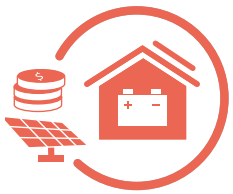
FACT SHEET PORTABLE BATTERY PACKS



Introduction

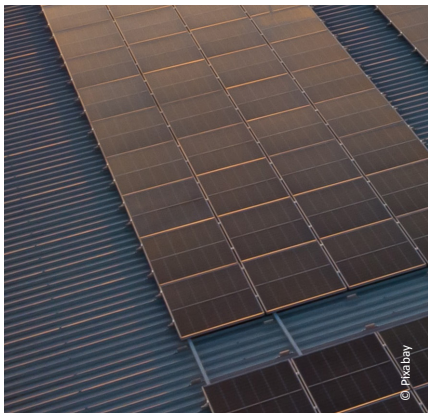
Tanzania has one of the fastest-growing electricity connection rates in the world, with access increasing from 7% in 2011 to 38% in 2020.[1] Despite the substantial progress, overall electricity access remains low, especially in rural areas where access rates are three times lower than in urban areas.[2] Grid utilities face challenges in increasing access due to the high costs of extending grid infrastructure to new regions.

Solar technology is increasingly used to overcome grid challenges and electrify off-grid households. Millions of people in Tanzania have already gained access to electricity through solar lanterns, solar home systems, and solar-powered mini-grids.

Innovative new business models are emerging in the off-grid sector in Tanzania to provide electricity access to remote and low-income households. This fact sheet focuses on portable battery packs that power household appliances and leapfrog the grid.

Application in a Nutshell

Technology	Portable lithium-ion battery packs
Application	Powering household and microenterprise appliances.
Technology Overview	▸ Rechargeable lithium-ion battery packs under 300 watt-hours (Wh) are charged at a solar-powered hub and rented out to users. ▸ Users carry the battery packs to their homes or businesses and use them to power appliances. ▸ Typically used for lights, radios, televisions, and other small appliances.
Economic and Financial Feasibility	▸ Battery pack rentals start at $0.22 per day and have minimal upfront costs. ▸ Cheaper than kerosene with household savings of $40–$80 per year. ▸ Affordable for households living on the poverty line.
Benefits and Outcomes	▸ Over 50,000 households are accessing electricity through battery pack systems in Tanzania. ▸ Positive impacts on the environment, employment, and women's economic opportunities.
Constraints and Risks	▸ Companies that use hubs to distribute battery packs need to assess local market conditions and strategically locate their hubs. ▸ Companies using rental models face risks of customers not returning rented assets.
Future Perspectives	As battery technology develops, companies will have opportunities to develop higher-capacity portable systems and overlap with battery systems used in other sectors, such as e-mobility.



7% to 38%

Electricity connection rates in Tanzania 2011 to 2020.

Technology information

Lithium-ion batteries have high energy density and high discharge capacity, making them compact and suitable for both mobile and energy-intensive applications. From 2010 to 2019, the cost of lithium-ion batteries decreased by 87%, leading to their increased utilisation in solar lanterns and solar home systems.[3]

Battery packs used for household and small business applications range in size from 50 Wh to 300 Wh. This size is sufficient for providing a rural household with electricity for 1–3 days, depending on appliances and usage. The packs typically have direct current (DC) voltage outputs of 12 volts, enabling them to power energy-efficient DC appliances directly without the need for inverters.

The appliances used with battery packs are commonly available from solar distributors and include lights, radios, televisions, fans, hair clippers, and mobile phones. Larger devices and equipment, such as refrigerators, water pumps, and electric vehicles, can also run on batteries. However, these are typically unavailable off-the-shelf or require battery systems designed for specific equipment. For example, some portable water pumps are designed to run on battery packs and are sold exclusively with their own battery system that regulates charging and power output.

