



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

LEVERAGING ENERGY ACCESS AND OFF-GRID TECHNOLOGIES TO REALIZE NATIONAL SOCIAL AND ECONOMIC DEVELOPMENT PRIORITIES

Powering Agriculture, Enterprise, and Public Services

WHITE PAPER



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ABOUT IKEA FOUNDATION

The IKEA Foundation is a strategic philanthropy that focuses its grant-making efforts on tackling the two biggest threats to children's futures: poverty and climate change. It currently grants more than €200 million per year to help improve family incomes and quality of life while protecting the planet from climate change.

Since 2009, the IKEA Foundation has granted more than €2 billion to create a better future for children and their families. In 2021 the Board of the IKEA Foundation decided to make an additional €1 billion available over the next five years to accelerate the reduction of greenhouse gas emissions.

ABOUT GOGLA

GOGLA is the global association for the off-grid solar energy industry.

Our 200+ members provide millions of low-income and climate-vulnerable people with affordable, high-quality products and services; rapidly increasing customers' productivity, connectivity, and resilience.

To enable sustainable businesses and accelerate energy access, we provide market insights, standards and best practice, and advocate for catalytic policies, programmes and investment. Working with partners, our pioneering industry can improve the lives of 1 billion people by 2030.

To find out more, visit www.gogla.org.



ABOUT THIS PAPER

By unlocking access to electricity and electricity services, off-grid solar technologies are an ‘enabler’ of several development impacts, including those linked to agriculture, enterprise, health, education, and climate. This paper sets out the ways that off-grid solar technologies are supporting the attainment of these development goals, for example by increasing crop yields and income, generating green jobs, and improving climate adaptation and resilience.¹

The aim of the paper is to inform energy officials about the potential benefits of collaborating with other ministries, including those focused on agriculture, enterprise, health, education, and climate. These collaborations can enhance the utilization of off-grid solar solutions to achieve a broader spectrum of development goals.

The paper can also serve as a resource for engaging with development actors working in agriculture, enterprise, health, education, and climate who are also supporting the attainment of national and international development goals.

The off-grid solar technologies profiled in this report include:

- Solar lighting and home systems, and appliances.
- Solar generators, usually including an AC-DC inverter,
- Solar irrigation pumps and systems,
- Solar refrigeration and cold storage solutions.
- Solar mills and solar dryers

THE STRUCTURE OF THE PAPER

Following an introduction, the paper explores the potential use case of off-grid solar in:

- Agriculture, Animal Husbandry and Fisheries
- Enterprise and Industry
- Health and Sanitation
- Education
- Environment & Climate Change

To expand on these overviews, a series of case studies that illustrate the positive impacts of off-grid solar on agriculture, enterprise, health, education, and climate resilience are included in the Annexure.

LIMITATIONS

Please note that the impact areas explored in this paper are not exhaustive. The off-grid solar industry can also play a positive role in achieving a range of other national and international development goals, including the contribution to modern infrastructure, enhancement of digital inclusion and connectivity, and progress on gender equality. While these topics have not been explored in this paper, they warrant further attention and could provide the basis for future studies.



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1 [GOGLA \(2023\) Powering Live and Livelihoods: Scaling Productive Use of Renewable Energy \(PURE\).](#)

INTRODUCTION

Currently, over 675 million people² live without access to electricity. This limits economic opportunities and acts as a hindrance to growth, job creation and enterprise, while undermining the social welfare and status of families and communities. According to UNCTAD, the UN’s Trade and Development body, “Access to a reliable and quality energy supply is vital to the economic development of any country. It drives industrialization, boosts productivity and economic growth, spurs human development, and is crucial to achieve almost all of the United Nations Sustainable Development Goals (SDGs).”³

Access to electricity and energy services is a critical enabler of national economic and social development goals. Across many low energy access countries today, governments are proactively seeking to realize the SDG 7 target of universal access to clean modern energy through integrated electrification approaches that leverage off-grid

solar solutions. In countries with high electricity access deficits, off-grid technologies are complementing existing grid and grid extension efforts. They provide electricity services to those who have limited or no access to the grid. This enhanced energy access can rapidly increase the resilience of the poorest and most vulnerable communities and unlock green growth and job opportunities. Today, off-grid solar technologies are already used by almost 500 million people, support more than 10 million businesses, and power hundreds of thousands of smallholder farmers.⁴ They play a significant role in addressing national challenges, including improving food production and access to markets, enabling business growth, and electrifying public infrastructure. Figure 1 provides an overview of the ways that off-grid technologies are supporting agriculture and fisheries, commerce and industry, and social services.

However, there is a lack of knowledge on the ability of off-grid solar to drive a wide range of development outcomes. In addition, there is lack of deliberate planning and action to leverage energy access to drive economic and social development, particularly for rural off-grid communities. This paper aims to address this knowledge gap and support collaborative action and planning between energy ministries and their government counterparts and development partners.

