Lessons Learned – Developing Off-Grid Energy Systems During the COVID-19 Pandemic

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***Abstract*— In this article we, as energy developers, present some important lessons learned in our experience of developing energy access systems for off-grid rural communities in Nigeria during the COVID-19 pandemic. We believe that this could be helpful to other developers in the energy access space across sub-Saharan Africa (SSA). We also believe that this could have some value in post COVID-19 energy access research and efforts around achieving SDG-7. We have also avoided "academic" style writing because our goal is to ensure that this is accessible to all stakeholders in the energy access space.**

Keywords*— *COVID-19, Off-Grid Energy Systems, Energy Access

I. INTRODUCTION

The Coronavirus, like a swarm of locusts, is leaving death and destruction in its wake as it eats through the very fabric of humanity. With over 6.4 million confirmed cases and over 396,000 deaths in over 185 countries/regions, according to real-time data from Johns Hopkins Center for Science and Engineering (CSSE), at the time of this writing, the Coronavirus disease has put many countries in total lockdown, caused businesses to shut down and has slowed down the world economy.

In Nigeria and across sub-Saharan Africa, the economic effect could be more devastating, as the amount of wealth accumulated by their counterparts in Europe and the United States to weather this storm, is largely absent.

From what we currently know, there are no cures for the virus, but with the help of modern technologies like ventilators surviving the illness for those who become symptomatic becomes possible. To effectively do all these, one needs electricity.

There are 840 million people in the world without access to electricity [1]. In sub-Saharan Africa, only 47% have access to electricity. In Nigeria only 55% of people have access to electricity. This number is smaller for people in rural communities, where the electrification rate is 39% [2]. Therefore, in Nigeria, about 95 million people do not have access to electricity and 65% of them live in rural communities.

By electrification, we mean those who have a connection to the local or national electric grid. While the African population is generally young — in Nigeria the median age is 17.9 years — and may probably be more resilient to the pandemic than their European and American counterparts, for those who get sick from the virus getting a ventilator powered to electricity could literally be the difference between life and death. In a country with 200 million people and an available capacity of generating 6000MW from an installed capacity of 12,522 MW shortages abound. To put this in perspective Finland generates around 16,000MW for 5.5 million people [3]. Hence, there are serious reliability issues. Even those who are connected to the national grid experience extensive outages and power cuts. For example, according to World Bank estimates there are over 32.5 outages a month in Nigeria and for some the average duration of an outage is 8 hours [4].

Hence electricity is an important service, especially in dealing with the novel coronavirus. In the United States, steps have been taken by stakeholders in the electric utility industry to ensure the reliable supply of electricity. While many people have been able to work from home, electric utility operators, especially those that work in control centers and power plants, have had to live at work.

While this is not the case for Nigeria, it is time for off-grid power systems developers to ramp up their operations to not just meet the demand for electricity but also address the increased energy demand of those working from home and hospitals.

As energy developers in the energy access industry we successfully constructed a mini-grid during the COVID-19 pandemic. While this project reached financial close in December 2019, most of the construction work was undertaken between March and July 2020 – during the height of the COVID-19 pandemic. Fig. 1 and 2 shows the site of this project In this paper we recommend potential strategies for mini grid developers and solar homes systems (SHS) companies that must continue operating to provide much needed electricity to those that need it.

Fig.1. Bulldozer on the construction site.

Fig.2. Construction site with solar panel.

II. GET AN EXEMPTION STATUS

This is very important for your operations. The lockdown in many parts of Nigeria are enforced to different degrees. For example, it was more relaxed in Rivers 4 weeks ago and strictly enforced in Lagos. The different degrees of enforcement are changing. In the last week Lagos has been easing up movement restrictions and Rivers has become stricter. But since electricity is an essential service, you can get an exemption. You also need your employees to carry their ID cards, especially if the name of your company has the following words "energy," "electricity," and "power" in it. To get an exemption, the Renewable Energy Association of Nigeria (REAN) is helping its members get this. Larger companies can get this from the necessary state government agencies. The more exemption documentation you are able to secure the better it is for you if your team gets accosted by law enforcement agents.

