



Off-grid Solar

Executive Summary

In the late 1990s and early 2000s, the price of solar power plummeted alongside mounting calls for sustainable energy. But even as solar power began to be adopted in lieu of fossil fuels, nations lacking effective power grids to which to connect “solar parks” saw few gains. In the 2010s, off-grid electric devices entered the market, helping bring solar power to people in countries including Uganda.

As off-grid solar became technologically possible, there was an influx of capital for solar entrepreneurs in developing countries. This was due in part to shifting policies at international institutions such as the U.N., in part to a newfound focus among private investors on socially responsible investing and microfinance.

This Columbia SIPA case study focuses on Uganda’s off-grid solar history and the challenges the industry faces today, focusing on the experiences of two Ugandan firms that provide off-grid solar energy: ARED and Innovation Africa. It includes interviews with Xavier Michon, Deputy Executive Secretary of the United Nations Capital Development Fund, and members of the capstone project, through which SIPA students travelled to Uganda to consult with off-grid solar companies. The following written case study is based off their findings.

The case includes the following elements;

- a) Video Intro and Discussions – Available Online
- b) Written Case Study (This Document)
- c) Annex A – Original Documents
- d) Annex B – Selected Interviewee Bios and Interview Transcripts (Not needed for core case, presented for research purposes).

This case was written by Adam Stepan and Kyle Neary for the Picker Center Digital Education Group at Columbia’s School of International and Public Affairs (SIPA). Additional case research by Alicia Gorecki, Beibei Tan, Eskedar Gessesse, Javier Leon, Rodrigo Inurreta Acero, Yifan Li, and Yilmaz Akkoyun. The faculty sponsor is Dr. Ellen Morris.

Copyright © 2019 The Trustees of Columbia University in the City of New York. No part of this publication may be reproduced, revised, translated, stored in a retrieval system, used in a spreadsheet, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise) without the written permission of the Case Consortium.

From Colonialism to Idi Amin

In the late 2010s, Uganda faced many of the same economic difficulties as it had for decades, with 88% of its population living off less than \$5.50 a day.¹ Yet its economy was on a promising track, with sustained development since the 1990s, averaging 6.5% annual GDP growth between 1990 and 2018.² In the late 2010s, it became a leading recipient of investments in East Africa, attracting \$1.3B in foreign direct investment in 2018, over double the amount two years earlier. Many lauded it as a regional success story, especially in regard to its government's restrained fiscal policies. However, the country's history, both colonial and postcolonial, plagued Uganda with enduring challenges.

Beginning in the 1890s, Uganda existed as a protectorate of the British Empire, for nearly three quarters of a century. Initially, it was under the indirect control of the British Crown through the Imperial British East Africa Company, which established the protectorate in 1894 in order to exploit its agriculture, in particular, cotton and coffee. In 1900, the English government took formal control, which it would maintain for seven decades. Beginning with anti-British rioting in 1949, Uganda became increasingly independent under the liberal governor Andrew Cohen. The national legislature now comprised elected, local representatives from across Uganda, and the king of Buganda, the largest kingdom within Uganda, took on executive powers, becoming president in 1962.

In 1961, as a global movement for decolonization was taking hold, Uganda gained independence and held elections for its National Assembly. Milton Obote was appointed prime minister; he secured enough power to make himself president in 1967 and to ban opposition parties in 1969. His policies of a planned economy and nationalization of major industries, led to a major economic downturn, marked by significant food shortages.³ In 1971, a military coup forced him into exile and brought military army commander Idi Amin into power. Amin also expropriated land and businesses, but instead gave these to supporters, making corruption even more rampant.

Most destructive to Uganda's economy in the long run, however, was Amin's decision to expel 60,000 Asians, mostly Indians, from Uganda. These South Asians had been brought to Uganda by British colonists to serve as intermediaries between black locals at the bottom and white colonists at the top of the plantation system.⁴ But after independence, they never received citizenship and proved an easy scapegoat for the country's economic ills. When Amin expelled them, a vital part of the country's commercial and professional class was lost. Further, Amin, called "the Butcher of

¹ The World Bank, "Poverty headcount ratio at \$5.50 a day (2011 PPP) (% of population)." 2016.

² The World Bank, "GDP growth (annual %) - Uganda." 2018.

³ Phares Mukasa Mutibwa, *Uganda Since Independence*, London: C. Hurst & Co., 1992. pp. 65–70.

⁴ Godfrey Mwakikagile, *Ethnicity and National Identity in Uganda: The Land and Its People*, New Africa Press, 28 October 2009. p. 26.

Uganda,” is estimated to have overseen the deaths of 300,000 civilians, continuing a legacy of human rights abuses begun under Obote.⁵

Obote’s Return and Museveni

In 1979, Ugandan rebels and the Tanzanian army ousted Amin; by the following year, Obote had returned to the presidency. His economic policies were less disastrous than either his previous administration or Amin’s, but a civil war drained the economy, and the government continued to kill civilians. According to a U.S. government estimate, between 100,000 and 200,000 Ugandans were deliberately starved to death or killed by the army.⁶ Another military coup removed Obote from office for the last time in 1985. In 1986, Yoweri Museveni became president, a position he held as of 2020.