FIGURE 1: EXAMPLES OF OFF-GRID SOLAR SOLUTIONS USE CASES

| AGRICULTURE & FISHING | COMMERCIAL & INDUSTRIAL | SOCIAL SERVICES | |
|--|--|---|---|
| | | HEALTH | EDUCATION |
| <ul style="list-style-type: none"> • Irrigation • Cooling • Poultry • Agro-Processing • Heating | <ul style="list-style-type: none"> • Agro- processing • Entertainment • Cooling • Tailoring • Carpentry • Barbershops • Cooking | <ul style="list-style-type: none"> • Refrigerators • Vaccine Storage • Medical Appliances • Water supply • Heating | <ul style="list-style-type: none"> • Lighting • ICT • Cooling • Heating |

² World Bank (2022) The Energy Progress Report

³ UN Trade and Development: Special issue on access to energy in sub-Saharan Africa

⁴ GOGLA (2023) New paper highlights the critical role of off-grid solar technologies in powering climate adaptation and justice



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HIGHLIGHTING KEY OPPORTUNITIES

ENERGY IN AGRICULTURE, ANIMAL HUSBANDRY AND FISHERIES

CONTEXT

There are 33 million smallholder farmers in Africa, who contribute as much as 70% of the continent's food supply.⁵ Agriculture plays a huge role in economic and social development, accounting for 25%-40% of GDP in countries including Kenya, Uganda, Tanzania, Rwanda, Burundi, and Republic of South Sudan. The sector is the leading employer for over 80% of the population.⁶ Despite this, a staggering 60% of Africa's population still grapple with food insecurity, and 240 million Africans endure daily hunger.⁷ Off-grid solar can help to modernise food production and value addition through irrigation, processing and preservation.

OPPORTUNITY

- **Irrigation:** Solar water pumps (SWPs) ensure a reliable water supply for crops throughout the year but especially during dry seasons. The role of SWPs in helping to improve agricultural outcomes is becoming increasingly recognised by pioneering countries, with existing commercial technologies. For example, In India, the government introduced the PM Kusum Scheme, intending to tackle the issue of water scarcity for irrigation, component B of the PM Kusum scheme provides support to individual farmers for installation of standalone solar agricultural pumps of capacity up to 7.5 HP in off-grid regions, with no access to the grid supply.⁸
- **Cooling:** Off-grid solar refrigeration units (SRUs) and cold storage facilities contribute to the preservation

of harvested produce. SRUs and cold storage facilities play a crucial role in prolonging the shelf life of perishable goods, enhancing their value, and minimising food wastage. In Uganda, an estimated 20-40% of milk is lost due to inadequate timely cooling measures.⁹ To address such problems, solar cooling systems such as freezers, milk chillers, cold rooms are emerging technologies that can help preservation for produce in fruit and vegetable, dairy, fish, and meat value chains. For example, Ecozen's Ecofrost, a cold storage solution, helped a Farmers Producer's Organization in the state of Andhra Pradesh, India to reduce loss and wastage of fruits and vegetables by 30%.¹⁰

- **Processing:** Decentralized energy efficient agricultural processing units include solar milling machines for grinding grains or producing flour and solar dryers for drying agricultural products like fruits, or coffee. Although these appliances are still in early stages of market development, agricultural milling, processing, and other machinery hold significant potential to improve post-harvest management and operational efficiencies. For example, milling machines sold by Agsol a social business based in Kenya, have efficiently transformed staple foods into higher value products, replacing inadequate practices like manual processing or reliance on small diesel mills prone to failure. In addition, these machines help generate new income through milling services, enhancing local labour efficiency, retaining money within the community, and enabling various new business opportunities through their solar powered technology.¹¹
- **Fishing:** Solar energy is used to power ice-making machines, which are crucial for preserving fish freshness during storage and transportation. This

5 IFAD: Invest more in smallholder agriculture

6 East Africa Community: Agriculture and Food Security

7 AFDB (2021) Raising Africa Agricultural's Productivity

8 MNRE: Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyaan (PM-KUSUM)

9 UOMA (2019): Productive use of off-grid energy: The business case in Uganda's dairy value chain – UOMA

10 Ecozen (2022) Ecozen's Ecofrost helped this FPO reduce Losses by 30% | Ecozensolutions

11 Agsol

is particularly beneficial for fishing communities in remote areas without reliable access to electricity. Solar-powered refrigerators and freezers help in storing the catch, reducing spoilage, and maintaining the quality of fish until it reaches the market. Solar lighting systems are used on fishing boats and at fish processing facilities, enhancing safety, and allowing for night fishing and operations without relying on fossil fuels. Solar dryers are utilized to dry fish more efficiently and hygienically compared to traditional open-air drying methods. This method reduces the drying time and improves the quality and shelf-life of dried fish products.

- **Livestock farming:** Solar-powered pumps are used to provide water for livestock, particularly in remote areas where access to the electrical grid is limited. These pumps can supply water to troughs, automated watering systems, and irrigation for pastures. Solar lighting systems provide illumination for barns, stables, and outdoor areas, improving visibility and safety. Solar lights can also extend the working hours on farms, allowing for activities such as feeding and milking to be conducted efficiently. Solar-powered incubators are used to hatch eggs, providing a reliable and controlled environment for embryo development. This is particularly useful in remote areas without consistent electricity.



© Futurepump - Ann irrigating with a hose pipe



© Agsol

ENERGY IN ENTERPRISE AND INDUSTRY

CONTEXT

Micro, small, and medium-sized enterprises (MSMEs) are the building blocks of the economy, contributing to 50% of gross domestic product (GDP) globally.¹² MSMEs account for 90% of businesses worldwide and up to 70% of jobs, driving employment and economic growth.¹³ For example, In Tanzania over 95% of businesses are small enterprises. These SMEs contribute approximately one-third of the country's Gross Domestic Product (GDP) and account for up to 40% of total employment.¹⁴ Beyond the economic contribution of MSMEs to the economy, lies improved livelihoods among individuals, entrepreneurs, and the community at large.