III. NOTE TO MINI GRID DEVELOPERS IN CONSTRUCTION STAGES.

Before the COVID-19 became a global pandemic construction on many mini grids had begun. Hence the lockdown caught many construction workers stranded at the construction sites. This resulted in unplanned costs for extended accommodation and feeding for the teams. In many cases equipment needs to be moved to site. Hence those coming from outside could potentially expose those on site. Efforts need to be taken to prevent those who bring equipment to site from exposing those who are on site.

Secondly, these projects need to continue because many of them were financed with high ratios of debt, which must be serviced by the project revenues. Commercial operation dates (COD) have to be pushed back. This is potentially dangerous for the economic viability of the projects. But to be realistic it has to be done. If possible, reach out to your investors and financiers to ask for a moratorium on debt repayment and debt calculation. If you can get both great! if you can get a repayment moratorium, good! If this is not possible you should try to get the project to the COD as soon as you can.

IV. CASH MANAGEMENT

The pandemic has brought so much uncertainty, so spending money anyhow is a terrible idea. You must institute the strictest controls on cash flows. Do not pay cash if you do not have to. IOUs should be your go-to option. For example, if you purchased some inverters from a vendor or distributor, and they are willing to accept a 20% payment of the full price of the equipment for now and the complete payment of 80% in 6 months, with a guarantee that they would be your only vendors for inverters for the next 3 years or with an extra 10% on the 80% balance in 6 months, you should do that. Also, if you are cash strapped and you have receivables, you should be willing to sell it for kobos on the naira (or cents on the dollar). There would be unplanned costs that you would have to deal with. If you did not get a purchase agreement for equipment in the mini grid project planning phase — not a good best practice by the way — the prices of equipment could increase. I will address this in the supply chain section of this piece. But it is important to note that budget overruns will happen, and you must have the cash to deal with all these. Or at least have the capacity to negotiate payment plans and IOUs. Businesses fail not because they did not make profit but because they run out of cash to meet their obligations.

Finally, on this topic, we would add that you can always get a loan for working capital. Try getting this from your current investors and financiers, as no one would be more interested in seeing you succeed. If they are not able to risk any more capital, they would be able to find people in their network who can help.

V. EMPLOYEE STATUS

This is a difficult one. Cash management may require the furloughing of some employees. This is hard but may have to be done. Many of the companies in this industry are really small and a shock like this could put them out of business. But then talent in this industry is scarce. Letting people go may not be to your advantage. A strategy that could work is requesting that your employees take a temporary pay cut with an IOU agreement to pay the difference in the future plus an interest. Hence borrowing from your employees. For example, if the salary of an employee is $500 per month, and they agree to take a pay cut of $250 for the next 4 months. You can agree to pay them the $1000 difference after the 4 months plus a 10% added on. So at the end of the 4 months or some mutually agreed upon time you pay them $1100. Essentially you are borrowing from them.

VI. IDENTIFYING YOUR CUSTOMERS

In this Pandemic there are three types of customers of major importance:

1. Those who live in rural communities off the grid
2. Those who live in urban communities
3. Health centers, Isolation centers and hospitals

Non-health Commercial and industrial (C&I) customers, are not of serious importance currently, because they usually can provide electricity for themselves quite effectively, and with the reduction of people going into work we are seeing a demand in electricity by these customers.

