AFRICA SOLAR IMPACT CASES

SOLAR PROJECTS SHOWCASING THE LIFE-CHANGING CAPACITY OF SOLAR ELECTRIFICATION

MARCO DOROTHAL
TOM VAN DER LINDEN
# Table of Contents

- P5. **Introduction**
- P8. **Case #1: Tororo Solar Plant**
  Tororo, Uganda /// Utility-Scale
- P15. **Case #2: Entasopia Microgrid**
  Entasopia, Kenya /// Microgrid
- P21. **Case #3: Solar Vaccine Refrigerators**
  Northeastern Nigeria /// Off-Grid
- P26. **Case #4: Mashaba Mini-Grid**
  Mashaba, Zimbabwe /// Mini-Grid
- P31. **Case #5: Malindi Solar Plant**
  Malindi, Kenya /// Utility-Scale
- P37. **Case #6: DRC Off-Grid Solar**
  Democratic Republic of Congo /// Off-Grid
- P43. **Unlocking Solar Capital Africa**
- P44. **Sources**
Solarplaza seeks to accelerate the global sustainable energy transition by organizing high-level conferences and trade missions across the world and provides its readers and subscribers with articles, reports, studies and analysis about the most relevant solar topics and trends. Our track record contains over 100 events, in over 30 different countries on 5 continents. Learn more about Solarplaza at www.solarplaza.com.

Lydia Van Os
Africa Lead
lydia@solarplaza.com
+31 10 302 7907

Laura Fortes
Account Manager
laura@solarplaza.com
+34 6 5004 6220

Marco Dorothal
Research Analyst
marco@solarplaza.com
+31 10 302 7912

Tom Van Der Linden
Content Manager
tom@solarplaza.com
+31 10 302 7914

Disclaimer: This overview is provided by Solarplaza International BV ("Solarplaza") as a service to its customers on an "as-is, as-available" basis for informational purposes only. Solarplaza assumes no responsibility for any errors or omissions in these materials. Solarplaza makes no commitment to update the information contained herein. This overview is protected by copyright laws, and may only be reproduced, republished, distributed, transmitted, displayed, broadcast or otherwise exploited in any manner only by accrediting Solarplaza as the source of it and providing a full hyperlink to https://africa.unlockingsolarcapital.com where it was originally published.
CONTRIBUTORS / SOURCES

FMO
Entrepreneurial Development Bank

Ashden
Sustainable solutions, better lives

Building Energy
Investment works

Bboxx
the solar revolution

Thomson Reuters Foundation
INTRODUCTION

Powering Africa

Africa is hungry for electric power. Plagued by the lowest electrification rate of all the continents, and faced with the ever-growing power needs of its rapidly emerging economies, Africa is looking to leapfrog old-fashioned development cycles to create immediate impact. To change lives for the better and empower its people. Solar energy, as it turns out, is the swiftest, simplest, most cost-effective and most ethical way to achieve these goals of bringing electric power to the 600 million Africans that are struggling without reliable, safe and affordable energy.

On average, electricity is only accessible to 30-50% of the population, with urban areas accounting for the lion’s share of connections. Even in those cases where there is ample power supply, the offerings are primarily sourced from fossil fuels (65%), which - apart from their unsustainable nature - have proven to be very costly for both African governments and consumers.

For a more detailed and elaborate overview of the current state of Africa’s (solar) energy markets, we suggest you also consult our extensive ‘Solar Facts & Figures: Africa’ report, published this August for the third consecutive year.

Closing the gap

How then, can solar contribute to closing the electrification gap? And which roles do local governments, local entrepreneurs; and international companies and institutions have in this process? Roughly, we can distinguish between three approaches:

1. **Utility-scale**: Extending the existing energy grid and attaching additional utility-scale solar capacity to it.
2. **Mini-grids & microgrids**: Establishing mini-grids and microgrids to serve larger communities in remote, non-grid-connected places.

There’s no one-size-fits-all solution for Africa in that sense. In the many different contexts of African countries, the different ways of electrification can prove to be most impactful and cost-effective. Generally speaking, the method of extension of the grid and its capacity are logically most attractive to those who are already located relatively close to an existing grid, ergo the urban and peri-urban populations. Mini-grids and microgrids, then, are best suited for communities located so far from the grid that installing local generation and storage capacity becomes cost-effective, yet densely populated enough to jointly carry the costs of setting up the basic infrastructure. Off-grid home systems...
are most attractive to all others on the spectrum; those who live in remote locations, whose homes are not in close proximity to each other’s.

Analysis from Crossboundary puts some numbers to those categories. Of the roughly 600 million unelectrified Africans (as estimated by the World Bank), 210 million would be most cost-effectively serviced by the extending the existing grid (thus implying utility-scale solar development); 100 million would be best served through establishing mini-grids/microgrids; and the remaining 310 million should revert to solar home systems.

Bloomberg New Energy Finance, meanwhile, put general price-tags to the various options. They came to $1 USD / kWh rate for a new grid connection; a $0.29-0.77 USD / kWh range for solar mini-grid/microgrid connections and a $1.5 USD / kWh average cost for solar home systems.

Financing the change

How should these costs be covered; how much should and can come from consumers; and how much foreign capital - be it private or institutional - needs to be injected to get the wheels turning?

For utility-scale solar development, African countries are, and will continue to be for the short- to medium-term, mainly driven by multilateral programs. Large-scale energy-auction, as also kickstarted by the IFC’s ‘Scaling Solar’ program, are quickly becoming the norm for large-scale solar energy development. This area is dominated by mainly foreign players. On the finance
side, development finance institutions (DFIs) - such as KFW DEG, Proparco, FMO, the World Bank (in major ways) and increasingly the African Development Bank - are taking up the challenge of bringing in the high-risk early capital investments.

In the off-grid and mini-grid/microgrid sectors, we can see a lot more involvement from private investors, often hailing from Silicon Valley or Europe. In 2016, they accounted for more than $200 million USD in venture capital, up from $19 million USD in 2013. One of the major challenges for companies operating in this space, however, is the lack of available cash from consumers (who are often without any credit history), which makes for an ongoing puzzle towards finding the holy grail of payment-structures. One of the major methods coming forward from this quest is the pay-as-you-go (PAYG) approach. From 2012 to 2017 this specific PAYG home system sector in Africa raised over $750 million USD. Meanwhile, the top 5 mini-grid developers together managed to raise $100 million USD over the past 5 years.

Still, these amounts seem almost insignificant when compared to larger power infrastructure investments. Take Kenya for example. This single country has announced $1.4 billion USD worth of investments, supported by $675 million from the World Bank, for expanding grid infrastructure.