The absence of reliable electricity access poses significant challenges for MSMEs. Without access to affordable and continuous power supply, businesses face significant operational hurdles, including those related to their ability to operate, the number of hours that they can operate, interruptions in production processes, delays in delivery schedules, and damage to perishable goods. According to a paper by the New Climate Economy, in Africa, businesses lose approximately 4.9% of their annual sales resulting from power outages.¹⁵

OPPORTUNITY

Beyond providing access to lighting, solar home systems (SHS) are often bundled with phone charging, televisions, fans, refrigeration units, radios which are used by a range of businesses to enhance and extend their opening hours and provision of services. Other systems are sold with

specific business appliances or AC-DC converters which can be used to power a range of AC appliances. Research on the SHS markets in Kenya, Mozambique, Rwanda, Tanzania, and Uganda, found that 24% of SHS are used in home businesses or income-generating activities.¹⁶ A few key areas where off grid solar technologies are supporting enterprises and increasing revenues are:

- **Lighting:** Solar-powered lighting systems provide reliable lighting for shops, bars, restaurants, and a range of other commercial enterprises. This allows these businesses to extend their hours of operation. In areas with unreliable grid, they enable businesses to extend their trading hours, thus increasing their income.
- **Communication:** Solar-powered communication devices such as mobile phones and internet routers also offer reliable connectivity to the rest of the world. Information and Communication Technology (ICT) based appliances and products powered by off-grid solar help businesses to identify business opportunities, including ascertaining fair market prices for their products and services, and staying connected with their customers, suppliers, and stakeholders, facilitating smoother business operations and transactions.
- **Cooling:** Refrigeration units (often below 200L) are mainly designed for income-generating activities such as cooling beverages and food in retail outlets and restaurants or refrigerating milk for small-scale agricultural producers. To reduce food loss and waste, cold chain technologies are used for post-harvest pre-cooling, packing, cold storage such as walk-in-cold rooms, ripening chambers, refrigerated vehicles, and retail refrigeration.¹⁷ More insights on the role of

¹² Coke-Hamilton (2023). *Micro-, Small and Medium-Sized Enterprises are Key to an Inclusive and Sustainable Future*

¹³ *ibid*

¹⁴ TanzaniaInvest (2023) *Tanzania's small and medium enterprises*

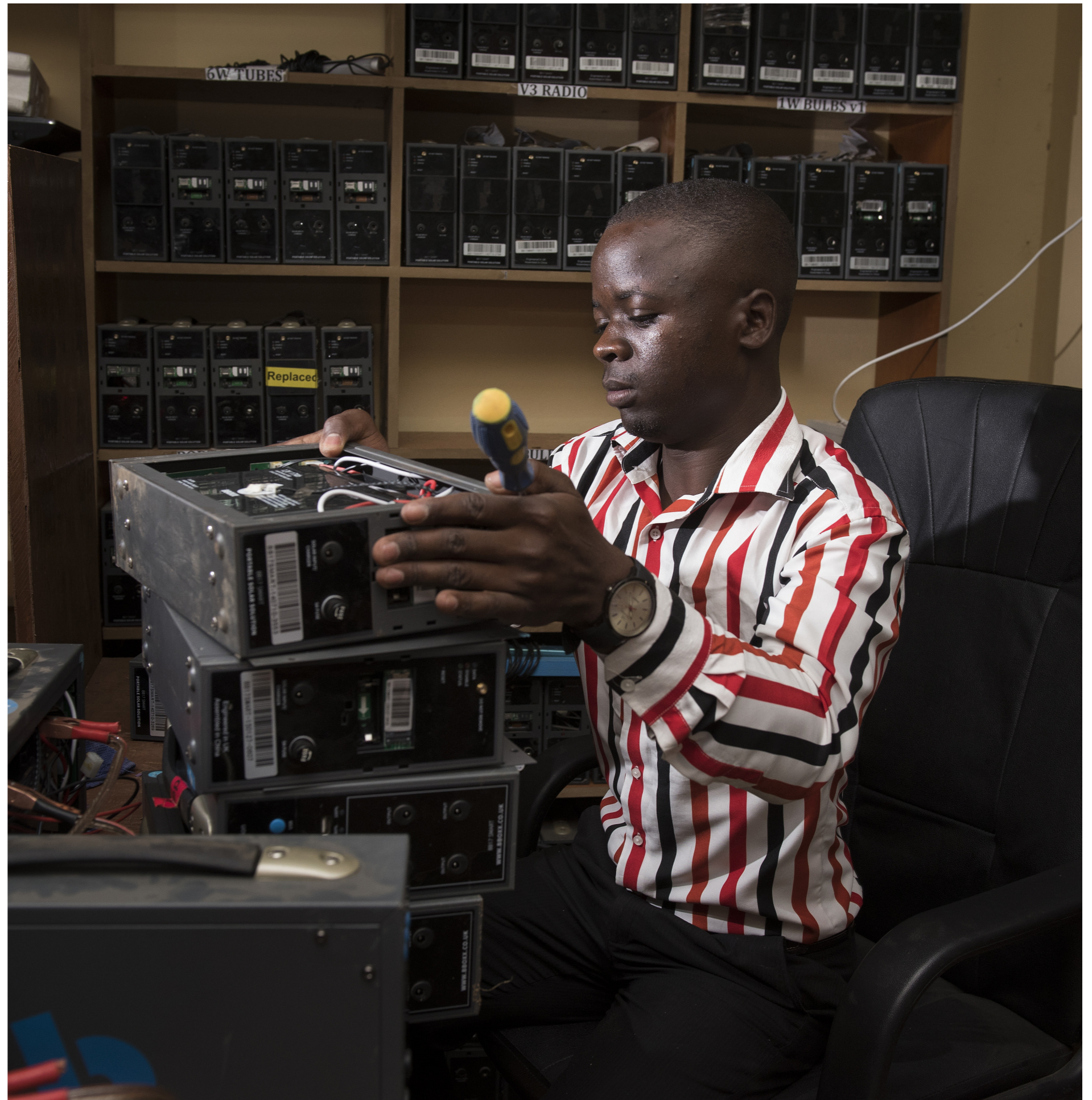
¹⁵ WRI (2021). *Energy Access is Key to Sub-Saharan Africa's Economic Recovery*