Despite persistent corruption, poverty, and unemployment, Uganda’s economic recovery was steady since the 1990s. Notably, the 1991 Investment Code offered tax incentives to local and foreign investors alike. Privatization, divestiture, austerity, and currency reform allowed Uganda to attract private investors and secure loans from international financial institutions (IFIs).

But even with these successes, Uganda in 2019 still faced major infrastructure deficiencies, due in part to the destruction inflicted under Obote and Amin. In the 2010s Uganda committed about 33% of its government expenditure to infrastructure spending, making major inroads in road safety, mobile connectivity, and more.⁷ But particularly difficult to address has been the population’s lack of access to electricity. The electrification rate of 22% is one of the lowest on the continent; in rural areas, the rate is as low as 10%.⁸ Fortunately, however, advances in renewable energy technology and heightened international attention to the issue of energy access converged to offer a promising option to Ugandans – solar power.

Solar Gains Traction

People had recognized the potential of the sun as a power source since the early centuries B.C., using mirrors, windows, and magnifying glass to harness heat and light from the sun. But the basis for modern solar power technology was not developed until 1839, when French physicist A. E. Becquerel discovered photovoltaics, the conversion of light into electricity. He did so by placing conductive plates in chemical solutions under the sun. However, his findings would remain of almost exclusively academic interest for the following two decades.

In the 1860s, solar power technology was first developed in earnest due to concerns that global coals deposits would be exhausted. By the 1880s, the world’s first solar array was installed in

⁵ Patrick Keatley, “Obituary: Idi Amin,” in *The Guardian*, 17 August 2003.

⁶ Amnesty International Publications. *Amnesty International Report 1985*, pp. 108-109. 1985.

⁷ Uganda Investment Authority. “Opportunities in Infrastructure.”

⁸ Central Intelligence Agency, “Uganda,” in *The World Factbook 2018*. p. 774.

New York City. The technology then had a mere 1% efficiency rate in converting the sun's energy into usable electricity. It would take over a century for the technology's efficiency to compete with traditional fuels, with typical cells being 15-20% efficient in 2019.⁹

However, low demand for solar energy products stymied progress in photovoltaic research. Coal and oil were cheap, reliable sources of energy, rendering photovoltaics a marginal area of research with few incentives outside curiosity. Nevertheless, advances in semiconductor technology and the work of a handful of physicists, Albert Einstein in particular, ensured some leaps in photovoltaics were made. In the mid-20th century, solar power began being considered for niche practical applications, such as powering dollar bill changers and even the houses of Americans concerned by shortages of power in WWII.¹⁰ In 1958, the U.S. and the Soviet Union launched satellites that used solar power technology, demonstrating its utility in cases where connection to an electric grid is unavailable. Nonetheless, these represented fringe cases, and solar remained outside the conscience of the global public and most governments until fossil fuels' shortcomings became apparent.

Oil Loses Favor

Two oil crises in the 1970s exposed the economic necessity of finding alternative energy sources. In 1973, a cartel of Arab oil-exporting countries hiked up the price of crude oil 70% and place an embargo on nations supporting Israel in the Yom Kippur War, most notably the U.S.¹¹ The resulting fourfold increase in oil prices were economically devastating, triggering one of the worst global recessions since the Great Depression. In 1979, oil production in Iran plummeted after the Iranian Revolution ousted the Shah. Global oil supply decreased only 7%; however, due to panic and hoarding, prices roughly doubled.¹² Both crises demonstrated to the public that relying on oil could be deleterious to consumers, and governments adjusted their energy policies accordingly. Most notably, President Jimmy Carter signed into law the creation of the Department of Energy.

By the 2000s, solar power was no longer an obscure scientific field; in addition to gaining support on environmental grounds, it even became a security priority for many national governments, who wanted to decrease their dependence on imported energy. With government funds to back research and development, photovoltaics became commercialized. Costs were no longer prohibitively high, allowing residential solar panels to go to market through retailers like Home Depot by 2009.

⁹ Elizabeth Chu and D. Lawrence Tarazano, "A Brief History of Solar Panels," in *Smithsonian*, 22 April 2019.

¹⁰ U.S. Department of Agency. "The History of Solar," p. 3.

¹¹ Rapid Transition Alliance, "From oil crisis to energy revolution – how nations once before planned to kick the oil habit," *rapidtransition.org*, 16 April 2019.

¹² Laurel Graefe, "Oil Shock of 1978–79," in *Federal Reserve History*, 22 November 2013.

In developed countries in particular, governments helped fund the creation of solar parks (also known as photovoltaic power stations), large areas of solar panels which connect to the electrical grid. For example, in the 2000s and 2010s, Germany, Japan, and South Korea offered feed-in tariffs, in which the governments offered above-market prices on solar energy as a financial incentive.¹³ Other strategies included tax breaks to firms investing in solar technology and subsidizing installation of solar equipment.

Since the creation of the first solar park in California in 1982, they were mostly private, but with increasing numbers of public or utility-owned ones in operation. Yet in all these cases, solar power's success relied on the presence of a functional power grid. Uganda and other developing nations appeared positioned to reap few benefits from advancements in solar power. But in the 2010s, an alternative model to solar parks emerged, creating new possibilities in the effort to electrify Uganda.

