Lighting Tanzania's Rural Areas: Solar Energy and Battery Swap for Households with Less Than USD 2 Per Day

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Executive Summary

Jaza is a last-mile solar energy company that targets off-grid households in rural Tanzania. The company builds solar battery retail locations, called energy Hubs, and rents batteries that customers take home and use to power lights and appliances. In 2020, USAID and Shell Foundation, a UK-registered charity, partnered with Jaza, to support the company to develop energy products to serve households that earn less than $1.90 per day. This report shares findings and lessons learnt from this process.

The need for a viable energy solution in Tanzania is particularly high, where approximately half of the population lives on less than $1.90 per day and 62% of Tanzanians have no access to electricity[1]. In Tanzania Jaza rents batteries across 63 Hub locations and handles more than 70,000 battery swaps each month. The company leveraged a wide range of both qualitative and quantitative data to help with its product development. In total, Jaza staff conducted 4,407 in-house interviews. By partnering with 60 Decibels, an insights firm to survey, an additional 256 users were interviewed. Jaza also collected quantitative data from 860,000 battery swap transactions with customers.

Findings

The extensive process of developing the battery services for the rural poor households generated seven significant findings.

1. 80% of customers underutilise their battery capacity: In general battery usage was less than expected, with 80% of customers using less than a full battery each day. This key insight stood in contrast to the qualitative data that Jaza was collecting through interviews, where customers were often asking for bigger batteries that they were often not be able to afford. As the result of this finding, Jaza developed a service around small sized batteries.

2. Understand your customers' 'unspoken' comfort levels on product prices: Jaza was able to identify customers' discomfort zone for service prices. The price options were paired with daily energy use and household budget. To further refine price options, Jaza also identified acceptance levels of the fees required to start the service. As a result of improved understanding about different preferences for the price, Jaza decided to remove the upfront fee and adjust the service prices to meets the affordability and flexibility requirements of the Jaza customer base.

3. Don't assume energy usage is linked to level of customer engagement: The amount of energy used per household also had no predictive ability regarding how often a customer used the battery. A customer that used less than 60Wh of energy each day was just as likely to use the battery every day as a customer that would use a full 180Wh battery each day. As long as a customer was able to meet their daily energy needs then they would use the product daily.

4. Retaining customers means giving them more than functionality: Customers also often asked for more features from the battery swap services. Jaza learnt that lighting and phone charging were not enough features. As a result, it added a feature in the batteries to allow customers to power appliances like TVs and stereos. Moreover, it offered unlimited swaps during a set period of time as a feature for being members.

5. Create a simplified portfolio that is based on optimal combination energy use and revenues: Jaza saw the need to have a simple offering that was based on optimal combination of energy use and revenues. Jaza learnt that generally the more energy customers use per day, the more they spend. However, this plateau went down at the 60-90 Wh level of consumption. Jaza also knew that customers who used between 30-60 Wh per day spent more than the average customer. As a result, Jaza develops 4 service options that encourage customers to come to the threshold of using 30-60 Wh/day. These options are offered across all Hubs to avoid confusion for customers.

6. Changing sales tactics is needed to boost sales and cut cost: Jaza found that the sales process that was based on agents who visited customers at home was not effective. The cost to cover this sales tactic equalled the upfront fee customers paid for joining the service. With this knowledge, Jaza changed the agent sales tactic to hub-based sales that rely on Hubs' women staff, Jaza stars. The

[1] World Bank. 2021. Access to Electricity [WWW] https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=TZ

change allowed Jaza to reduce the joining fee, increase interaction with customers, thus knowing their needs better, tailoring its services and boost revenue.

7. **Empowering women in the work force increase sales for the company:** Jaza's changed sales tactics has been dependent on the employment and training of Jaza Stars. Throughout the service development process, Jaza noticed the difference women could make to its business model. The agent-based sale tactics proved costly and with low customers 'retainment. Changing to hub-based sales, where 100% of Jaza's hub operators are women, resulted in higher sales volumes. As a result, the company empowers women in its workforce to provide both services and sales, promoting gender equality while increasing women's role in promoting modern technology in rural Africa. The key for this to work is to provide Jaza Stars with relevant training, networking opportunities and a professional development path, which helps them to increase their income, confidence, and respect.