¹⁶ Power for All (2019). *Powering Jobs Census 2019: The Energy Access Workforce*

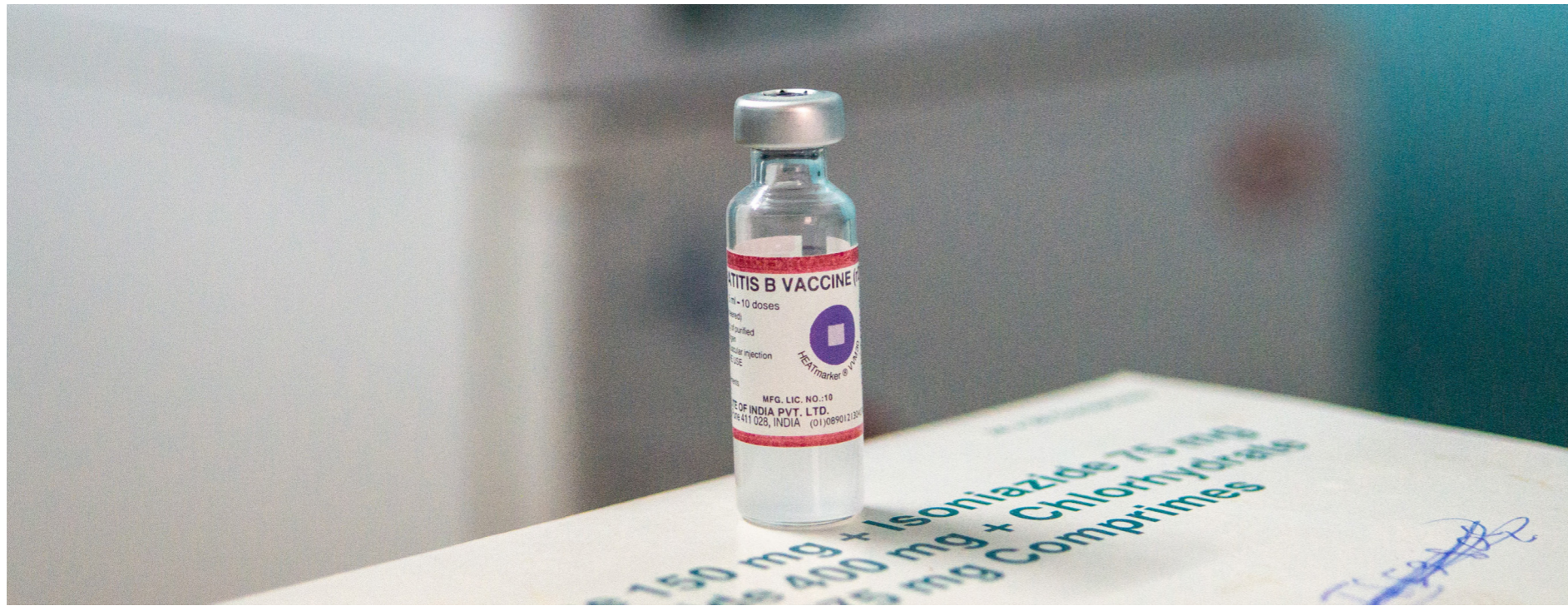
¹⁷ Efficiency for Access Coalition (2023). *Keep it Cool: Harnessing Cold Storage to Reduce Food Loss and Support Sustainable Food Systems in Emerging Economies*

refrigeration and cold storage for agriculture can be found in the section above on Energy in Agriculture, Animal Husbandry and Fisheries, and accompanying case studies can be found in the Annexure.

- **Creation of green jobs:** According to the 2022 Powering Jobs Census conducted by Power for All, the Decentralized renewable energy (DRE) sector contributes significantly to job creation in India, Kenya, Nigeria, and Uganda. In India it directly employs more than 80,000 workers, with opportunities in manufacturing, installation, maintenance, and repair, while in Kenya and Nigeria it employs about 50,000 workers. DRE jobs in Kenya outnumber those by the formal utility – Kenya Power (8,000 workers) while those in Nigeria are inching closer to those employed in the oil and gas sector (65,000 workers). In Uganda and Ethiopia, DRE has generated employment opportunities nearing 30,000 and 14,000 individuals respectively.¹⁸



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ENERGY IN HEALTH AND SANITATION

CONTEXT

Approximately 1 billion people in low- and lower-middle-income countries are served by healthcare facilities that lack reliable access to electricity or have no access to electricity at all.¹⁹ In Sub-Saharan Africa, 25,000 healthcare facilities completely lack access to electricity, with 70,000 experiencing unreliable electrical supply, while, in South Asia, 12% of healthcare facilities have no access to electricity.²⁰ Off-grid solar solutions can play a critical role in electrification of healthcare systems and can provide vital inputs to the provision of care.