Going of the Grid

That model was off-grid solar power, comprising small, sometimes mobile solar panels for consumer use and mid-sized systems for groups, *e.g.*, small villages. For most of the 2010s, the idea of providing energy without connection a large regional or national grid was considered impractical and too difficult to scale. Though personal solar home systems (SHS's) had great growth potential in poor countries, they remained financially inaccessible to most households. However, the same technology could be adapted to serve poor communities.

In Uganda, where the remoteness of its rural regions is the main cause of disconnection from the electrical grid, one option was solar-powered microgrids for villages. Yet even this option requires some investment in infrastructure; as a result, many entrepreneurs began turn to even more grid-free solar technology. For example, some entrepreneurs offered solar kiosks which customers could use to charge their phones and pay bills. Others imported and installed solar panels for buildings with pay-as-you-go models, through which customers unable to pay immediately would do so over time as they use the product.

These small, off-grid solar enterprises were able to proliferate due to a series of developments in the 2000s and 2010s that made them financially plausible, in addition to solar power's plummeting costs as technology advanced and supply expanded.

First, in the early 2000s, a business movement was growing to target a traditionally underserved market: the staggering 4 billion people then living off less than \$2.00 a day.¹⁴ C. K. Prahalad's and Stuart L. Hart's 2004 book *The Fortune at the Bottom of the Pyramid* popularized the notion that the global poor held vast untapped potential as consumers and entrepreneurs. This idea was extremely appealing to foreign investors because it suggested not only profit for them, but

¹³ International Energy Agency, "Trends in Photovoltaic Applications: 2019," pp. 26, 27, 35-36

¹⁴ UK Aid, The Impact Programme. "Tracking reach to the Base of the Pyramid through impact investing," p. 10. 2015.

greater prosperity for local populations. Large multinational corporations such as Procter & Gamble soon began pursuing their own low-price, low-margin, high-volume strategies to tap into the bottom of the pyramid. At the same time, profits and non-profits alike, such as Acumen and Asia Development Bank, created funds for local entrepreneurs to pursue their won bottom-of-the-pyramid enterprises.¹⁵

From a development perspective, focusing on those at the bottom of the energy pyramid was especially appealing, given the necessity of electricity for other advancement goals. In particular, “higher incomes, higher productivity, higher education, [and] better health ... correlate very clearly with access to energy,” as explained by Ellen Morris, Adjunct Professor of International and Public Affairs at Columbia University.¹⁶

Second was the increased pressure for firms to practice socially responsible investing (SRI), an investment strategy with ethical guidelines requiring investments do no harm. This development was driven by the environmentalist groundswell of the 1990s, due to which SRI became increasingly synonymous with green investing. In 2007, the idea of “impact investing” was popularized. This investment strategy went further, involving lending funds to projects that would make a positive impact.¹⁷ Impact investment was friendlier to small enterprises in developing countries than traditional finance. By 2020, impact investment was predicted to reach a full \$300B.¹⁸

Finally, recognizing these trends, IFIs changed their strategies for fighting poverty and promoting development. Funds that previously would have been lent to national governments or applied to subsidies now went more directly to those they were intended to help. Sometimes, this meant assistance for local governments; often, IFIs lent to local entrepreneurs or businesses to encourage economic growth.

Think Globally, Lend Locally: IFI’s and Microfinance

One main lender in the drive for lending to private firms was the World Bank, which launched programs for owners of small and medium enterprises (SME’s). Strengthening such enterprises was an essential step in growing national economies; in 2007, SME’s accounted for only 15.6% of

¹⁵ *Ibid.*, 14

¹⁶ Adam Stepan’s interview with Ellen Morris on April 12, 2019, at Columbia University SIPA, New York City. All further quotes from Morris, unless otherwise attributed, are from this interview.

¹⁷ Anna Katharina Höchstädter and Barbara Scheck, “What’s in a Name: An Analysis of Impact Investing Understandings by Academics and Practitioners,” in *Journal of Business Ethics* Vol. 132, No. 2, December 2015. pp. 449-450

¹⁸ Vivek Pandit and Toshani Tamhane. “A Closer Look at Impact Investing,” p. 14, *Accountancy SA.*, April 2018.

GDP in low-income countries, compared to 51.5% in high-income countries.¹⁹ SME's in the developing world typically struggled with "access to finance ... [and] basic infrastructure that you might need to run a business," as Morris explained. As a result, job creation, innovation, and diversification of the economy, all of which SME's were particularly effective in promoting, were stymied in these countries.²⁰

An additional benefit of SME's was their greater employment and ownership by women than large enterprises. But development programs and impact investors had to address the particular lack of access to credit for women entrepreneurs in developing countries. As a result, a robust network of microfinance programs was instituted to make small loans to these women with minimal, sometimes even zero, interest. Microlending became a well-noted success for its high repayment rates, averaging 95-98%, and its ability to raise women out of poverty.²¹

Likewise, beginning in the 1990s, the U.N. wielded microfinance in the global fight against poverty. It did so through the U.N. Capital Development Fund (UNCDF), established in 1966 "to assist developing countries in the development of their economies by supplementing existing sources of capital assistance by means of grants and loans." Rather than focusing on national governments or corporations, the organization developed expertise in assisting both local governments and private actors. The latter became increasingly important when the UNCDF formally committed to "financial inclusion" in 2014. Financial inclusion was advanced in response to the exclusion from necessary financial services faced by most of the global adult population due to poverty.

