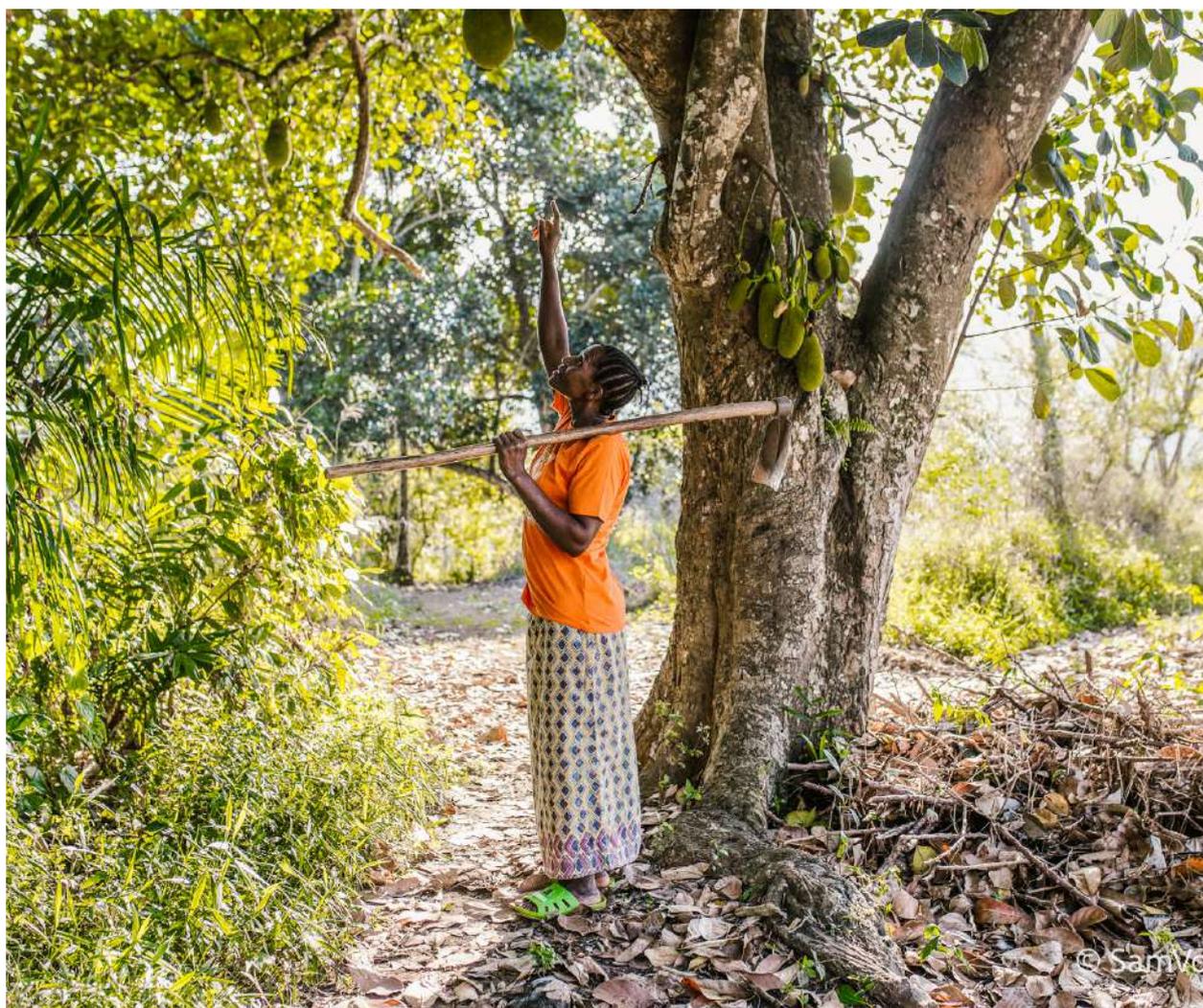
Outsized CO₂e reductions

Displacing Diesel and Kerosene through Off-Grid Solars

Today, kerosene and diesel are commonly used to produce off-grid electricity in remote regions of Mozambique, where access to the main power grid is limited. Diesel generators play a significant role in supplying power to businesses, public institutions and wealthier households, while kerosene is often employed for lighting in rural regions. These technologies emit CO₂, as well as the short-lived climate pollutant, black carbon; with the latter having a high CO₂ equivalency.³² In addition, diesel is also used for farming equipment such as pumps and processing machinery, whilst there are significant emissions from food loss waste.³³