OPPORTUNITY

- **Powering Medical equipment:** Electricity plays a vital role in powering essential services and for

operating medical equipment (ultrasound, heart monitors, ventilators etc) necessary for safe childbirth, immunization, and routine and emergency procedures.

- **Lighting:** Many health centres are already using off-grid solutions such as solar energy kits for lighting that enables health care facilities to provide services and conduct emergency operations even at night. Solar lighting provides reliable illumination for examination rooms, operating theatres, patient wards, and outdoor areas, enhancing the overall safety and functionality of health facilities.
- **Energy Storage:** Solar generators that provide 24/7 energy storage can also act as a critical power supply or backup energy source in areas of intermittent grid. Solar generators contain inverters that can convert Direct Current (DC) power to Alternative Current (AC) and power medical equipment and appliances in healthcare centres and hospitals. Additionally, by replacing fossil fuel-based equipment like diesel

generators at healthcare facilities with DRE energy efficient equipment, they can help reduce carbon emissions with a potential to mitigate 42 tonnes of CO₂e emission per health facility over a span of 20 years.²¹

- **Communications:** Solar-powered devices such as mobile phones, internet routers, and computers are also contributing to the support of healthcare facilities by enhancing connectivity and strengthening health systems through efficient data collection. Solar energy kits and efficient ICT appliances are popularizing telemedicine by enabling health workers to communicate with patients, thus improving service delivery and patient care. Access to health information is also a vital input to efficient and effective healthcare provision. Additionally solar powered ICT devices enable health workers to maintain better record keeping and communicate with relevant government agencies ensuring better planning for health services.
- **Cold storage for vaccines:** In areas with limited power supply, it is challenging for healthcare facilities to ensure safe storage of vaccines, medicines, and laboratory samples. The integration of electricity and solar-powered refrigeration units (SRUs) in health facilities can significantly improve healthcare services by ensuring proper storage of vaccines, samples, and medicines. To date, over 45,000 solar direct drive refrigerators and freezers have been disseminated across sub-Saharan Africa by the vaccine alliance, GAVI. Solar powered refrigerators have made a huge difference in many countries. For example, due to the introduction of solar powered refrigerators, the vaccination rate of children in South Sudan has improved since 2016, reaching 76% vaccination of children with at least one jab in 2022.²²

19 WHO (2023) Energizing health: accelerating electricity access in health-care facilities (who.int)

20 SEforALL (2024) State of the Market Report for Healthcare Facility Electrification

21 SELCO Foundation: Enabling Resilient Health Systems using Decentralized Sustainable Energy

22 Gavi (2024); The vaccine cold chain: A history



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ENERGY IN EDUCATION

CONTEXT

Access to electricity plays a crucial role in the education of students, this is even more evident in recent years. The COVID 19 pandemic caused a global upheaval, with over a billion school children impacted around the world.²³ Millions of students in developing nations lack access to basic amenities like electricity, let alone the technology or internet access needed to gain the benefit of distance learning and connectivity. Off-grid solar solutions can address the energy gap, ensuring first time access or dependable power supply to schools located in rural areas.

OPPORTUNITY

- **Lighting:** Off-grid solar can revolutionize the education system by providing sustainable power solutions to schools and educational institutions worldwide. In regions with no access to electricity, appliances like solar lanterns and solar home systems have also enabled students to extend their study hours into the evening with well-lit homes. An example case study included in the annexure illustrates how children with access to these solar appliances have improved their academic performance.
- **Access to Information and Communication Technology (ICT):** The installation of solar power in academic institutions facilitates the integration of modern technology into classrooms, enabling access to computers, internet connectivity, and other electronic educational resources. Additionally, solar-powered devices like tablets and laptops can be utilized for digital learning initiatives. For example, in response to the impact of COVID 19 on children

affected by the pandemic the United Nations Industrial Development Organization (UNIDO) collaborated with Kamaleon, a local private sector organization in Mozambique, on the Community Tablet Initiative. This initiative aimed to develop solar-powered tablets for community education campaigns covering various topics, including measures to prevent the spread of COVID-19.²⁴ Additionally, having access to these technologies can unlock access to free online courses and lessons which can help students to earn credits towards technical qualifications and university degrees or enable ICT focussed learnings that can be used to enter professions such as software development and coding. These tools can help to bridge the gap between urban and rural education by bringing modern teaching tools to remote areas.

- **Improved teaching conditions:** Teachers benefit from a well-lit and powered environment, allowing them to use electronic teaching aids and prepare lessons more effectively. It also improves their overall working conditions, making it easier to attract and retain qualified teachers in remote areas. Also, solar-powered education facilities can support extracurricular activities and community events after dark, fostering a more vibrant school environment and community engagement.