Since 2015, when all U.N. member states adopted the Sustainable Development Goals (SDGs), the UNCDF focused primarily on the first goal, eradicating poverty. In Africa, job creation was "coming from medium enterprises, which is basically two thirds of jobs in Africa ... This is where the middle class is coming [from]," explained Xavier Michon, Deputy Executive Secretary of the UNCDF.²² Therefore, the UNCDF sought to fund medium enterprises in order to reduce poverty. However, some financial inclusion projects were able to tackle additional goals.

Capital with a Cause: UNCDF in Uganda

In the case of Uganda, the UNCDF CleanStart program was developed not only to alleviate extreme poverty, but also to make clean and affordable energy more accessible. In 2012, the U.N.

¹⁹ David de Ferranti and Anthony J. Ody. "Beyond Microfinance: Getting Capital to Small and Medium Enterprises to Fuel Faster Development," p. 3. 2007.

²⁰ World Bank Group. "What's Happening in the Missing Middle? Lessons from Financing SMEs." 2017.

²¹ Suresha B and Dr. Gajendra Naidu, "Micro finance – Role of Banking Intermediaries in Inclusive Economic Growth," p.127, *International Journal of Management, IT, and Engineering*, Vol. 1, Issue 5, October 2011.

²² Stepan's interview with Xavier Michon on April 29, 2019, at Columbia University SIPA, New York City.

launched CleanStart to invest \$26 million in renewable energy enterprises in six of the world's poorest countries. With multimillion commitments from Norway and Sweden, CleanStart was able to operate in Cameroon, Ethiopia, Myanmar, Nepal, Tanzania, and Uganda from 2012 to 2020.

In 2018, the UNCDF launched a new program to target Uganda's burgeoning off-grid solar industry for growth. Since 2013, various funds had already invested \$300M in the industry, signaling its financial promise.²³ Concerned about the acute lack of access to electricity for rural Ugandans, in 2017, the UNCDF launched the Uganda Renewable Energy Challenge Fund. It opened applications in 2017 for grants ranging from \$100,000 to \$500,000. From 63 applicants, the UNCDF chose eight recipients that had promising, innovative strategies to supply rural communities with micro-grid and off-grid solar solutions. Winners included a solar water pump venture, a solar refrigeration venture, and several general-use pay-as-you-go installation companies.²⁴ In accordance with its emphasis on financial inclusion, the UNCDF was eager to promote pay-as-you-go projects due to their ability to bring solar power to poorer customers than traditional payment schemes.

In fact, the challenge winners and similar ventures in Uganda's off-grid solar market helped bring microfinance to rural Ugandans in other ways too. Solar energy, whether delivered via home systems, micro-grids, or portable kiosks with panels, facilitated the spread of mobile money. These digital alternatives to traditional banking made checking and in particular saving easier for poor and rural customers who were historically underbanked. The financial self-determination offered by mobile money was especially consequential for women and women-led households, in line with UNCDF's pursuit of the SDG for gender equality.

Mobile money for microfinance purposes was first spearheaded immediately to Uganda's east. In Kenya in 2007, Vodafone launched M-Pesa, which would grow to serve over 35 million customers in ten countries by 2018.²⁵ In Kenya, the widespread adoption of M-Pesa was credited with lifting 194,000 households out of poverty and leading 185,000 women to switch into retail or business.²⁶ In Uganda, other multinational telecommunications corporations began to offer their own services. Most notably, South African company MTN entered the mobile money market in 2009, followed by Indian company Airtel in 2012. Charging small fees for transactions, these companies were able to operate profitably while helping to alleviate poverty.

UNCDF supported mobile money both directly through dedicated programs and indirectly through programs like the Uganda Renewable Energy Challenge Fund. Yet the scope of the challenge was limited, favoring the enterprises that had the resources to create the most detailed

²³ Uganda Off Grid Energy Market Accelerator. "Mapping the Ugandan off-grid energy market," p. 17. 2018.

²⁴ "Announcing the 8 winners of the Renewable Energy Challenge Fund - Solar Window," *United Nations Capital Development Fund*, 2 July 2019.

²⁵ Vodafone Group. "What is M-Pesa?", vodafone.com/what-we-do/services/m-pesa,

²⁶ Tavneet Suri and William Jack, "The long-run poverty and gender impacts of mobile money," *Science*, Vol. 354, Issue 6317, 9 December 2016. p. 1289.

and practicable proposals. Most solar entrepreneurs, however, lacked such resources. The question remained as to what exact improvements failed challenge applicants could make.

SIPA Capstone

In 2018, the UNCDF commissioned a report from the Columbia School of International and Public Affairs (SIPA) to answer that question. The UNCDF identified seven companies that had been shortlisted but not won grants. The high-potential companies were to receive advice, which the UNCDF could generalize for its other programs assisting solar enterprises in Uganda, from a team of graduating SIPA students. Morris, one of the capstone's faculty advisors, explained, "We had seven students and we had seven solar energy companies in Uganda. So, each student was given a company to basically take and embrace and really dig deeply [into]."