The findings have unlocked a way to better serve low-income rural customers in Tanzania. Jaza decided to make their batteries smaller, simpler, and less expensive, which helped get the right products into the hands of the right customers while addressing barriers to customer adoption. The physical network of solar-powered village hubs serves as both the battery charging station and the point of customer engagement and service. The way the battery swap service is offered also presents limited risks for rural Tanzanian households while directly meeting their needs at an affordable price. This in turn allowed Jaza to increase the number of people they served at each hub 10 times - and therefore intensify their impact. With a proven solution and a learning process in place, Jaza is now positioned to scale to power 60,000 households across 400 locations by add date.

Key steps to building a data-led, gender-inclusive and customer centric energy business

Through the development and implementation of the battery swap model, Jaza has extracted few important lessons on the promotion of energy access for rural poor households in Tanzania. For tech-driven, or platform-based products, massive amounts of passively collected data is not useful in and of itself. It is important to be clear about what questions to be answered and how current datasets can help shed light to these questions. Also, it is important to have a robust product development process that is based on research, field testing and continuous learning. For a low-income market, it is important gain trust for the product by employing community-based sale tactics, flexible payment arrangements matched with how low-income households earn money. In addition, having an impact mindset in developing a product helps build a product truly wanted by customers. That mindset is built around the desire to understand the need of the customers and changing the product or service to match their needs. With regards to how best to empowering women while growing the business, remaining committed to the cause is a great way to support women against pushing back from their communities. The best way to persuade communities and support women is to set examples of how support should be given to them; and by, providing opportunities for them to gain income and knowledge. At the same time, technical training, peer learning and networking are essential in increasing women's confidence while offering them career development opportunities. These measures prove to empower women in last mile rural communities while enhancing company's profit.

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During the process of product development and testing for solar energy battery swap services, Jaza would like to thank all customers who shared their views and feedbacks to help us improve. Special thanks are due also to Jaza's staff, especially the Jaza Stars for their contribution as partners in delivering solar energy services to the communities Jaza works to serve.

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List of acronyms:

ARPU	Average Revenue per User
USAID	United States Agency for International Development
Wh	Watt hour

1. Introduction: Challenges and Opportunities for Solar Energy in Tanzania

With the support of the Shell Foundation (SF) a UK registered charity and the United States Agency for International Development (USAID), Jaza was able to develop the pricing, product and business model required to serve remote, last-mile households in Tanzania that were previously living without access to reliable energy services.

Jaza was able to develop a solar battery rental service model in rural Tanzania, with a focus on low-income households. By reducing operational risk through grant capital, Jaza has been able to test a segment that has been traditionally considered economically unviable. This report shares findings and lessons that Jaza learnt from the process of developing and testing the solar battery rental services.

About half of the Tanzanian population lives on less than $1.90 per person per day. In 2019, 62% of Tanzanians had no access to electricity, and the number was significantly higher in rural areas[2] (see Figure 1). About 64% of those who live in off-grid areas rely on kerosene[3] which is expensive and has a negative impact on health, especially for women and children. Kerosene is also a significant source of atmospheric black carbon.

Figure 1: Energy Access in Tanzania (Source: World Bank, 2021 and Lighting Africa, 2021[4])

Given the large geographical size of the country and the dispersed population, off-grid energy is well positioned to play an important role in reaching the rural population when grid expansion is not economically feasible in many rural areas. The government of Tanzania has made expanding access to energy a national priority[5].

2. Methodology

Faced with both challenges and opportunities in the country, Jaza Energy wanted to develop suitable products to increase energy access among low-income households in rural Tanzania. To achieve this goal, it needed to conduct thorough research to understand its customers and the products that respond to their needs and incomes. Jaza employed mixed approaches for its study. It conducted market surveys directly at the Hub, through a smartphone application, called the HubApp that Jaza Stars use to manage inventory, transactions and customer data. On every 7th swap, customers are asked a series of questions to better understand their level of satisfaction, the appliance they are

[2] World Bank. 2021. Access to Electricity [WWW] https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=TZ
[3] Lighting Afirca and World Bank Group. 2021. Tanzania – Off-grid energy to serve a dispersed population [WWW] https://www.lightingafrica.org/country/tanzania/
[4] Ibid
[5] ibid

currently using or wish to use in the future in addition to questions about their professions and family size. In 2021, 4407 welcome surveys were conducted at Hub locations.

From the customer side, it also contracted 60 Decibels, an end-to-end impact measurement company, to conduct customer surveys. 60 Decibels contacted 256 of Jaza's customers across two regions and provided key insights into the customer profile, impact the service had on customer quality of life and value for money. 60 Decibels insights are benchmarked against other services offered in the energy access sector – providing Jaza with a view into how the service was being perceived in comparison to the services offered by over 50 companies across 18 countries.