²³ Power for All (2020) Why Off-Grid technologies are key in bridging the digital divide amid COVID19

²⁴ Power for All (2020) Why Off-Grid technologies are key in bridging the digital divide amid COVID19



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ENERGY IN ENVIRONMENT AND CLIMATE CHANGE

CONTEXT

The majority of energy poor communities are amongst those most vulnerable to climate change. They are also the least responsible for the extreme weather conditions they now face, having contributed the least to global emissions. Mozambique provides a compelling example. The country combats devastating floods and cyclones almost every year exacerbated by climate change, while 22 million of Mozambique's population lacks access to electricity.²⁵

One of the 30 key objectives outlined in the COP 27 Sharm El-Sheikh Adaptation Agenda is to achieve universal access to electricity via climate-smart and resilient energy systems.²⁶ Off-grid solar technologies can play a key role in achieving this target and in delivering modern electricity services to the majority of individuals who currently do not have access. Improving access to off-grid solar can also help to reduce reliance on highly carbon intensive

alternatives such as kerosene, diesel, and petrol that will help reduce carbon emissions.

OPPORTUNITY

- **Climate Adaptation:** Off-grid solar technologies can help to reduce the impact from a range of climate hazards. Communications technologies can help to power early warning systems in the face of climate disasters. An example is provided in the annexure that demonstrates how solar-powered appliances such as radios, TVs, and phones can assist in delivering timely and accurate information to communities on the front lines of extreme weather disasters.
- **Climate Resilience:** Solar irrigation is expected to be vital in food production in regions vulnerable to climate change. For instance, improved irrigation in sub-Saharan Africa could result in a 50% increase in agricultural productivity.²⁷ Whereas solar refrigerators and cold storage facilities can help in food preservation and prevention of food loss and wastage thereby increasing food security. Furthermore, diversified income sources aside from agriculture also become

possible with the introduction of solar technologies. For instance, in just two years, SokoFresh, a company operating 14 walk-in cold rooms across Kenya, has assisted more than 8500 farmers in increasing their incomes by up to 40% and has generated 40 permanent and 1200 seasonal jobs.²⁸ This not only enables productivity and improve livelihoods, but helps to protect communities against climate shocks.

- **Minimizing Carbon emission:** Millions of litres of kerosene continue to be used for lighting homes, businesses, and communities at night. The most vulnerable households bear the brunt of its harmful emissions, particularly impacting women, and children. Apart from emitting CO₂e, kerosene lamps release black carbon in the form of soot, which is both toxic for human health and possesses a high warming potential. When this black carbon is included in estimates for emissions reductions replacing one kerosene lantern with a solar alternative saves approximately 431 kg of CO₂e equivalent (CO₂e) annually. Even without factoring in black carbon emissions, transitioning from a kerosene lantern to a solar alternative is still projected to prevent around 92 kg of CO₂e emissions per year.²⁹ Solar home systems also provide a low-carbon alternative to diesel generators. It is estimated that backup generators emit over 100 million metric tons of CO₂e annually. In 2016 alone, 25 million backup generators were deployed in developing countries, producing power equivalent to 700-1000 coal-fired power plants.³⁰ The KUSUM scheme in India, which aims to replace diesel-powered water pumps and irrigation systems with solar-powered alternatives, is also focused on avoiding emissions, and has the potential to avoid up to 27 million tons of CO₂ annually.³¹

25 [GOGLA \(2023\) Adaptation and Resilience in the Face of Climate Disasters in Mozambique: The Role of Off-Grid Solar and Energy Access](#)

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

27 [IFPRI \(2020\) Irrigation to Transform Agriculture and Food Systems in Africa South of the Sahara](#)

28 [FoodFlow \(2022\) Impact Report – FoodFlow](#)

29 [Namene Solar - Carbon credits](#)

30 [IFC \(2019\): The Dirty Footprint of the Broken Grid](#)

31 [MNRE: Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyaan \(PM-KUSUM\)](#)

FIGURE 2: OFF-GRID SOLAR POWERING ADAPTATION

SOLAR POWERING ADAPTATION



ENABLES RESILIENCE AND GREEN GROWTH



Creates climate resilient electricity infrastructure



Unlocks the transfer of critical adaptation knowledge



Powers clean energy jobs and enterprise



Improves ability to respond to shocks

COMBATS CLIMATE HAZARDS



Mitigates **drought** risk and improves **food and water security**



Reduces the impacts of **extreme heat**



Improves **disaster response and planning**



Lowers the **risk of disease**

THE CHALLENGE AND NEED FOR ACTION TO REALIZE AND MAXIMIZE IMPACT

To enable countries and governments realize their full social and economic development objectives from the enhanced access realized from the national energy access efforts, it will be necessary to ensure that all the critical enablers are not only present but are fully leveraged. Currently, limited awareness, especially in rural and off-grid communities, hinders the utilization of the numerous benefits that can be unlocked by improved energy access. This represents a missed opportunity. To maximize the impact of off-grid solar electrification on various development goals, a more strategic approach is needed. This requires deliberate recognition of off-grid solar potential, followed by concrete planning and execution. These are the proposed three key levers necessary:

INTERGOVERNMENTAL COORDINATION

Traditionally, national, and local government institutions and agencies focus delivering on their individual mandates while respecting mandates of other peers. However, this can lead to siloed decision making and planning which may lead to duplication of efforts and inefficient use of scarce government resources. As energy actors drive the delivery of enhanced energy access across their respective geographies, coordination and collaboration with other government ministries and agencies responsible for other sectors will play a crucial role in enabling the alignment of enhanced energy access to the utilization on target socio-economic pillars to drive realization of development goals.