Off-grid solar technologies can rapidly replace the use of fossil fuel powered technologies in homes, enterprises and agriculture. Where diesel is being used to power public facilities, there is also a clear opportunity to minimise emissions via off-grid solar alternatives. For example, an estimated 190 million tonnes of CO₂e has already been avoided by the off-grid industry globally, equivalent to taking 51 coal-fired power plants offline for a year.³⁴

While off-grid solutions have a significant role to play in supporting resilience and adaptation, they also have a key role in driving emissions reductions and the transition to new, clean energy infrastructure.



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32 [GOGLA, 2023. Powering Adaptation and Climate Justice: The Critical Role of Off-Grid Solar Technologies.](#)

33 [Ibid.](#)

34 [Lighting Global/ESMAP, GOGLA, Efficiency For Access, Open Capital Advisors \(2022\), Off-Grid Solar Market Trends Report 2022: State of the Sector. Washington, DC: World Bank.](#)

Conclusions and Call to Action

Off-grid solar is vital for enabling electricity access for the poorest and most climate vulnerable communities in Mozambique. It has the power to aid disaster planning and response, provide vital inputs for food and water security, electrify health infrastructure and boost welfare and resilience. The off-grid industry is also generating clean energy jobs and driving green growth and opportunity.

To accelerate these critical impacts, we call for greater focus and funding to support the off-grid solar sector through a range of key actions undertaken by the Government and development actors, including:

1. Recognition of the role of off-grid solar for enabling climate adaptation and resilience

The role of off-grid solar is not widely acknowledged in policymaking or practise for its potential to aid climate adaptation, even as considerable energy use is required in most adaptation initiatives. Given the increasing impact of climate change, it is crucial for Mozambique to recognize off-grid solutions as a vital component of adaptation and resilience to climate change events. Modern off-grid technologies offer a lifeline when traditional infrastructure may fail. By acknowledging the pivotal role of off-grid solutions, we can start to develop resilient, self-sustaining energy systems that can operate independently of the centralised grid during climate emergencies.

2. Integration of off-grid solar solutions into Mozambique's climate response, adaption, and resilience plans

Off-grid solutions such as solar energy kits, irrigation and cold storage are vital for creating sustainable energy, water, and communication systems. There is a need to integrate and adopt these technologies in disaster planning and response strategies, efforts to unlock climate-smart agriculture and green growth, and in plans to improve public infrastructure. To achieve this, the government will specifically need to review its 2021 Nationally Determined Contribution commitment and other climate action plans, to incorporate off-grid solar.

3. Development of education and awareness campaigns amongst vulnerable communities to inform them about the impact of off-grid solar

In some climate vulnerable regions of Mozambique, knowledge about off-grid solar technologies is limited, and training around the use of solar to support enterprise and agriculture is lacking. By promoting awareness and providing education for climate vulnerable communities on off-grid solutions, we can pave the way for communities to adopt renewable energy sources and unlock economic opportunities.

4. Development and implementation of more initiatives to enhance affordability and access to off-grid solar by low-income communities

Now, more than ever, Mozambique must build collective efforts to make off-grid technologies more affordable and accessible. A range of mechanisms should be explored and implemented, including more subsidy programs, results-based financing schemes, VAT and customs duty exemptions and programmatic support for business innovations designed to reach last mile communities. We urge policymakers, businesses, and development stakeholders to prioritise the development of policies and programs that make off-grid solutions economically viable and accessible for all people in Mozambique, irrespective of their income level.

5. Partnership with private sector players to rapidly scale the deployment of off-grid solar technologies

In our pursuit of a sustainable and resilient future, it is important for the public sector to embrace strategic partnerships with the private sector players given their critical role in delivery of off-grid solar solutions. By collaborating with private entities, new avenues of investment can be unlocked, as well as technological advancements, and market driven solutions that have the potential to increase the reach of renewable energy. We urge the government of Mozambique to extend a hand to the private sector in order to leverage and amplify the impact of off-grid solutions and ensure the creation of a sustainable energy landscape that will benefit the people of Mozambique.

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The Voice of the **Off-Grid Solar Energy** Industry