Impact cases

This, in very brief terms, sets the stage for solar developments in Africa. Roughly distinguishing between the three areas of utility-scale (I), mini-grid / microgrid (II) and off-grid (III) solar development, we see a myriad of governments, institutions, companies, start-ups, and spirited individual entrepreneurs contributing to the solar electrification of Africa. Although we kicked off with another zoomed-out vision on the African solar market as a whole, the aim of this document is to zoom in on individual projects and cases, highlighting the involvement of these different types of actors in the creation of resounding impact on local communities and individuals. To go beyond the numbers and - through the stories and experiences of lesser-heard voices - showcase the significance of solar energy development. To do that, we have selected a small number of cases across the aforementioned three segments to paint a human picture of the evolving solar energy markets of Africa.
CASE #1: TORORO SOLAR PLANT

Intro

With these kinds of impact-cases, the mind first drifts towards small systems and hence small-scale effects. Something like a set of solar panels in the middle of an unelectrified village, which brings light to dark homes and powers for agriculture and commerce. A utility-scale solar plant, on the other hand, tends to feel large and faceless in comparison. However, in its large size and magnificent capacity to generate clean power, these plants can - for those with access to the grid - create an immediate impact on a grand scale and improve thousands of lives. The first case that we will highlight sets the tone for such impacts and concerns the ‘Tororo Solar’ project, a 10 MW utility-scale solar PV farm, located in Eastern Uganda.

Organizations involved

Building Energy is a multinational, vertically-integrated company, operating as a Global Integrated IPP in the Renewable Energy Industry on four continents. The company active in all stages, from the development of projects to the actual sale of energy. With a pipeline of over 2,600 MW in 20 countries, and a short-term construction pipeline of 700 MW worth of generating assets over the next two years, Building Energy is positioned to be one of the major players on the international renewable energy scene.

FMO is the Dutch development bank. As a leading impact investor, FMO supports sustainable private sector growth in developing countries and emerging markets by investing in ambitious projects and entrepreneurs.
Project origin

Concept of the project

Under its ‘GET FiT’ facility, Germany’s KfW issued a tender for the development of two first utility-scale solar plants in Uganda, one of the first major solar development plans in the region. After the issue of the Tender, Building Energy carefully analyzed the provisions and the rules attached to it, and started to scout potential sites and research accordingly. They started their research by identifying the most suitable existing UETCL’s electrical substation at transmission voltage, thus narrowing the search area. Then, a selection was made of several potential suitable areas, which were ranked based on strict criteria—i.e., private land, uncultivated land, without resident people and without environmental or social constraints. Moreover, several meetings with village chiefs were conducted, in order to inform them about the research and obtain their approval and support. This process led to Building Energy identifying the Tororo site.

Timeline of the realization

Various difficulties were faced in developing the program, since there were no precedents for photovoltaic projects in Uganda. Most of the issues were related to the non-mature state of the market, such as lack of experience from government stakeholders and lack of qualified local suppliers. Major milestones included securing the land; obtaining the Environmental and Generation Licenses; signing the PPA and DA; finalizing the financing documents; and reaching financial close; followed by breaking ground on the construction of the project; and - last, but not least - the test to connect the site to the grid.

To ensure the success of the project, it proved vital to have a presence of local partners, duly guided from the company’s Cape Town offices. Key enablers in this transaction were patience, perseverance and the will to understand a different and complicated environment.
**AFRICA SOLAR IMPACT CASES**

**TURORO SOLAR PLANT**

**Key Facts**

- **$20 million**
  - Project investment, of which $15 million debt (arranged by FMO) and $5 million equity

- **8.8% IRR**
  - return or impact figures

- **10 MW**
  - Capacity of the project (fixed tilt)

- **306 construction jobs**
  - 306 Ugandan employees during construction

- **20 permanent jobs**
  - 20 Ugandan employees during operation

- **6 local vendors**
  - From Tororo were contracted

- **2,264 panels**
  - 14 hectare

- **4 inverter / transformer stations**

- **0 accidents**
  - During construction and operations

- **16 GWh**
  - Generated annually, serving

- **35,838 people**
Project impact

The project was commissioned on the 6th of October 2017 and began feeding power into the grid immediately. As mentioned in the key facts and figures, the project has been impactful in three ways. Firstly, 306 local workers along with 6 local vendors were employed in to realize the project. The operational phase resulted in the employment of 20 permanent workers. Last, but not least, the 10 MW power plant is serving close to 36,200 people in Uganda, brightening and empowering their lives. The Tororo plant has had an immense socio-economic impact on the region. In order to gain a better understanding of such impacts, we are shedding light on a few personal stories.

PEOPLE OF TORORO SOLAR

Jessica Mukimba

Jessica, 28 years old, has been working at the Tororo solar project for 5 months. During this time, she has worked as a storekeeper and site cleaner. The income she receives from working at the solar plant has enabled her to take care of her 7-year-old son, Awena Ian and even afford to pay his tuition fees. She has also bought a goat to add to her livestock and has built a grass-thatched house too. Jessica is very optimistic about the solar project in Tororo. She is confident that it will promote prosperity in the region through all the jobs, it is creating.
Kenneth Osike

Kenneth, 24, is a manual laborer at the Tororo solar project. His work ranges from digging to building and woodwork. He has a young family of his own. As he goes to work his wife Lydia looks after their two young daughters; 2-year-old Margaret and 5-month-old Mary. With so many obligations at a young age, Kenneth believes that he is able to fulfill them thanks to the stable income he earns. His stable income proved crucial during the recent famine that hit the Tororo region after the prolonged drought in 2016 as he managed to sustain his nuclear and extended family. Kenneth has also expanded his source of income; he has purchased a cow and planted rice and groundnuts.

Geoffrey Othieno

Geoffrey, 56, is a flagman and traffic controller at the solar project. He directs both public traffic and vehicle traffic for the solar site to ensure safe road usage during construction operations. He has lived with his wife since 1975. Prior to his employment at the solar project, Geoffrey last worked as a warehouse
porter in 1973. After the warehouse closed, he ventured into small-scale agriculture using clan land. His clan soon repossessed most the land and this made it tough for him to make ends meet at home. With a reliable stream of funds, Geoffrey is now better capable of looking after five of his own children, who still stay at home as well two children of his deceased daughter. He can also take care of basic household needs and tuition fees as the sole breadwinner of the family.