In India, the Ministry of New and Renewable Energy (MNRE) collaborates with the Ministry of Agriculture to promote solar-powered irrigation systems.³² This collaboration not only enhances energy access for farmers but also improves agricultural productivity and sustainability. By leveraging such synergies, governments can maximize the impact of off-grid solutions on economic development, social welfare, and environmental sustainability.

MULTI-STAKEHOLDER ENGAGEMENT

While energy access and electrification in general has been in the sole purview of national utilities and government agencies, the energy sector has evolved. Today, it includes private sector companies developing, selling, and supporting off-grid solar solutions, investors and development partners providing needed financing and public sector institutions that not only set policy and regulatory oversight for the sector, but also facilitate market growth through incentives and provision of other public support.

By engaging with the private sector, and development partners, governments can further leverage the expertise and resources of various stakeholders, access funding, and gain technical assistance. For instance, Mali's Ministry of Health recognised the need to improve the vaccine cold chain across the country and selected SureChill, a pioneering platform cooling technology company, as their partner to do so. Mali received assistance from UNICEF and

funding from UNICEF partners to rebuild the cold chain from regional cold stores to health post refrigerators.³³

INTEGRATED PLANNING

As we look towards leveraging enhanced energy access to realize national economic or social service development objectives, integrated planning across sectors will be necessary to not only recognize the specific energy needs and uses in target sectors, but to also take cognizance of the potential enabled by these energy access solutions and mainstream them into the specific sector plans and strategies for each social service or economic development pillar.

Off-Grid Solar technologies should therefore be properly integrated not only into government electrification plans, but also the specific sector plans relating to climate, water, agriculture, education, health, industry, trade, and green growth. This should include the a) national sector strategies, policies, and plans, and b) the sector specific programmatic efforts of all ministries and agencies where these solutions can help meet targets. The Ministry of Health in Kenya for example has announced plans to spearhead climate-friendly initiatives, to adopt solar power for healthcare facilities across the country and investing in solarized facilities plans.³⁴

³² MNRE: Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyaan (PM-KUSUM)

³³ SureChill

³⁴ The Star (2023) MoH to adopt Solar Power for Hospitals to combat Climate Change

CALL TO ACTION

Off-grid solar technologies can play a significant role in achieving a range of development benefits that cut across various sectors. However, the knowledge of these solutions is often limited to Energy Ministries and those working in the electrification space. To address this challenge and extend awareness of the impact of off-grid solar solutions, this paper recommends three approaches on how energy actors can seek to partner with other government institutions and other stakeholders to leverage energy access to maximize its impact on social and economic development objectives.



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INTERGOVERNMENTAL COORDINATION:

- Establish a dedicated task force or working group within the Ministry of Energy to coordinate off-grid solution efforts with other relevant ministries, such as agriculture, health, enterprise, education, and environment.
- Develop an inter-ministerial action plan to integrate off-grid solutions into broader national socio-economic development strategies.
- Regularly convene high-level meetings or conferences with representatives from different ministries to discuss progress, challenges, and opportunities for collaboration in scaling up off-grid solutions.

MULTI-STAKEHOLDER ENGAGEMENT:

- Facilitate regular dialogues and partnerships between the government, private sector, civil society, and development partners to leverage their expertise, resources, and networks in scaling up off-grid solutions.
- Create platforms or forums for knowledge sharing, capacity building, and best practice exchange among stakeholders involved in off-grid solutions.
- Encourage private sector investment and participation through incentives, policy support, and regulatory frameworks that promote the growth of off-grid solutions.

INTEGRATED PLANNING:

- Conduct holistic sector assessments to identify areas with high potential for adoption of distributed energy renewable solutions. Analyse socio-economic factors, energy needs and existing solutions to ensure fit of applicable Distributed Renewable Energy (DRE) solutions.
- Properly integrate DRE solutions into the specific sector plans including into the a) sector policies, plans, and strategies and b) the sector specific programmatic efforts of all relevant ministries and agencies and institutions. These plans should specifically recognize the goals, actions necessary and measures to be undertaken.
- Design and implement initiatives and support programs specifically tailored to target user groups and beneficiaries to increase awareness, provide capacity building and training and but enhance access through access to finance and other measures. Foster partnerships with sector specific organizations such as agricultural, cooperatives, and educational institutions to strengthen awareness and ensure long-term capacity building.

ANNEXURE

CASE STUDIES

OFF-GRID SOLAR IN ACTION: SUNCULTURE SOLAR WATER PUMPS RAISE YIELDS AND INCOME IN EAST AFRICA

SunCulture, a company based in Nairobi, Kenya has been providing solutions through their *Climate Smart* solar water pump (SWP) system. The technology is integrated with *Pay-As-You-Grow Consumer Financing* that enables farmers to buy their SWP over time through monthly instalments. The cost of the instalments is 45% cheaper than the recurring cost for fuel pumps. Once the instalments are paid the systems are then owned outright by the farmers and so free for them to use or rent/lend to their neighbours. Through this solution, SunCulture has played a significant role enhancing the business and income of thousands of smallholder farmers. On average, the company estimates that the annual revenues of farmers' using their systems increase by 5x due to higher value crops and more cultivated land, and that increased water for cows can increase milk production by 1.5x.³⁵