Battery packs are used similarly to power banks. Like power banks, battery packs are charged in one location and then used to provide power at a different location at a later time. Generally, companies that distribute battery packs follow a standard model, wherein they establish a charging hub that maintains and charges an inventory of battery packs that customers can rent out. Once the battery pack is depleted, customers can swap their depleted battery pack with a fully charged battery pack for a small fee. As rural households generally consume small amounts of energy, it is feasible for charging hubs to run on solar power. Charging hubs can be entirely stand-alone systems, but mini-grids can also operate charging hubs in order to serve remote households without extending their grid coverage.

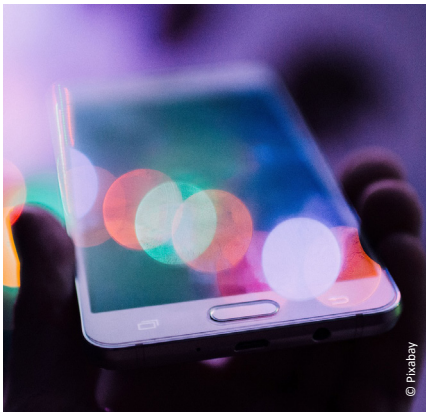


Table 1: Off-Grid Appliance Power Consumption and Run-Time Estimates: Households that rely on solar systems and battery packs have a limited daily energy budget to power different appliances. While a battery can easily power a set of LED light bulbs or even a TV, households must consider the energy efficiency of larger appliances, such as refrigerators, to avoid prematurely depleting the battery system. Sources: [4, 5, 6, 7]

Appliances	Typical Power consumption	Run time on 180 Wh battery packl
LED Light	2–3.5 W	51–90 hours
Medium TV 22”	9–22 W	8–20 hours
Portable Radio	2 W	90 hours
Mobile Phone Charging	5 W	36 hours (or 12 full charges)
Pedestal Fan	7–20 W	9–26 hours
Refrigerator	5–40 W	4.5–36 hours

Economic and Financial Feasibility

User perspective

Battery packs enable remote households to access affordable electricity by reducing capital investment costs. Currently, the costs of grid connections to Tanzania's primary utility, TANESCO, start at $137 for a 30-metre connection, and costs increase with distance. For example, a 120-metre connection costs $298 at $1.54 per-metre extension.[8] The price for this connection is high because households are required to pay for the installation of new electricity distribution poles and lines. Although rural households pay subsidised prices, many rural households remain unconnected despite being in areas of grid coverage.[9] Based on TANESCO's current prices, extending a grid connection by half a kilometre would cost $883, which is more than a household living on the poverty line would earn in a year.

Comparatively, portable battery systems in Tanzania have upfront costs as low as $1 and daily rental fees as low as $0.22.[10, 11] At this price point, a household could pay to use a battery pack system for 11 years before exceeding the estimated $883 to extend the grid by half a kilometre.

The $0.22 rental fee is less than the price of kerosene, resulting in household savings of between $40 to $80 per year, representing a 6%–12% increase in annual savings.[12] Saving this amount of money is significant because many rural households in Tanzania live near the poverty line of $1.90 per day.

Table 2: The high upfront costs of grid electricity and the high recurring costs of kerosene lighting have created market opportunities for solar and battery-powered lighting solutions. Although entry-level products are typically priced to be comparable in cost to kerosene lamps, solar and battery-powered lighting solutions offer higher value with cleaner, brighter, and longer-lasting lights.