Francis Owori

Francis is 38 years old and has been a carpenter for the last 10 years. He makes household and other custom furniture. His furniture shop’s roadside location is how the solar project management team noticed his work. He was sought after and requested to make tables and suggestion boxes for the project. Francis was glad to make the custom furniture and is hoping for more carpentry work from the solar project because he believes that opportunities like these are the reason his furniture business is thriving.
Future outlook

Running time of the project

The Project Lifetime is linked to its PPA tenor. Building Energy has expressed its interest in extending the life of the project, in which case, a revamping of some equipment will be necessary (i.e. inverters, PV modules). Otherwise, the Plant will be decommissioned.

Durability and practical experiences

So far, after one year of operations, the experiences have been very positive. The only “issue” is the need to frequently clean the panels, due to the dusty nature of the area. The Tororo project can also proudly boast that in its development and operations, there have been no recorded accidents at all.

Possible expansion or replication

The Project was developed under the GetFit program. Should similar tenders be published in Uganda, Building Energy stated that it will surely submit another proposal. In any case, since the inception of the plant, the company has been engaging with local authorities in efforts to expand its footprint in the country. Unfortunately, there have not been any tangible results so far, but the company is determined to persevere.
CASE #2: ENTASOPIA MICROGRID

Intro

Bringing clean energy to remote communities in Kenya has proven to be quite a challenge over the years. One way to tackle that problem is with the use of microgrids. Besides regulatory and aggregation issues, microgrids have been found to be able to make a significant difference to the lives of the residents by providing electricity to households, schools and businesses even in the most remote locations. SteamaCo, a privately owned business founded in Kenya, has decided to tackle the challenge of energy access by installing an 8.5 kW modular solar microgrid in the small village of Entasopia in Kenya.

The company has also developed the technology to remotely manage the control of these systems, as well as manage mobile-money payments. Although this technology was initially used only by SteamaCo, the service and technology are now sold to other microgrid operations in order to provide the benefits of this technology to an increasing number of off-grid customers.

Organizations involved

SteamaCo (previously known as Access:Energy) is a privately-held business based in Kenya. It was founded in 2012 by Harrison Leaf and Sam Duby who took the opportunity to combine their management and technical expertise to increase energy access through renewable energy. In 2014, SteamaCo had employed 12 people and had an income of $290,000 USD (46% from sales, 54% grants).

SteamaCo’s original business model started off as the production, sale and installation of individual renewable energy systems. Later on, its business model evolved towards installing microgrids due to the company’s belief that it could reach more customers by selling units of electricity rather than hardware. It was this experience that showed the value of remote management of metering, control and payments.

The company is now focused on the development and sale of the technologies that enabled its remote management tools. SteamaCo sells its hardware to micro-grid developers and leases the software on a monthly basis while also providing consultancy services.
Project origin

Concept of the project

Entesopia is a small village located near Lake Magadi in the south of Kenya. The village is bustling with a myriad of regional tribes but does not have access to grid electricity. Instead, the people living there are powered by an 8.5 kW modular solar microgrid, owned by Vulcan Philanthropy and managed by SteamaCo. The microgrid supplies more than 60 homes and businesses, including a petrol pump operator, a small cinema and a number of welding shops.

The idea for this project was formed as a way to tackle the fact that 1.5 billion people around the world don’t have electricity. SteamaCo believes that energy grids powered by renewable energy could be a solution for providing affordable power. However, the biggest barrier for microgrids has been the reliability of the systems as well as the payment regularity of its customers, both of which are very challenging in remote areas.

The Entesopia project was launched in 2013 when SteamaCo installed its first fully-automated microgrid management system. By April 2015, the company had installed 23 systems in Kenya and two in Tanzania. These systems have a renewable energy capacity of 80 kW, with around 1,000 homes and small businesses connected, and are able to generate 50 MWh/year of electricity. SteamaCo owns and operates three of these microgrids, while the others are owned by five investors - Vulcan, E.ON, PowerGen, Renewable World and Cleanstar Ventures - who pay for the different levels of support from SteamaCo.

How does it work?

SteamaCo operates Entesopia's microgrid using both its own hardware and software technologies. The company’s modular solar microgrid hardware, known as the bitHarvester, comprises of several discrete modules designed to be easy to install and set up, eliminating the need for SteamaCo staff to be present. This system monitors the power use and also keeps track of credit associated with each customer line. It also saves data from each customers keeping track of their credit and automatically switches them off once their credit runs out, allowing customers to only buy power when they need it.
The company’s software, namely, Steama, performs a wide variety of data management operations, such as information monitoring and payment notifications from mobile-money providers. This software allows for kWh use and payments to be inspected, from the whole systems down to individual customers.

How much does it cost and how do users pay?

For the bitHarvester hardware, SteamaCo’s direct customers (microgrid owners) pay a one-off charge ranging between $1,500.00-$2,000.00 USD. For the Steama software, users have to pay a license fee of around $100.00 USD per month, which allows them to view and get data from their own microgrids using the Steama dashboard. Electricity tariffs are set by the microgrid owner and implemented via Steama, usually being around $10.00 USD for the connection and around $2.00-4.00 USD per kWh for electricity used. Although these costs are high compared with grid electricity, it is significantly cheaper than kerosene for lighting and comparable with the charges for pay-as-you-go (PAYG) solar home systems.

Project impact

The 8.5 kW microgrid project consists of 24 panels and required an estimate of $75,000.00 USD to install. The project was commissioned in July 2014 in the town of Entasopia, Kenya. The town was chosen because of its strong business activity, which could benefit from the extra power that such a microgrid system can provide.

As mentioned in the key facts and figures, the project has been impactful not only on an individual level, but also to the community as a whole. It supplies more than 60 homes and businesses across the village, from a petrol pump operator...
AFRICA SOLAR IMPACT CASES

KEY FACTS

ENTASOPIA MICROGRID

8.5 KW
SIZE OF THE SOLAR MICROGRID LOCATED IN ENTASOPIA

$2-4/KWH
AVERAGE COST OF ELECTRICITY USED, KICKED OFF BY $10 CONNECTION FEE

$27,000
TOTAL PROJECT COSTS

> 60 HOUSEHOLDS
MORE THAN 60 HOUSEHOLDS IMPACTED

ACTIVE IN
KENYA
TANZANIA
BENIN

25 SYSTEMS
INSTALLED IN TOTAL, GOOD FOR 80 KW AND POWERING 1,000 HOMES

WITH INVOLVEMENT OF
VULCAN, E.ON POWERGEN, RENEWABLE WORLD & CLEANSTAR VENTURES

25 systems installed in total, good for 80 kW and powering 1,000 homes.