In addition, Jaza also used data generated from its smart battery to learn about customers' energy assumption, payment arrangements and battery services. Each battery is outfitted with data logging capabilities built into the battery's circuitry. When the batteries are used in a customer's home, the battery records how much energy is being drawn from the battery, which can be used to infer loads or the appliances powered. Additionally, the battery records the time of day for usage and gives Jaza a clear view into how often the battery is being used in home. Once the battery is returned to the Hub and plugged into the Hub controller to be charged, the data is downloaded at the Hub and then uploaded to Jaza's server through a modem built into the charging hardware. This data is than analysed and used to inform product and battery decision making, as well as monitoring system and battery health. Battery usage data from 860,000 transactions have been published and collected in Jaza's database since the service launched in 2017.

Informed by this data, Jaza has launched and tested its battery swap service in three unique Tanzanian regions. It has segment customers by how much money each household earns daily and the quantity of energy they require. Jaza trialled 17 different price offerings and used software built into their smart battery to test different battery sizes and daily energy needs. Each offering was launched at a cohort of 6-10 Hubs across different regions, and Jaza measured business performance and customer satisfaction rates. For business performance, Jaza measure the number of customers that used the service on a weekly basis, and the revenue generated by each user. On the customer satisfaction side of the equation, Jaza measured customer engagement, or how many days out of the month each household powered their home with Jaza's service. Surveys to measure each cohort's Net Promoter Score were conducted at the Hub through both welcome surveys (4,407 conducted) and through follow up outboard calls.

3. Findings

By combining data collected from the batteries, business performance and customer interviews Jaza learned 7 key insights to better serve our customers in the way they need.

Finding 1: 80% of customers underutilise their battery capacity

Through a deep look at usage within their lowest income customer segment, Jaza found that customers underused their battery capacity. In phase 1 of our testing, we found that over half (58%) of customers use 30-60 Wh per day. In Phases 2 and 3 more than half the customers (69% and 57%) of customers use less than 30 Wh per day. Overall, half of our customers use less than 30 Wh of energy per day (see Table 1).

Table 1: Daily Energy Consumption by Customer Cohort

Energy consumption	<30 Wh	30-60 Wh	60-90 Wh	90+ Wh
Phase 1	23%	58%	12%	7%
Phase 2	69%	24%	4%	3%
Phase 3	57%	26%	9%	8%
Appliances/ utilities used	1 Light	2 Lights + phones	4 Lights + phones	TVs and stereos + lights

This key insight stood in contrast to the qualitative data that Jaza was collecting through interviews, where customers were often asking for bigger batteries. Their battery usage indicated that they didn't need such a big battery after all. Jaza also learnt from these surveys that the majority of customers still wouldn't be able to afford bigger batteries even if Jaza improved quality to justify the expense. As a result, Jaza developed a service around small sized batteries by first using software in the battery to reduce the battery size before they invested in an expensive and lengthy manufacturing process.

Finding 2: Understand your customers' 'unspoken' comfort levels on product prices

In parallel to the data that was being collected on energy use, Jaza was also exploring different pricing options to pair daily energy use with the household budgets available for energy. When the product launched Jaza charged an upfront fee to start the service. Although the monthly cost of Jaza's service was less than what a household would typically pay for kerosene, only 24% of customers stated that Jaza was good value for their money. Customers felt as though they had already "bought" the service and were being charged unfairly for each subsequent transaction. As a result, Jaza decided to remove the upfront fee and adjusted the service prices.

Jaza also tested different payment options. Taking into account that 75% of all Tanzanians earn their income from the agricultural sector[6], Jaza set small payments every few days, rather than one payment for its customers. In doing so, Jaza matched its products with the affordability and flexibility requirements of Jaza's customer base. One customer in Kigoma, Tanzania shared their feedback as following "*I have a monthly package. My battery is well charged and I can use it for my phone. The service works very well for me and my family*."

By making these changes, Jaza could decrease costs of battery packs by 62%, thus lowering barriers to entry. This in turn saw the increase of 10 times in new monthly users and 2 times in monthly revenue per user.

Finding 3: Don't assume energy usage is linked to level of customer engagement

Jaza segmented their customers based on energy consumptions, or the quantity of energy used daily, and then mapped this data to the number of days that a customer would use the service each month. With this knowledge when Jaza built its solution, it assumed that the customer that used more energy would also be the ones that were most engaged with the service. However, when testing this product and assumption in the market, Jaza found that its assumption was not correct. The insights were surprising: energy use did not predict how often a customer would use the service. A customer that used less than 60Wh of energy each day was just as likely as a customer that would max out their full

[6] IFAD. 2021. Tanzania [WWW] https://www.ifad.org/en/web/operations/w/country/tanzania

180Wh battery each day. Energy use was a function of the appliances or service a customer required and were not a determining factor of how much the service was used. As a result of this, Jaza positioned the product as something could power a range of products, spanning from 1-2 lights and mobile phone charging to a more aspiration product that could power TVs and stereos.