Lighting solutions	Typical costs	Additional info
Kerosene	$0.25 per day, equivalent to 8 hours of kerosene lamp usage that produces 37 lumens of lighting.	▸ Negative impact on health and the environment ▸ Risk of fire
Grid Electricity	▸ $137 for a 30-m connection ▸ $221 for a 70-m connection ▸ $298 for a 120-m connection ▸ $0.04 per kWh after connecting. One kWh is sufficient to power a 10-W LED light that produces 900 lumens continuously over four days.	▸ Limited according to grid location. ▸ Costs increase for connections greater than 120 metres because customers must pay for the distribution poles and lines.
Solar lantern	▸ $5–$55 total per lantern depending on the features, with a typical output of 25–160 lumens per lantern and up to 36 hours of battery life.	▸ Simple lanterns have built-in panels. ▸ Advanced lanterns can have separate panels and integrated phone chargers or radios.
Asset Financed (Pay-as-you-go) Solar Home Systems	▸ $0.25–$5 per day depending on the system size and what other appliances are bundled in. Payments are made either daily or monthly ▸ Down payments of up to $500 ▸ Systems typically include: a 50 W–200 W solar panel and 3–12 lights, which are rated at 2–3 W power and outputting 200-480 lumens per light. ▸ Run time depends on the number of lights used and the battery size. A typical system will include 4 lights and have sufficient battery to continuously power all lights at full brightness for over 2 days.	▸ Loan terms typically range between 6-48 months. ▸ Systems are locked or repossessed if customers miss payments.
Portable Battery Packs	▸ $1–$25 deposit, with smaller systems able to power a 2 -W LED light producing 200 lumens for 30 hours. ▸ $0.22–$0.80 per day in rental fees, depending on the batteries and selected rental appliances.	▸ Requires regular charging at a powered hub.

Financial Implications of Rental and Lease-to-Own Models

Companies using hub and battery pack rental models face competition from companies that sell decentralised solar home systems with pay-as-you-go (PAYGO) asset financing because they target the same customer base and offer similar products at similar price points. PAYGO allows customers to pay small amounts daily or monthly until they own their assets (lease-to-own model).

Although owning a solar system is desirable, rental models can be more attractive in rural Tanzania where income and savings are limited. Both models allow customers to purchase affordable electricity, but systems purchased with PAYGO asset financing tend to have higher down-payment costs and less flexible payment terms because customers are locked into leasing agreements. With these leasing agreements, customers must make daily or monthly payments for several years, which could become a liability. [17] In comparison, the battery pack rental model has shorter-term rental periods of 1–3 days and allows customers to opt in or out of renting.

Benefits and Outcomes

Portable battery packs provide electricity and power appliances in tens of thousands of off-grid households in Tanzania. [10] The technology primarily serves low-income households in rural areas that often cannot afford solar home systems.

As 58% of off-grid households in Tanzania rely on kerosene for lighting, if solar-powered lighting would replace the use of kerosene, there could be positive impacts on health and the environment.[13] Another positive environmental benefit of the hub and battery rental model is that the company owns the battery, so it is responsible for managing the electronic waste from depleted systems in an environmentally safe manner. Battery pack technology can also improve employment opportunities. Charging hub construction and operation creates jobs.[18] Additionally, microenterprises can use the rented battery packs to power appliances such as lights to keep a shop open late or TVs to entertain patrons at a restaurant or bar.

Constraints and Risks

Companies that employ a hub and battery rental model need to strategically locate their hubs and assess the local market size of each potential hub. To accurately measure the market size of a potential hub, companies need to consider a variety of factors, including how far members of rural households travel (estimated at up to 10 km) and the presence of other services nearby (e.g. milling and the penetration of alternatives such as solar lanterns).[19]

Companies that operate hubs limit their risk of losing assets by requiring their customers to provide down payments, guarantees, letters of support, and other documented evidence of creditworthiness before they are allowed to rent battery packs. Companies must consider that high down-payment costs and overly stringent requirements may lock out potential customers. However, companies must also perform due diligence because lax financial background checks can result in battery packs not being returned. Off-grid households generally prefer to own solar systems rather than rent them. However, the costs of purchasing a solar system are often prohibitive, and leasing terms can be unattractive. As the prices of batteries and solar panels decline, more off-grid households can purchase solar systems with cash, creating competition with companies operating a hub and battery rental model.