More than 60 households impacted.

Average cost of electricity used, kicked off by $10 connection fee.

Total project costs of $27,000.

Active in Kenya, Tanzania, Benin.

8.5 kW size of the solar microgrid located in Entasopia.
to a number of welding shops. It even powers a small cinema and a nightclub. The environmental impact of this project helps to cut greenhouse gas emissions due to the displacement of kerosene for lighting and diesel-powered generation. For the 25 micro-grids managed by SteamaCo technology, annual savings are an estimated 485 tonnes of CO2 per year. In order to highlight the impact of this project on an individual level, we’re focusing on a few personal stories.

**John Pabio**

John, 24 years old, is a young electrical engineer who runs a shop repairing electrical appliances in Entasopia. Before SteamaCo’s microgrid, he would have had to send damaged appliances to a repair shop 95 km away, because there was not enough power to run a soldering iron on his solar-home-system. Now, with the power from SteamaCo’s microgrid, he is able to fix them immediately in Entasopia. He also cleans the microgrid’s PV cells once a week and troubleshoots for customers suffering outages, trips, or damaged cables.

**Nancy Kaisa**

Nancy Kaisa, 42, owns the village fuel filling station in Entasopia. She uses SteamaCo’s microgrid to harness energy from the sun to pump fuel because it is cheaper and easier to use than the diesel generator that she used before.

**Margaret Mwangi**

Margaret Mwangi, 36, owns a small general store in Entasopia. When the microgrid was installed in the village, she was able to buy a refrigerator in order to sell cold drinks. She also started a hairdressing salon behind her shop now that she has enough power for a hairdryer.
Ibrahim Chegi

Ibrahim Chegi, 33, is a businessman and owner Club 360, a nightclub in Entasopia. He uses the microgrid to power all the equipment in the nightclub, including lights, sound system, TV and DVD. A huge benefit for his business is the fact that now the power is stable and reliable, which does not damage the equipment, therefore lowering his costs and increasing the efficiency of his equipment.

“SteamaCo’s innovative product is helping to take energy access in off-grid rural areas to the next level. By developing hardware and cloud-based software to remotely monitor energy use and payments, it has overcome one of the key barriers to making micro-grids investable.” - Ashden judging panel (2015)

Future outlook

By 2015, SteamaCo had installed around 23 microgrids in Kenya and 2 in Tanzania. The technology is currently being installed in neighboring villages as well as used to build a new microgrid in Benin. The project is not time-bound as microgrids have an extensive lifecycle depending on the components used. Since SteamaCo’s microgrid uses a solar array, the only thing that would need to be replaced are the solar panels, which have a life cycle of around 30 years.

Over the past few years, there has been an increasing interest in microgrids in many countries, especially in countries where the national grid does not extend to remote areas. In order for the sector to grow rapidly, private investment in microgrid hardware is needed.

SteamaCo aims to be a key provider of asset management systems to this growing sector. The company has also launched an investment round to scale up growth. Sam Duby, SteamaCo’s co-founder and chief technical officer, believes that, just as microgrids are changing people’s lives in villages like Entasopia, they have the potential to transform the prospects for scaling up solar energy elsewhere in Africa and the developing world.
CASE #3: SOLAR VACCINE REFRIGERATORS

Intro

Vaccines for polio, tuberculosis and diphtheria have to be kept cool, from their point of production until the moment of final use. In the hot conditions of northeastern Nigeria, though, they can deteriorate rapidly without proper cooling. Your every-day refrigerators are of little use in remote areas where the main power supply is either unreliable or simply non-existent. Since 2004, KXN has deployed vaccine refrigerators powered by solar photovoltaic (PV) modules, to keep the vaccines cool. Though the project is a bit older, it serves as an excellent pioneering example of high-impact off-grid solar deployment, proving how mature the technology is and how suitable it is for off-grid applications. In fact, solar-powered refrigerators already can boast a track record of usage off-grid locations dating back to the 1980s.

Organizations involved

KXN Nigeria is a private company established in 1999 by Anthony Ighodaro and Knowledge Exchange Network Ltd of the UK. It aims to use solar technology to deliver dependable energy supply and improve general living standards in Nigeria by distributing, assembling and maintaining PV systems. In 2010, it noted a turnover of US$2.7 million, had a team of 8 people and a board of 6 directors. It received funding from the Nigerian government and Rotary International. In 2005, KXN won an Ashden award for the initial phase of the project, between 2002 and 2004.
Project origin

Life-threatening diseases like polio, tuberculosis and diphtheria can be kept at bay, and may eventually be wholly eliminated through the use of vaccines. However, unless the vaccines that are key to their eradication are kept suitably cool (at around 3°C), from the point of production until the location of their final use, they may deteriorate rapidly. In remotely located health centers in northeastern Nigeria, standard refrigerators connected to the main electricity supply are of little use, because the supply is either unreliable or just non-existent. Similarly, diesel generators need a reliable supply of fuel, something that cannot be guaranteed in remote areas. Kerosene absorption refrigerators could be used as well, but still require a reliable supply of fuel.

KXN developed a vaccine refrigeration system utilizing photovoltaic (PV) modules for its power supply, with lead-acid batteries for energy storage, enabling continuous operation 24/7.

KXN’s system consists of a vaccine refrigerator and freezer, with PV modules, batteries, a charge controller and associated cabling. One fridge is powered by 240 Wp worth of solar PV modules, which keep the batteries charged for 24-hour cooling. The solar panels are connected to the battery through the charge controller, which protects the battery from over-charging and over-discharging, and provides a steady DC operating voltage for the refrigerator. With heavy insulation, the refrigerators require little electricity to operate and can keep cool despite high ambient temperatures.

Costs and funding

The average PV vaccine refrigeration system has a price tag of around US$10,800 (1.4 million NGN). Although these constitute high costs, the system holds over US$5,400 worth of vaccines when full, meaning the investment is well justified.

167 of the 189 KXN systems were funded by the National Programme for Immunisation, and installed in remote areas, as part of the national campaign to battle polio. That represented a 20% share of all installations under the National Programme, with different installers working in other states. The remaining 22 systems were funded by Rotary International Nigeria.
Key Facts

Off-Grid Solar Vaccine Refrigerators

240 WP
Of PV modules power each vaccine refrigerator, keeping the battery charged for 24-hour cooling.

$10,800
Costs of a typical PV vaccine refrigeration system.

6,000 People
People are served by each vaccine refrigerator system.