"I have been able to diversify my farming since I can now easily irrigate my farm. Because of the pump, I am now able to plant different crops which enables me to boost my productivity and income"

Female SWP Customer – 26



SunCulture's ClimateSmart & Rainmaker, SunCulture

OFF-GRID SOLAR IN ACTION: KOOLBOKS SUPPORTING SMALL AND MEDIUM ENTERPRISES

Koolboks, a solar cooling company, provides a reliable long term cold storage solution with superior insulation and ice battery technology. Leveraging its embedded pay-as-you-go (PAYGo) technology, Koolboks enables customers to purchase their freezer using lease-to-own consumer financing. With this innovation, Koolboks has been able to address the affordability gap for both individuals and shop owners who can make small monthly or weekly instalments to eventually own a solar refrigerator. Recently, Koolboks was selected by the Cooling as a Service (Caas) Initiative Incubator program to pilot their 'fee-for-service model' designed to help more people access cold storage. Koolboks received support from BASE to integrate Caas into their cooling solution to reach those at the bottom of the pyramid.³⁶

TESTIMONIAL:

"Ever since I got Koolboks, my profit margin has increased. Life has been made easy; I pay monthly instalments with ease."

Mrs Adrinoye, Restaurant Owner



A customer stands with her Koolboks freezer, Koolboks

OFF-GRID SOLAR IN ACTION: SURECHILL SOLARIZING HEALTH

At the beginning of 2014, Mali's Ministry of Health recognised the need to improve the vaccine cold chain across the country. and received assistance from UNICEF and funding from UNICEF partners to make critical improvements.. A UNICEF cold chain consultant was based in country for three years and developed an overarching strategy that had a key objective of preventing vaccines from freezing.. SureChill was engaged to support the infrastructure improvements via the use of the freeze-free solar-powered vaccine refrigerator. SureChill refrigeration units were supplied to Mali from 2014 to 2019, equipping the entire cold chain of the country and ensuring that vital vaccines are protected throughout the country's clinics and outreach centres. Training from SureChill's team of experienced engineers was provided to technicians responsible for looking after the units, ensuring that knowledge of servicing, fault diagnostics, maintenance, and repairs were transferred. In total 1700 units were supplied over a 6-year period. Today, 98% of the refrigerators are still operational. These vaccines fridges have been saving lives for 10 years. They have protected over 18 million doses of vaccines so that they could be used to safeguard the health of 1.1 million children.³⁷



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OFF-GRID SOLAR IN ACTION: SOLAR AID TRANSFORMS EDUCATION AND BRIGHTENS FUTURES

SolarAid, is an international development charity working to support the development of a sustainable market for solar lights in Africa via its social enterprise, SunnyMoney. It works directly with schools and education networks to help families to access solar lanterns and lighting systems, with a goal of helping children have clean safe light under which they can do their homework at night. The organisation's research shows that access to solar lighting has led to school children dedicating an additional hour to their studies each day on average. Headteachers from the schools partnered with SunnyMoney have observed enhancements in the performance, attendance, concentration, and motivation of their students. When children excel academically, they are more likely to remain in school for a longer period and gain access to greater knowledge and opportunities.

Testimonial:

“Borrowing books and lamps has improved my school performance because I have time to read at home.”

Rhoda Unyolo Student at Kalira School in Malawi



OFF-GRID SOLAR IN ACTION: CLIMATE DISASTER AND RESPONSE

ENGIE Energy Access is one of the off-grid solar providers in Mozambique dedicated to empowering communities with sustainable electricity solutions. Engie offers its MySol solar home systems that contain lights, radio, and TV units, enabling illumination and information sharing. 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. 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.³⁸



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TABLES

TABLE1: KEY EXAMPLES OF APPLICATIONS USES ACROSS SECTORS (NON- EXHAUSTIVE)

| Sector | Opportunity | Technology | Maturity stage |
|---|--|------------------------|--------------------------------|
| Ministry of Agriculture | Irrigation | Solar water pumps | Near-to-market |
| | | Walk-in cold rooms | Emerging |
| | Cooling | Refrigerators | Near to market |
| | | Freezers | Emerging |
| | | Milk chillers | Emerging |
| | | Ice makers | Emerging |
| | Fishing | Fishing lamps | Near-to-market |
| Poultry | Egg incubators | Emerging | |
| Ministry of Micro, Small and Medium Enterprises | Agro-processing | Mills | Horizon |
| | | Threshers | Horizon |
| | | De-huskers | Horizon |
| | | Oil presses | Emerging |
| | | Dryers (Solar-powered) | Horizon |
| | Entertainment | TVs | Commercial |
| | | Radios | Commercial |
| | Cooling | Fans | Commercial |
| | Tailoring | Sewing Machines | Horizon |
| | Ministry of health, Water and Sanitation | Cooling | Cold storage (vaccine storage) |
| Storage | | Generator | Near-to-market |
| | | Solar Lanterns | Emerging |
| Heating | | Solar Home Systems | Emerging |
| | | Solar Heaters | Emerging |
| Cooking | | E-cooking | Emerging |
| | | Solar Lanterns | Emerging |
| Communication | | Solar Home Systems | Emerging |
| | | ICT | Emerging |
| Clean Cooking | | Solar generators | Emerging |
| | Solar Home Systems | Emerging | |
| | Solar Lanterns | Emerging | |
| | E-cooking | Emerging | |



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