Among the companies were ARED, a solar kiosk provider, and Innovation Africa, a solar water pump provider:

- ARED had a business structure differed from those of the other capstone companies in that it was a franchise. At the kiosks, users could not only charge their phones or use connect to the internet, but also receive digital services such as payment services from the franchisee. In addition to the host of otherwise unavailable services these kiosks made available to rural Ugandans, the devices economically empowered a group often denied opportunity in the Ugandan labor market. "Most of the kiosk owners were women," explained Morris. Yifan Lee, the SIPA student working with ARED, added, "It was really inspiring to see them supporting not only themselves but also their family."²⁷
- Innovation Africa was also unique, in its catering to not only households but farms. Though the UNCDF had overseen similar challenge funds in other CleanStart countries previously, it had taken applications only from companies marketing to households. But farms similarly lacked access to electricity in Uganda, where seven out of ten workers are employed in agriculture. Accordingly, the UNCDF took applications from agriculturally oriented companies in 2018.²⁸ By introducing solar-powered water pumps for drinking and irrigation, Innovation Africa helped both to raise the burden of unpaid work off women and to improve community health. As Eskedar Gessesse, the SIPA student working with Innovation Africa, explained, without these water pumps, women and girls "would have to walk kilometers to get drinking water from nearby rivers or other water sources, which typically tend to be contaminated."²⁹

²⁷ Stepan's interview with Yifan Lee on April 2, 2019, at Columbia University SIPA, New York City.

²⁸ "Announcing the 8 winners of the Renewable Energy Challenge Fund"

²⁹ Stepan's interview with Eskedar Gessesse on April 3, 2019, at Columbia University SIPA, New York City.

Consulting in Uganda

It was clear that the capstone companies were generating positive social impact in their communities while sustaining growth attractive to potential investors. Yet the capstone team identified several challenges to growth that the enterprises shared, describe below.

One such challenge, reaching new customers, the team helped to directly address. As part of its consultancy, the SIPA team collaborated with a local videography company to provide employees from four of the companies a workshop on cost-effective marketing strategies in social media and video. Beyond revising their own outreach strategies, the workshop provided a valuable venue for different companies' leadership to network and discuss "help[ing] one another build the wider sector," as Morris explained. In addition to marketing, the team researched problems particular to the Ugandan solar marketplace, several of which are considered below.

First, disparities in quality of solar panels in Uganda threatened the credibility of companies. Because there are no enforced regulations to prevent it, many cheap Chinese panels flooded the market. As Alicia Gorecki, one of the capstone participants, explained, "consumers in rural Uganda can go to a market and buy a cheap solar panel that tends to break within a month or two."³⁰ After potential customers had such experiences or heard of others', they were loath to buy even from companies offering high-quality products. Since low and high-quality panels were difficult to differentiate, unreliable panels not only turned away many consumers altogether. They also caused rural Ugandans to not buy fewer high-quality panels because of their higher prices.

Second, the companies cited poor access to credit as an impediment to growth. Sourcing panels and other parts of solar energy systems represented a significant capital investment which companies needed credit to make. Further, solar enterprises frequently extended credit of their own to poor customers, often through pay-as-you-go schemes. As a result, these companies were in only more need of loans. However, in Uganda, finance institutions were too unwilling to lend to SME's on reasonable terms, with interest rates being as high as 30%. The consequences of such restricted credit were overreliance on cash, which significantly limited the number of transactions, and on grants to help them scale up.

Third, SIPA students identified common human resources issues that hindered business operations. Many enterprises faced high turnover due to employee's preferring more reliable income than commission on sales. The companies, however, were often unable to offer salaried compensation because of their being cash-stripped. Managers at some solar distribution companies noted that most of their sales force had been under their employ for less than six months. In addition, the enterprises struggled to find candidates with the business, financial, and technical skills needed to expand their customer base, attract investors, and ensure the quality of

³⁰ Stepan's interview with Alicia Gorecki on April 2, 2019, at Columbia University SIPA, New York City.

their products. The lack of women in managerial and technical positions, and companies' not targeting women for these roles, compounded these hiring challenges.

Fourth, irregular enforcement of regulations, taxes, and tariffs on solar products in Uganda introduced an uncomfortably high level of uncertainty into solar enterprises' business models. For example, due to the industry's reliance on imports, companies faced the prospect of having to pay unexpected tariffs on parts. In addition to the difficulties in business planning caused by these uncertainties, enterprises typically lacked the expertise to precisely quantify long-term goals such as growth and diversification. Because entrepreneurs had imprecise plans, investors were hesitant to finance their ventures.

Conclusion

Despite the many challenges facing the off-grid solar market in Uganda in 2019, by most indicators the industry was primed for success. Foreign investors recognized the industry's high growth potential due to rural Uganda's high insolation and consumer's desire for a cost-effective, safe alternative to traditional energy sources such as kerosene. Though the solar market as a whole remained small in 2019 – less than 5% of energy production³¹ – it was expected to become the largest source of power by 2050.³² Given Uganda's overwhelmingly rural population, off-grid solutions proved an exciting and much needed development in the country's electrification effort.