189 Refrigerators
Were installed across the northeast of Nigeria between 2002-2004 for 90 villages.

1.1 Million
People gained access to vaccination through the systems.

767 Refrigerators
Were installed in Nigeria by 2009.

4.6 Million
People were serviced by the total amount of systems.

12 Jobs Permanent
12 people trained as solar technicians to install and maintain systems.
Maintenance

The PV vaccine refrigerators require a specific installation procedure, and the health center staff needs to know how to properly use them. KXN realized there was a limited amount of PV technicians in Nigeria’s remote areas, but also concluded that the maintenance of vaccine refrigerators would not provide sufficient work for a dedicated PV technician to run a viable business. Therefore, KXN collaborated with the University of Maiduguri in Borno State and with BP Solar to train ‘general’ technicians to install and maintain both solar refrigerators and other PV systems.

Social and health benefits

Nigeria northeastern region is one of the few places in the world where polio has still not been fully eradicated. The main reason behind the installation of solar PV vaccine refrigerators was to enable a program of polio vaccinations in remote areas. Looking beyond polio, though, the program also provides immunization against other dangerous diseases, such as tuberculosis, diphtheria and whooping cough.

In the period between 2002 and 2004, KXN commissioned 189 vaccine refrigerator systems in 90 villages across the northeast of Nigeria. A single vaccine refrigerator can serve a population of about 6,000 people. So, in total, about 1.1 million people gained access to vaccination through the systems. By 2009, KXN managed to install 767 systems, serving 4.6 million people in total.

The main benefit of choosing solar PV over diesel or kerosene to run vaccine refrigerators is its enhanced reliability. Therefore, the WHO recommends solar...
PV as the best power source for remote areas. Furthermore, PV-powered refrigerators also avoid the noise and fumes of diesel generators and the pollution caused by diesel and kerosene spills.

**Employment benefits**

Twelve people received training, to qualify as solar technicians, capable of installing and maintaining the refrigeration systems. KXN enabled Three of those installers to expand their experience and become full-fledged solar entrepreneurs, able to generate additional income by selling commercial PV services, like solar home systems, battery charging and water pumping. Two locals have been employed on a casual basis for administration and warehousing purposes and local people aided in the assembly of the systems from imported components.

**Future outlook**

By 2009, KXN managed to install 767 vaccine refrigeration systems in Nigeria. Although KXN experienced slow growth in the sale of its solar home systems, the sale of PV modules and installation of large-scale PV systems to the private sector in Nigeria are thriving.

The example of KXN was taken up by other companies as well. UK-based Sure Chill, for example, developed a similar solar power vaccine refrigerator, which has been used in the Democratic Republic of Congo (DRC), as well as the Liwolo Clinic in South Sudan.

Another example is (again, UK-based) Dulas, who produce solar fridges that have been installed in the remote Comé region of Benin.

Even though solar refrigerators have actually been around since the 1980s, a major drawback has been the fast deterioration of the necessary batteries. In early applications, solar refrigerators were therefore often abandoned upon the end of the lifetime of the included batteries (3-5 years). Improvements in battery technology, battery availability and servicing have therefore made the solar refrigerator solution more sustainable in recent years.
CASE #4: MASHABA MINI-GRID

Intro

Until recently, farmers in Mashaba, a small town in southern Zimbabwe, struggled to provide water for their crops. Sparse rain over the last decade, a worsening problem associated with climate change, has caused many harvests to fail, and cut into the country’s generation of hydropower, which provides much of its electricity. This was due to the regular breakdown of the diesel engines that powered the country’s irrigation systems. As in most areas of rural Zimbabwe, rain-fed agriculture provides most of the jobs. According to the Ministry of Energy and Power Development, only about 40 percent of Zimbabweans have electrical power, and only 13 percent in rural areas. Rural communities meet 94 percent of their energy requirements through traditional fuels, mostly wood. In Mashaba, however, the community’s luck turned. In 2015, the town installed a solar mini-grid power station that has helped to transform the hot, arid area into a flourishing hive of entrepreneurial activity.

Organizations involved

The Mashaba Solar Mini-grid project, also known as the The Sustainable Energy for Rural Communities project (SE4RC), was developed through a partnership of public and private sectors, as well as donors. The project was jointly funded by the European Union (EU-ACP), the OPEC Fund for International Development (OFID), the Global Environment Facility (GEF) as part of a drive to promote universal access for modern energy in rural areas. Its construction was overseen by SNV, Practical Action, and Dabane Trust with the support of Government Ministries and Departments.
Project origin

Over the last decade, Zimbabwe has been facing a worsening problem associated with climate change, especially in the southern province of Gwanda. Sparse rains, together with heat waves, have caused many harvests to fail, and cut into the country’s electricity generation, which comes primarily from hydropower. To deal with these climate issues, Mashaba decided to install a solar mini-grid power station to help turn the hot, arid area into a green hive of entrepreneurial activity. Since its commissioning in 2015, the Mashaba Solar Mini Grid Project has made it possible to effectively irrigate crops, boost farming yields and fuel economic growth.

As of January 2017, the project comprises 400 solar panels, provides 99 kW of reliable clean energy, and services a 40km radius through a 33kv power line. The mini-grid has helped to power one school, one clinic, two business centers and two irrigation schemes, thus improving the health, education and livelihoods of the connected communities. The mini-grid also has a storage system consisting of 144 batteries as a backup and to provide energy at night or during cloudy days. According to local leaders in Mashaba, 10,000 people are benefiting directly from the clean power grid, which has increased the productivity of schools and has made medical facilities safer. The mini-grid is co-owned by an independent power producer and the community through the trust. For the day-to-day operation responsibilities of the mini-grid, a board of trustees was selected by the community. For the maintenance of the mini-grid, local community members have been trained on how to maintain and operate it.
Africa Solar Impact Cases

Mashaba Solar Mini-Grid

**Key Facts**

- **99 KW**
  Capacity of the Mashaba solar mini-grid
- **400 Solar Panels**
  400 panels provide solar power to the mini-grid
- **$3.2 Million**
  Total project cost
- **10,000**
  People benefiting directly from the clean power grid
- **40 KM**
  Radius of inhabitants that are powered by the mini-grid through the 33 KV line
- Powers
  - 2 irrigation schemes
  - 2 business centers
  - 1 clinic
  - 1 school
Project impact

The Mashaba mini-grid project has had a strong impact on the community of Mashaba and the surrounding areas. The project powers two irrigation schemes, the Mankonkoni and Rustlers Gorge irrigation schemes, which cover 32 hectares and 42 hectares respectively. Besides that, the project also powers the Mashaba Primary School; a business center with three shops; the Mashaba Clinic; and the Masendani Business Centre, which has four shops and an energy kiosk.