Future Perspectives

As battery technologies continue to develop, the costs of batteries and panels are expected to decline, leading to more affordable and larger systems.[3] Solar-charged battery pack systems are already competitive with the grid for lighting and small appliances. Battery pack systems may eventually surpass the grid for more energy-intensive applications such as agricultural processing activities. Companies like Jaza Energy anticipate that battery packs will play an essential role in enabling off-grid communities to leapfrog the grid entirely, just as mobile phones reduced the need for phone lines.[10]

There is still a significant difference in the size of the battery packs used for electric mobility and those used for household appliances, therefore necessitating a household to have two battery systems if they want to power appliances and an electric motorcycle or another vehicle. However, there are increasing opportunities for a single battery system to serve both purposes. As e-mobility becomes more commonplace, off-grid households may begin to plug home appliances into their electric vehicles and use the energy in the vehicle batteries to power their devices. And as battery-pack charging hubs increase their power generation capacity, they may be able to offer charging services for larger batteries and act as recharge stations for electric vehicles.

Case Study: Jaza Energy

Introduction

Jaza Energy is an off-grid energy start-up operating in Tanzania and Nigeria that establishes solar-powered charging hubs and rents out rechargeable battery packs to users. Jaza Energy's products' capacities range from 60 Wh to 180 Wh. They can be used to power lights, phone chargers, and household appliances such as televisions and stereos. Jaza battery packs are swapped at Jaza hubs, where 3-kW solar panel systems charge depleted batteries.

Jaza engages with local leaders to identify potential hub locations, primarily at local markets or village centres. The primary costs for establishing hubs are the CAPEX investments for: the batteries (imported), solar panels (procured locally), and hub module (made locally). After selecting a site, Jaza can deploy and construct a hub in less than half a day, which will then serve a customer base of 200 families within two months of operation

Picture 1: A Jaza Energy charging hub. Solar panels are placed on the roof, and charged batteries are located inside the hub, which customers can rent.

Picture 2: A customer walks to a Jaza Energy hub. Every hub is managed by Jaza Stars, who are young women from the local community.

Impact

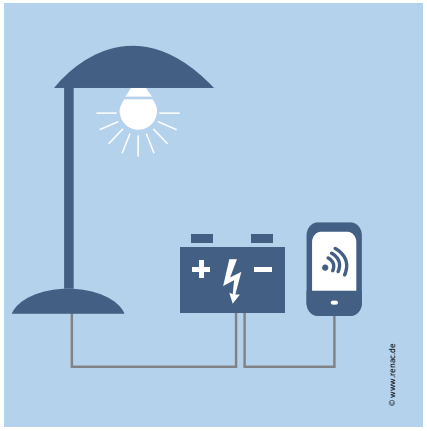
Since its founding in 2015, Jaza has established 86 Jaza hubs and provided over 50,000 people with access to electricity. The company targets a lower-income customer base and estimates that 77% of their customers live below the poverty line in Tanzania. 16% of Jaza's customers use Jaza products for business-related purposes, such as powering a television and subwoofer to create a local cinema or keeping a business phone charged for a telecom agent.

Jaza hubs are managed entirely by women from the local community who are referred to as "Jaza Stars." Empowering Jaza Stars is both a core purpose and one of the most crucial success factors in Jaza Energy's model. Currently, the company employs over 150 Jaza Stars; most are under 25 years old and working their first formal job at Jaza.

Financial overview

Jaza's hubs have a 30% gross profit margin in Tanzania and a 50% gross profit margin in Nigeria, resulting in each hub reaching profitability within 3 months and paying off the total CAPEX investment within 2 years. Jaza Energy has raised over $4 million from grants and investments. It is currently raising $5 million to $6 million in equity and $3 million in debt finance to expand its operations in Nigeria.

Picture 3: Charging hubs enable the surrounding community to access electricity. Hubs are strategically located in areas that users regularly visited, such as markets and village centres.



Graph 1: Battery packs have ports for connecting lights and other appliances. When the battery is low, the appliances are disconnected so the battery pack can be returned to a hub and swapped out for a fully charged pack. Copyright RENAC 2023.

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