Though solar entrepreneurs were in need of greater access to credit, better tax and tariff enforcement practices, and more skilled labor, much had aligned in their favor. First, despite the destructive economic policies under Obote and Amin, Uganda was able to make significant pro-market reforms that attracted international financial institutions and foreign investors alike. Next, the rise of microfinance and social impact investing provided new sources of credit and grant funding; the UNCDF's strategy of financial inclusion was particularly well suited to support the nascent off-grid solar industry. Finally, the many positive externalities of the off-grid solar business made it an attractive industry to support. In addition to being environmentally friendly, off-grid solar power empowered rural Ugandans, women in particular, to advance themselves economically.

³¹ "Installed Capacity." Electricity Regulatory Authority. April 2, 2019.

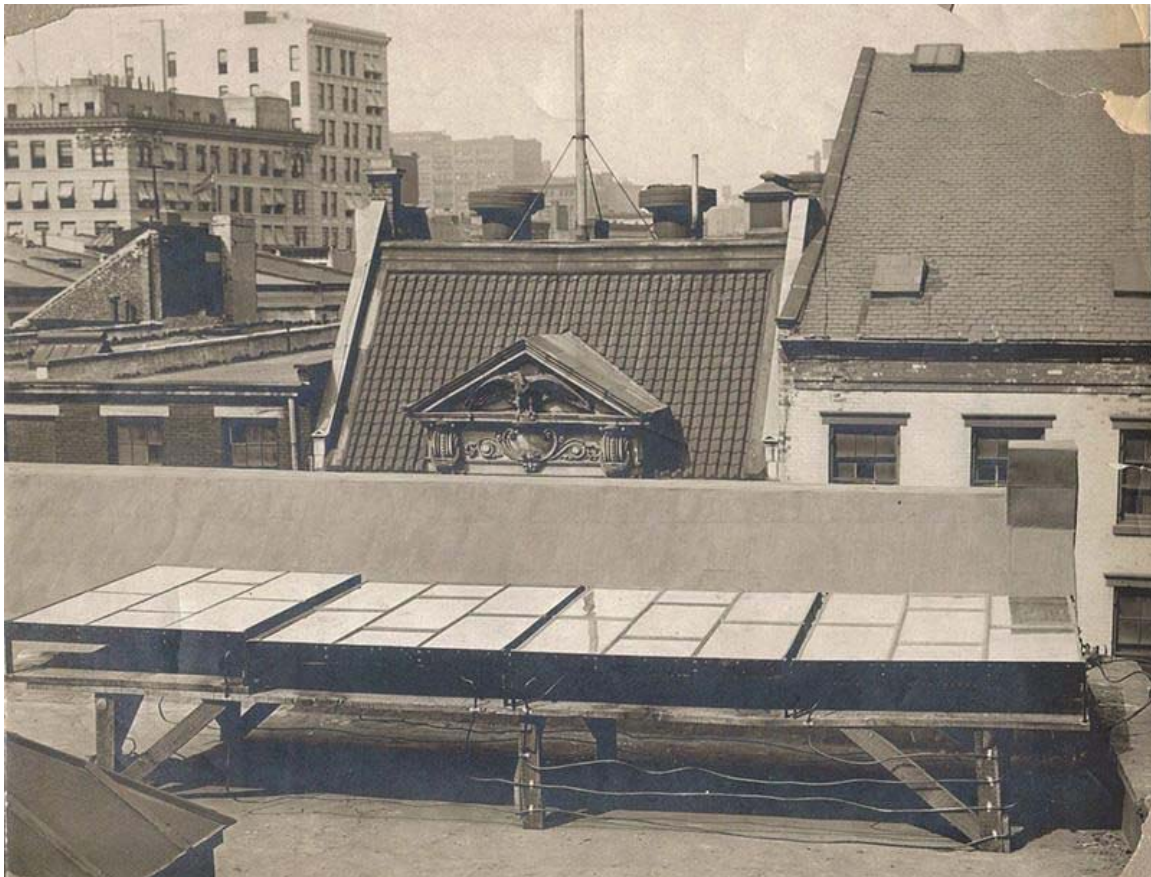
³² Avellino, Oting et al. "Uganda Solar Energy Utilization: Current Status and Future Trends." *International Journal of Scientific and Research Publications (IJSRP)*, Volume 8, Issue 3. March 2018.

ANNEX A: Original Documents

- Annex A-1 Photo of early solar panel in 1880s
- Annex A-2: Photo of ARED solar kiosk
- Annex A-3: Price history of photovoltaic cells
- Annex A-4: UNCDF call for applications to CleanStart
- Annex A-5: Map of Ugandan night light
- Annex A-6: Map of Uganda's photovoltaic power potential

Annex A-1

The first solar cell was installed on this New York rooftop in 1883. Though the materials used differ from those popular today, the basic photovoltaics did not, hence the similar appearance to modern cells. Available from the Smithsonian Institute at <https://www.smithsonianmag.com/sponsored/brief-history-solar-panels-180972006/>.