Mpokiseng Moyo

Mpokiseng Moyo is a mother of three who grows winter wheat on a plot of 0.2 hectares at Rustlers Gorge. According to her, in the past she could barely produce a tonne of food. However, since the new mini-grid was installed, she can now easily harvest 15 tonnes. Selling the surplus harvest has made it possible for her to send her children to school and buy provisions for the family. Moyo is one of 41 farmers (26 women and 15 men) who collectively own an irrigation plant that services the 42 hectares at Rustlers Gorge.

“Before being connected to the solar grid, we irrigated our crops using diesel pumps and traveled as far as Gwanda (more than 100km away) to buy diesel for the pumps. The pumps broke down many times, affecting productivity. But with solar energy we are able to farm throughout the year without any hassles,” Moyo said.

Obert Joseph Ncube

Obert Joseph Ncube is the deputy head of Mashaba Primary School. According to him, the school’s enrolment figures and exam results has improved since the mini-grid was commissioned. He says that the presence of a reliable power supply has dissuaded teachers from transferring to other schools. “We’ve registered an improvement in Grade 7 (pass) results from 21.5 percent in 2014 to 53.9 percent in 2016, which is a positive upward trend premised on our retention of all qualified staff,” Ncube said.
Sikhangele Ndlovu

Sikhangele Ndlovu is the nurse in charge of the Mashaba Clinic. She is very happy that the clinic finally has a steady supply of electricity. She says that the installation of the mini-grid has allowed health workers to be able to work at night without having to rely on torchlights, especially in stressful situations such as surgery or delivery babies. According to her, pregnant women who come to the clinic to give birth are no longer required to bring their own candles, kerosene lamps and matches. “It was difficult for us to operate or suture patients using candlelight or mobile phones, which meant that procedures took longer to finish, or we had to wait until daylight or refer the patients elsewhere,” Ndlovu said.

Future outlook

The major aim of the 99 kW Mini-grid project is to promote universal access to modern energy services for 10,000 rural inhabitants in 2,800 households in Gwanda South, which contributes to a situation of improved economic conditions and social well-being.

The biggest test for the Mashaba community will be to keep its solar grid functioning. Right now, the project provides power for 2 irrigation schemes, 2 business centers, one school and one clinic. However, there are plans for the coming years to increase the reach of the mini-grid to also include one more irrigation scheme, three more business centres and a study center. By doing so, the project will be able to demonstrate a business and financial model of providing decentralized renewable energy through a partnership of public and private sectors and donors. The project also has further plans to include a resource/study center, which will house facilities that include ICT provision, e-learning, internet, TV, after-hours study facilities and community information. Other future plans include erecting more solar-powered mini-grids in isolated rural communities in both Zimbabwe and Malawi.

Such expansions do not come without their challenges. One of them being
the fact that community members do not pay beforehand for electricity, but have to wait for a determination on the tariff to be charged. “We’ve installed a prepayment system but we are still working on the tariff system. Once a tariff is agreed with ZESA (the state-owned power utility), the energy regulator and the community, users will then start paying,” said Shepherd Masuka, Practical Action’s project officer for sustainable energy for rural communities. According to Ncube, they have had meetings with farmers and they are already putting aside some grain reserves so that when they are asked to start paying for electricity they are ready.
CASE #5: MALINDI SOLAR PLANT

Intro

The next project we’re highlighting is a second utility-scale solar project, one that’s set to become almost four times as big as the plant that was described at the start of the report. This is the 40 MW Malindi Solar PV plant, which is currently in very advanced stages of development near Malindi, Kenya.

Organizations involved

Malindi Solar Group is developing a 40MW (AC), 52 MWp photovoltaic greenfield project near Malindi, Kenya. MSG has a 20-year Power Purchase Agreement (“PPA”) with the national utility, Kenya Power & Lighting Company (“KPLC”).

The original developers of the Project are AEDC, a company founded in 2013 by Jared Keburi and Zohrab Mawani, and IDEA Power, a renewable power development and investment company established in 2014 which recently commissioned a 5.5MW hydropower project in Western Kenya. Globeleq, the project sponsor, is one of Africa’s leading private power companies and is owned by CDC (70%) and Norfund (30%). Globeleq currently has eight power plants, located in Kenya, Tanzania, South Africa, Côte d’Ivoire and Cameroon. It generates approximately 1,300 MW and has another 2,000 MW in development.

CDC is the UK’s Development Finance Institution. CDC provides financing to private companies in Africa and South Asia. CDC is the lead arranger for the debt to MSG.
Project origin

The project is part of the feed-in tariff Programme, which was first introduced by the Kenyan Government in 2008 to encourage electricity generation from renewable sources as a means of diversifying national power sources, enhancing national energy security, and creating employment and income generation.

This specific project has been in development since 2013 by AEDC, who led its original day-to-day development, as well as initial discussions with KPLC and the relevant authorities. MSG was incorporated in 2015 as a joint venture between AEDC and IDEA, which provided financial backing and assisted in the project development.

Since 2017, Globeleq has been working with MSG on the final stages of development and will legally enter the project as majority shareholder ahead of financial close. Globeleq will be the 90% shareholder of the Malindi project, with its partner AEDC holding the remaining 10%.

Following a competitive process between various potential lenders, CDC was appointed to arrange the debt for the project due to its ability to work with MSG to meet the tight timeline of the project. The senior debt is $50 million. In total, the project costs have been estimated at $66 million USD.

Construction of the project is expected to commence in late 2018 and is forecasted to take 12 months, resulting in a projected COD date in late 2019. During construction, 250 local jobs will be created, whilst 150 permanent jobs are expected to be directly or indirectly created after the plant becomes operational.

The Project completed an ESIA study in line with local and international requirements and secured a license from the National Environmental Management Authority in June 2016.

Project impact

The Project supports the growth and ongoing industrialization of the economy. It will replace expensive HFO-fired electricity, thereby cutting retail power prices charged to Kenyans.

It is well aligned with the government’s plans to diversify generation away from hydro which constitutes a third of the generation mix in Kenya; but whose reliability is affected by weather conditions, including recent droughts.

The plant is in a region which currently has little generation capacity and load
shedding despite recent improvements in the transmission grid. Power demand is expected to continue to grow in this region which is currently served by diesel power plants in the coast region. Most of the Project generation is likely to be consumed locally, reducing local load losses and improving system stability.