Finding 4: Retaining customers means giving them more than functionality

During test and trial phases, the sales and marketing teams were repeatedly hearing that although the Jaza service offered core lighting and phone charging services, prospects were demanding a product that could also be used for entertainment, powering things such as TVs and stereos. As a result, Jaza developed a cable attached to the batteries, so that customers can power such appliances. We also learnt that members are 26% more likely to use the product daily than non-Members. Almost half (44%) of members fall into the High Engagement category, compared only about 25% of non-Members. As a result, Jaza understood it needed to increase its membership. It offers member customers to swap their batteries as many times as they would like during a set period of time.

Finding 5: Creating a simplified portfolio that is based on optimal combination energy use and revenues

While testing pricing and offerings, Jaza would often be confronted with a challenge. Customers did not know what to choose, or worse, would hear about different offerings being provided in another community and assumed that they were missing out. Moreover, customers were often caught trying to weigh the pros and cons of a long menu of offerings. Jaza saw the need to have a simple offering that was based on an optimal combination energy use and revenues. From the studies on the Average Revenue per User (ARPU) over a year in three phases, Jaza learnt that generally the more energy customers use per day, the more they spend. However, this plateau went down in Phases 2 and 3 at 60-90 Wh level of consumption. Jaza also knew that customers who used between 30-60 Wh per day spent more than the average customer across all phases. As a result, Jaza developed services that encouraged customers to come to the threshold of using 30-60 Wh/day, which narrowed down Jaza's offerings to 4 choices and deployed these offerings across all Hubs.

Finding 6: Changing sales tactics is needed to boost sales and cut cost

In 2020, Jaza recruited and managed a sales agent force for each hub of 2-3 agents. The sales process was lengthy, with agents often visiting a customer 5-6 times before closing a sale. The commission paid to agents was the same as the upfront fee customers were paying for the service. The customers acquired through the sales agent model often lived far from the Hub and had a low level of customer engagement, in contrast to walk-in sales or sales acquired by female employees called Jaza Stars at Hubs. A Jaza Star in Mtwara, Tanzania shared her perspective on benefits of the new sales tactics as following "*We used to use a lot of sales agents to get new customers. However, our customers often lived far from the Hub, which made interactions with Jaza less frequent. Now I find our customers at our hub and I know exactly who are our customers and what they need because I am from the same area.*"

Finding 7: Empowering women in the work force increase sales for the company

While testing the new product, Jaza also finds the importance of promoting gender equality in its workforce. As the women often know people in their community well, when potential customers visit hubs, Jaza stars can advise better types of services suitable for customers'

needs. As a result, they also them customers to reduce cost by providing right products. Our research showed that Jaza stars brought more customers and sales, which ultimately increases revenue for the company.

Moreover, Jaza finds that by training and employing young women the company can promote gender equality in rural communities. As most of the women hired live in last-mile communities with limited scope and possibilities, becoming a Jaza Star provides them with new skills and an income that can help support their families or pay for education. It also helps develop their self-esteem as one Jaza star shared "*This job has earned me respect in the community. People now see me as part of the solution solving our energy problem*".

As the result of the above understanding, it is the company's policy that each Jaza hub is operated by two Jaza Stars who are from the community it serves (see Picture 1). The women work in shifts and are paid a salary in addition to a commission based on the hub's monthly sales. The key for this to work is to provide Jaza Stars with suitable technical training (i.e training on the mobile app, battery management, sales tactics) and personal development (goal setting, financial literacy and confidence). In addition, to provide on-going support and peer learning, the Jaza Stars are encouraged to connect to each other in regional and country-wide WhatsApp groups. For long term development, through the company's Super Star programme, more experienced Jaza Stars are assigned help with onboarding of new hires.

Picture 1: Jaza stars at work

4. Jaza's achievements

The findings from the market surveys helped Jaza decide to make their batteries smaller, simpler, and less expensive, which helped get the right products into the hands of the right customers while addressing barriers to customer adoption. These physical network of solar-powered village hubs serve as both the battery charging station and the point of customer engagement and service with limited risks that more directly meets the needs of rural Tanzanian households at an affordable price. With Jaza's refined product, a household needs to pay $1 one off sign-up fee and additional of $0.22 per day for renting a battery pack (see Figure 2). This offer makes it possible for households with income as low as $0.75 per day.