Annex A-2

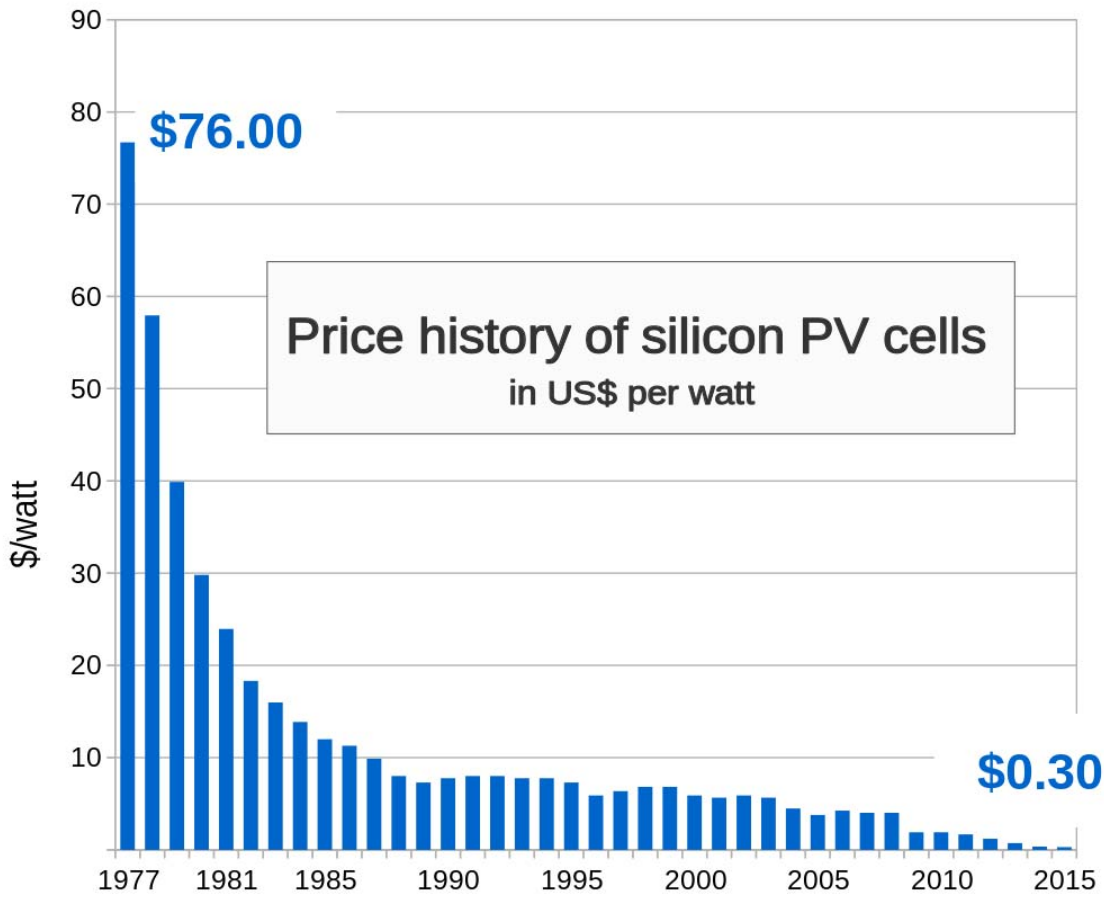
ARED's solar kiosk, the Shiriki Hub. The kiosk can be rolled by one person, has collapsible solar panels, and can charge 80 phones at once. Photo available at <https://www.bettervest.com/en/projekt/Solarkiosk-Ruanda-ARED>.



Annex A-3

Prices of solar energy since 1980 have been dropping exponentially, having already dropped below average retail electricity prices in 2013. "PV" refers to photovoltaic, and silicon is the standard material in modern solar cells; hence the data are representative of solar power prices generally. Available at

https://commons.wikimedia.org/wiki/File:Price_history_of_silicon_PV_cells_since_1977.svg#/media/File:Price_history_of_silicon_PV_cells_since_1977.svg.



Source: Bloomberg New Energy Finance & pv.energytrend.com

Annex A-4

The first page of the UNCDF's call for expression of interest from Ugandan solar firms. Full document available from the United Nations Capital Development Fund at <http://www.uncdf.org/download/file/127/4832/91117-recfsolarwindowgeneralinfopdf>.



CALL FOR EXPRESSION OF INTEREST (EOI)

UGANDA'S OFF-GRID SOLAR SECTOR

The solar photovoltaic (PV) sector has grown considerably in Uganda over the last decade. Today there are more than 200 companies active in the space with both local and international players selling products in the country.

Uganda has now established itself as one of the key markets for off-grid solar in Sub-Saharan Africa¹ – Between 2015 and 2016², reported off-grid solar product sales in Uganda increased by over 55%, with 383,420 units sold in 2016 alone. This growth is likely to continue in 2017 as 240,151 units have already been sold in the first half of the year according to the latest GOGLA/FC market report.³

THE CHALLENGE

Despite the solar sector's sizable growth, market penetration is low⁴ with a large portion of the addressable market still unreached – *Only a small fraction of Uganda's off-grid population of 33M⁵ is using solar energy. What can be done to increase the adoption of off-grid solar PV solutions across Uganda?*

Rural areas, remote and sparsely populated regions of the country, remain underserved with most sales taking place in higher-density areas – *Yet, 90% of Uganda's 5.5 million⁶ un-electrified households are in rural areas. How can the most underserved regions of Uganda be reached?*

Although products have become more affordable and various end-user financing solutions such as pay-as-you-go are now available, many of the poorest Ugandan households and small businesses still struggle to access quality solar products – *About 40%⁷ of the population without access to electricity in Uganda lives below the poverty line. How can solar PV products become more accessible and affordable to the poorest Ugandans?*

Increasing access to solar PV at the household level is only part of the solution. A holistic approach that includes institutional applications (e.g. schools and health centres, etc.) and power for productive uses (e.g. agriculture, small businesses, and industry) is needed in order to ensure Uganda's economic and social development.⁸ *How can Solar PV solutions for productive uses stimulate economic activity in Uganda and create employment opportunities for women and youth?*

About the Renewable Energy Challenge Fund (RECF)

The goal of the RECF is to increase access to renewable, efficient energy for domestic, productive and social uses amongst underserved poor households, businesses and communities, especially in rural areas.