In terms of beneficiaries this increase in generation is expected to benefit the industry (52% of demand), households (26% of demand) and small businesses (22% of demand), assuming similar KPLC sales.

CDC’s Chief Executive Nick O’Donohoe said: “Power infrastructure is vital for Africa’s economic growth and for the millions of individuals, families and businesses who struggle to access the electricity they need. Our investment will bring clean energy and jobs to a region of Kenya that struggles to reach its potential because of energy shortages. This investment is a first for CDC’s Project Finance team – the first loan agreement as a sole lender; and the team’s first direct debt deal in Kenya. It’s a great example of CDC’s ability to assess and make quick key decisions as a lender to a project and is a testimony to Globeleq and MSG’s strong development skills.”

As mentioned, some resettlement (~17 households) had to occur, with agreed compensation provided. MSG work closely with the community.

With the support of MSG through the lenders’ livelihood restoration plan, relocated households now have improved housing, water & sanitation and farming methods. One example of the many local people who have benefited is Esther Sidi, pictured below with her daughter. Esther had been living on the site in poor conditions and without land title, but she was relocated and provided with new housing, complete with water and latrine.
**AFRICA SOLAR IMPACT CASES**

**KEY FACTS**

**MALINDI SOLAR PLANT**

- **40 MW (AC), 52 MWP**
  - Of clean generation capacity the Malindi solar plant will add to the Kenyan grid

- **20 YEAR PPA**
  - (Take or Pay) was signed with KPLC in June 2017

- **$66 MILLION**
  - Total project cost

- **2.3 GW**
  - Current grid-connected power capacity in Kenya

- **40%**
  - Level of energy access in Kenya

- **1 OF 4 PLANTS**
  - That have approval under the Government’s FiT policy, 1st one to be connected

- **LATE 2019**
  - Expected COD after 12 months of construction

- **205 JOBS**
  - Construction

- **150 JOBS**
  - Permanent

- 250 local jobs expected to be created during construction

- Direct and indirect - jobs that are expected to be created once operations begin

- Late 2019 expected COD after 12 months of construction

- Expected 205 jobs construction

- 150 permanent jobs

- 250 local jobs expected to be created during construction

- Direct and indirect - jobs that are expected to be created once operations begin
Esther said: “I am so happy for the support from MSG. I couldn’t imagine that one day I would sleep in such a house with doors, window and a toilet.”

**Future outlook**

As a well-established private power company operating, owning and developing power generation in Africa since 2002, the project provides Globeleq with an opportunity to develop a solar platform in Kenya which has significant solar projects planned and leverage its O&M expertise from its South African renewable assets.

There is additional land available in and around the site which provides potential to add a second phase to the Project in the future, as well as adding electricity storage capacity.

Zohrab Mawani, AEDC’s Director said: “AEDC has been working for several years to bring the Malindi project to fruition. We are very pleased to have it reach this stage and are working closely with our experienced partners, Globeleq and CDC. We look forward to continuing our successes on the Malindi project and many more projects in Sub Saharan Africa.”
CASE #6: DRC OFF-GRID SOLAR

Intro

Looking beyond these cases of projects that are up-and-running and creating their impact, we’d like to highlight one extraordinary case that is set to make big waves in a tough region.

Organizations involved

BBOXX profiles itself as a next generation utility that’s making a big impact in frontier markets. It recently started providing off-grid electricity solutions to residents in Goma, Eastern Democratic Republic of Congo (DRC), with the support of the Shell Foundation, DFID, USAID and Power Africa. BBOXX also works with Victron Energy to provide large pay-as-you-go solar to urban businesses in Eastern DRC. BBOXX has continuously expanded its footprint in the DRC. It even signed a deal with the DRC government itself to provide reliable, renewable electricity to 2.5 million citizens by 2020, as part of the government’s “Energie pour Tous” initiative. This puts off-grid solar at the heart of solving the significant energy access issue in the DRC. BBOXX’s solar systems in the DRC are distributed through BBOXX’s network as well as with BBOXX’s distribution partner in Kinshasa, Orange Energie.
Project origin

Only 17 percent of the DRC’s population has access to electricity. When exclusively considering the rural population, this amounts to even less than 1 percent. In total, 62 million people in the DRC are living off-grid – amounting to 10 percent of Africa’s total un-electrified population. Even in urban areas, people experience major challenges in accessing a reliable electricity supply, with some large cities in the DRC simply not connected to the grid at all. In a country of 80 million people, the state-owned utility, Société Nationale d’Électricité (SNEL), has just 500,000 registered connections. In addition, for 75% of the time those lucky enough to be connected to the grid still deal with grid outages.

This is an unacceptable situation in the 21st Century. Thus, changing that is something that BBOX is highly passionate about. It was within this context that the Shell Foundation, DFID, USAID and Power Africa decided to financially support BBOXX’s efforts to start operations in Goma, Eastern DRC, an area home to 1 million people. Following this success, BBOXX signed its deal with the DRC government to expand its energy access programme to 2.5 million citizens. Customers will be able to pay through mobile money, paying as little as $15.00 USD per month for a light, radio and phone system.

The DRC is not the easiest place to do business, due to administrative bureaucracy and non-tariff barriers, which create a difficult business environment that is further challenged by unfavourable import tariffs and increasing tax costs. However, BBOX mitigates these risks by applying its organizational experience from other markets to the DRC. The company does this by identifying the right local partners, who have deep level of local expertise and insight; hiring top quality local staff on the ground; and using cutting-edge technology to minimize costs and risks. Due to these factors, BBOXX is now the only major off-grid player operating in the DRC.

The experience of working in the peri-urban region Goma has allowed BBOX to deepen its operations in the country, by expanding energy access to even more people in rural areas.
AFRICA SOLAR IMPACT CASES

KEY FACTS
DRC OFF-GRID SOLAR

62 MILLION
PEOPLE IN THE DRC LIVE OFF-GRID (10% OF AFRICA’S UNELECTRIFIED POPULATION)

$15 / MONTH
WILL BE THE RATE THAT CUSTOMERS WILL NEED TO PAY (THROUGH MOBILE MONEY) FOR A LIGHT, RADIO AND PHONE SYSTEM

85%
OF CUSTOMERS ALREADY HAD A MOBILE MONEY ACCOUNT BEFORE SIGNING UP FOR BBOXX

< 1 %
OF THE DRC’S RURAL POPULATION HAS ACCESS TO ELECTRICITY

10,000 LOCAL JOBS
WILL BE CREATED THROUGH THE ROLL-OUT OF BBOXX SYSTEMS IN THE COUNTRY

2.5 MILLION
PEOPLE IN THE DRC WILL GAIN CLEAN, RELIABLE AND AFFORDABLE ELECTRICITY BY 2020 THROUGH BBOXX
Project impact

Timeline

BBOXX’s project was launched on the 1st of August 2017, after funding was secured with support from the Shell foundation (DFID and USAID). The project was started in Goma, Eastern DRC, targeting peri-urban customers. In June 2018 it signed its deal with the DRC government to bring solar kits to 2.5 million people in the country. Most recently, in September 2018, BBOXX closed a partnership with GE to provide energy access for small businesses, schools and other organisations in Goma, Democratic Republic of Congo (DRC).