Picture 2: A Jaza Hub in Titye, Kigoma, Tanzania

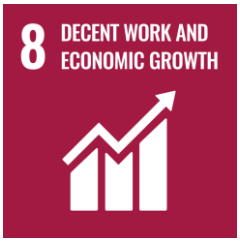
Figure 2: Jaza's product features

With these new battery swap services, Jaza also contributes to few areas of sustainable development goals.

Jaza's data show that customers switching from kerosene lighting to Jaza battery packs save an average of $42 per year, representing about 20% of their annual household budget. Approximately 16% of Jaza customers use the batteries to power small businesses, increasing local income opportunities

For Jaza, driving greatest impact was a matter of developing a product that responds to customer needs and understand the barriers to customer adoption of off-grid energy. These ultimately enable poorer family to access energy. To date Jaza has deployed 68 hubs providing power to about 51,000 people in last-mile communities

Jaza Energy recruits and trains local women to deliver the services provided by hubs -which are all are staffed by women. Known as Jaza Stars,these women typically work at their own hubs and take on the added role of trainers and mentors for new hires. This brings pride for women and increases their status in their communities



Over 150 Jaza Stars have been hired and trained. Decent jobs have been created for Jaza stars and local technicians with better working conditions and pay.

507,299 litres of kerosene displaced resulting in1,362,926kg of C02e emissions avoided. Jaza owns the batteries, so it can effectively manage reuse and disposal. This addresses one of the biggest challenges to solar e-waste management

5. Conclusion and lessons

This research has found that understanding how customers use energy, what they could afford was also critical to unlocking a solution for this underserved segment. Although customers were asking for bigger batteries, Jaza made the battery smaller, and reduced the transaction cost on a per rental or membership basis. By collecting data on how the battery was used, talking to customers and monitoring business performance and customer satisfaction levels Jaza was able to test product, positioning and service delivery in real-time.

Throughout the development and implementation of the battery swap model, Jaza has extracted few important lessons on the promotion of energy access for rural poor households in Tanzania. With regards to product development,

- All findings discussed above informed the product development and refinement, which was possible thanks to a robust research -based product development process. The company applied field testing and continuous learning during this process. Survey data and customer testimony is a critical part of designing a product or service. Listen to customers is important, but verifying what you heard against observations of customers' actual behaviour and usage are critical to refine a product in rural and disadvantaged settings, This allows Jaza to build practical battery packs with embedded services that are less expensive and match with how low-income households earn money.
- The findings 1 and 2 around how customers used data and their preferences for prices were discovered through a massive raw database that sometimes seemed to show conflicting pictures. For tech-driven, or platform-based products, massive amounts of passively collected data is not useful in and of itself - it even has the danger of taking up time aimlessly sifting through data, or presenting misleading results, if not properly analysed. Therefore, from Jaza's experience, it is important to take the time to get clear on what questions the company wants the data to answer, triangulate initial findings against different data sources, and then charts a new path forward.
- One the product is developed and accepted by the target customers, through findings 4 and 5, Jaza tested and learnt the importance how right prices, flexible payment solutions and added values to the services helped the company to attract and retain customers. These factors helped increase customers' confidence in the services.

- Moreover, success to build a product wanted by customers is helped by having an impact mindset. Having an impact is not simply to prove that your product or service works. True impact mindset means really understanding the needs of the customers and changing the product or service to match their needs.

With regards to how best to empowering women while growing the business, some reflections can be shared on how empowering women in the small-scale business environment can contribute to shifting gender norms in promoting technology in rural Africa.

- What makes the effort to empowering women a success is the strong commitment from the company leadership to support women in its workforce. When Jaza enters a new region, there has been some initial pushback in the communities about the company only hiring women. Jaza has remained committed to this approach based on the understanding that providing income opportunities for women in rural, developing contexts can exponentially increase every measure of impact.
- In addition, it is important to set examples. If you do enough of something, it becomes the way things are done. With an expanding network of hubs, it now goes unquestioned in the regions where Jaza operates that the hubs are run by women. Jaza Stars are the face of the of the company and the source of light for their communities.
- Provide training is an important part of empowering women. Training should be in various forms such as more formal training sessions on technical subjects to help women to carry out their daily responsibilities. At the same time, peer support and networking offer informal learning opportunities for women to grow.