By the end of 2020, RECF aims to support 153,000 low-income Ugandans to transition to renewable energy, and create 1000 new jobs. To this end, the RECF will fund a portfolio of renewable energy SMEs/value chain companies and/or financial institutions.

The RECF is managed by the United Nations Capital Development Fund (UNCDF) and funded by the Embassy of Sweden in Uganda.

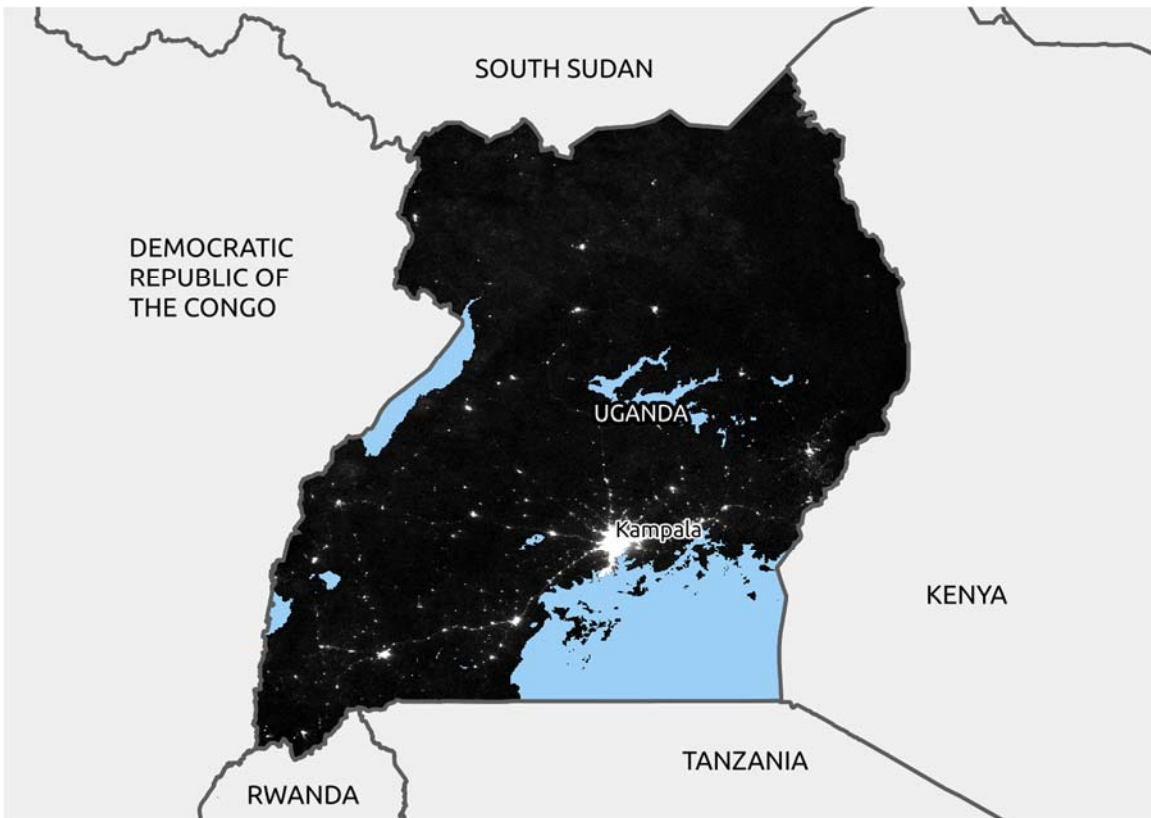
The RECF is looking for projects that combine the following characteristics:

- 1) **Additionality:** *not easily funded by commercial sources of finance; will resonate with the wider market and make a step change in the way modern energy products and services are offered and consumed by low-income people in Uganda;*
- 2) **Sustainability:** *commercially-driven business ideas that companies are ready to co-invest in, with a view to graduate to more commercial investments;*
- 3) **Inclusiveness:** *prioritizing business models with women and youth as active members of the value chain, as consumers, as well as owner/employers and employees/agents;*

The first funding window of the RECF focused on Clean Cooking Solutions and is now closed.

Annex A-5

A map of Uganda's "night light," *i.e.*, how much light is visible via satellite during the nighttime. Outside of Kampala and a handful of smaller cities in Uganda, there is exceedingly little light due to the low electrification rate. Available from the World Bank at <https://blogs.worldbank.org/energy/using-night-lights-map-electrical-grid-infrastructure>.



Annex A-6

Map of potential for solar power in Uganda. Though Uganda is not the most insolated country in the region, it has relatively few areas of low solar irradiation that would make standalone solar power impractical. Available from Solargis on behalf of the World Bank Group at <https://globalsolaratlas.info/download/uganda>.