Impact

“I tried other systems but none had the quality nor the warranty. I would recommend BBOXX to my family and friends.” - Regis, Goma

BBOXX distributes surveys to their current customers, which resulted in the following highlights:

- **Energy as a service:** Customers appreciate the customer service and warranty, with many having previously owned solar systems that stopped working.

- **Ease of use:** All customers appreciate the ease of use of BBOXX SHS products due to the payment method, Mobile Money, with SMS reminders that are greatly appreciated.

- **Reliability of supply:** Compared to the unreliable grid connection, customers appreciate BBOXX for providing a more reliable supply of energy for its customers.

- **Helpful installation:** Nearly all customers said that they would not have been happy to have installed the system themselves, which shows the usefulness and value that BBOXX provides its clients by taking care of the installation of its products.

- **100% of customers thought BBOXX services are good value for money.**
Future outlook

BBOXX has already started working with partners (Orange) to target opportunities in western DRC, starting with collecting the necessary capital. The company’s plan for 2019 would be to expand its operations beyond its current footprint, once the fundamentals for scaling up have been demonstrated.

Durability and practical experiences

BBOXX had two key concerns before starting operations in the DRC. It was concerned about poor portfolio performance due to theft and tampering, and about a lack of mobile money penetration. However, the company’s experience in the DRC has shown that both concerns turned out to be unfounded. So far, the portfolio performance has been comparable to that of its customers in Rwanda and Kenya, especially since the company’s fears of tampering were overblown. Most Congolese people were found to happily pay for a service that comes with proper explanations and assistance. In addition, the concentration of mobile connectivity and mobile money also proved not to be a hurdle. BBOXX found that 85 percent of its customers had a mobile money account before signing up for the company’s service, which shows that there is a healthy density of mobile money agents in cities such as Goma.

Possible expansion or replication

BBOXX is applying its strategy in different markets and regions across the developing world. In December 2017, BBOXX announced that it has signed another innovative deal, this time with the Government of Togo. The company won a contract to roll out 300,000 solar home systems to off-grid communities in Togo by 2022. BBOXX also sees West Africa as a key market to further develop, after established operations in Rwanda, and other countries in East Africa, as well as Nigeria.
Laurent Van Houcke, Chief Operations Officer and co-founder of BBOXX, said, “It is really encouraging to see the government in the Democratic Republic of Congo (DRC) recognize off-grid energy solutions as instrumental to providing electricity to its citizens.”

She also said, “The government has provided the right regulatory framework and tariff policies that has allowed private companies like BBOXX to work effectively in the country’s energy industry for the benefit of its citizens. We are also looking forward to working with the Government to support their campaign to raise awareness of the country’s energy access deficit – and playing a significant role in solving this pressing issue.”

“There are currently over 1 billion people in the world without access to electricity – we are committed to dramatically reducing this number. Our vision is to harness the power of pioneering data and technology to leapfrog traditional grid infrastructures and generate sustainable economic development by providing an on-grid experience in an off-grid setting”, said Van Houcke.

The Minister of Rural Development in DRC, Bitakwira Bihona-Hayi Justin stated: “The private sector has a key role to play in the off-grid electrification of the DRC. The DRC has passed a law in 2014 to completely privatise the energy sector to attract private investors. This partnership with BBOXX will bring basic energy services through a unique technology to the large off-grid population base in DRC”.

Both in its proven track-record in countries like Rwanda and Nigeria, and its ambitious plans for the DRC and Togo, amongst others, BBOXX is showing how innovative private companies can make high impact in providing reliable energy access to off-grid customers in the developing world.
Solarplaza and GOGLA are proud to announce the organization of this third installment of Unlocking Solar Capital: Africa - the unique international platform and 2-day conference focusing on unlocking capital for new solar project development in Africa. This event will connect solar project development and finance & investment in the three leading solar electrification segments (On-grid, micro-grids, off-grid lighting and household electrification).

Unlocking Solar Capital: Africa, Solarplaza’s 12th event on the continent, will bring together hundreds of representatives from development banks, investment funds, solar developers, IPPs, EPCs & other solar stakeholders. 350+ decision makers will gather to engage in extensive discussions to solve Africa’s solar energy funding gap - and get projects realized. Learn more about the program, speakers and participants here.

www.AFRICA.UNLOCKINGSOLARCAPITAL.COM

KEY CHARACTERISTICS
• 350+ senior finance and project development executives
• In-depth discussions over separate tracks for on-grid and off-grid/mini-grid solar financing and development
• Guaranteed matchmaking through our customized software, interactive networking breaks and many hours of dedicated networking time
• Taking place in one of Africa’s key hotspots, Kigali, Rwanda
AFRICA SOLAR IMPACT CASES

SOURCES

Intro
https://www.pv-tech.org/editors-blog/large-scale-solar-blossoms-in-africa
https://www.newyorker.com/magazine/2017/06/26/the-race-to-solar-power-africa

Case #1: Tororo Solar Plant

Case #2: Entasopia Microgrid
https://medium.com/thebeammagazine/microgrids-are-building-a-better-future-for-popolations-in-remote-areas-46d06b0c9966
https://e360.yale.edu/features/african_lights_microgrids_are_bringing_power_to_rural_kenya
https://www.ashden.org/winners/steamaco

Case #3: Solar Vaccine Refrigerators
http://www.ashden.org/winners/kxn
http://www.surechill.com/case-study-afca/
http://www.surechill.com/case-study-cress/
https://www.dulassolar.org/impact/case-studies/benin-immunisation-programme/

Case #4: Mashaba Mini-grid
https://www.newsday.co.zw/2018/03/the-long-walk-from-energy-poverty/
https://af.reuters.com/article/africaT ech/idAFKCN1BM1C0-OZATP?feedType=RSS&feedName=topNews
http://www.snv.org/project/sustainable-energy-rural-communitiesmashaba-solar-mini-grid

Case #5: Malindi Solar Plant