If you get a C&I non-health customer who asks you to develop a system for them, please go ahead. If not, focus on residential customers in urban communities — like the cities of Lagos, Abuja, Enugu, Port Harcourt, Ibadan, Abeokuta, Kano and Kaduna. Also focus on customers in rural communities. One caveat here is that the projects in these rural, mostly off-grid, communities should already be at the construction phase. I would advise against spending resources to develop these kinds of projects, because of the pandemic. Project development for off-grid power systems is still a fairly risky business. Two things that make it risky is assessing the ability and willingness of the customers to pay and finding financiers for the projects. And it takes a lot of leg work. For example, in Nigeria, the mini grid regulation framework requires that the consent of 60% of the community members must consent to whatever tariff is being agreed between the community and the project developer [5]. This means that as a developer you must go door-to-door to get those signatures in the communities. This is not good for physical distancing and during a pandemic the community members may not be willing to cooperate for fears of exposure.

Identify the rural communities that have health centers is recommended. Some of them do. A project could be proposed for these rural health centers. This still does not solve the problem of ability and willingness to pay, which is generally overcome by extensive ground work to get data to calculate the poverty probability index (PPI). What can be done is, is to finance the project through a blended finance structure — like a 50% grant and a 50% debt. The 50% grant could allow you to charge a lower tariff and the 50% debt still maintains the economic incentives for you to successfully develop, design, implement, operate and maintain the project, which is very important for a growing industry.

For urban residential communities — many people in this group, as far as they are able will be working from home during this period. This means an increased demand for electricity for comfort and to work at home. The average professional in corporate Nigeria spends most of their time at work, and just a few hours at home during the weekdays. During those few hours they spend at home they can provide comfort — Air conditioners and TV entertainments — for themselves by using small petrol (gasoline) or diesel generators. This is very common. But the global pandemic has changed these patterns.

For example, having a petrol or diesel to power your generator for 16 hours daily instead of the 4 hours you were accustomed to will increase the operation and maintenance costs leaps and bounds. Secondly, for those who have children, they would have to deal with bored out-of-their-minds kids and teenagers, who are home because schools have been shut down and cannot go outside to play or hangout because of social distancing and lockdown mandates. Unlike in the United States, sending children, especially teenagers to boarding school is very common in Nigeria and other sub-Saharan African countries that were former British colonies. Hence many teenagers who should have been in school are now home. Parents would need to provide electricity for comfort and entertainment for these kids and teenagers, so they do not become mayhems at home and resort to vices to keep themselves occupied.

A solar home system (SHS) solves this problem easily. With a SHS they would not need to run their generators for 16 hours and would reduce the cost of providing electricity in the long run. The problem I see here is affording the initial cost of the system. Providing them with different SHS options and stating what those options can safely electrify and for how long is recommended.

For example a person with a SHS that comprises of a 1kW solar, 2.5kVA inverter and a 4.8kWh storage system which costs a little bit over 750,000 naira ($2080) could power all home electrical and electronic appliances (lights, phones, TVs, laptops, etc.) for most of the day. When you have about 2 to 3 cloudy days, you would need to use the generator for about 4 hours to charge the batteries while providing electricity for the home. In the grand scheme of things, with respect to Nigeria, this is a large system. Smaller

systems are more common. The issue here is that as much as you can you would need them to pay up the full cost, at least of the system, at once.

Those who may not be able to afford the $2080 price tag for the system in a onetime purchase may be able to pay for the system in 3 or 4 payments. This is a great scenario where after you have included the labor costs and a decent margin on the system you can sell this receivable to a financial institution like a bank for about 80 kobo on the naira. If the customer defaults the bank would have the right to take the SHS. You can even offer your service, at a fee, to do the removal if it comes to this. Remember cash is king, and you must not run out if you want to survive this pandemic.

Also, in cases where the customer already has a generator you can appraise and value it. The monetary value will be agreed between you and the customer. Then you can deduct this value from the cost of the SHS. And then a temporary transfer of ownership of the generator from the customer to you will take place. When they pay the full cost of the SHS, then ownership of the generator will be transferred back to them.

We also recommend getting partnerships with different banks to support your financing of these projects. It is generally easier to assess the creditworthiness of this type of customer. Usually these kinds of partnerships generally take months of negotiations, and you may not have the time, so selling your receivables to any institution willing to buy them is recommended.

For mini grid developers — developing projects for hospitals and medical testing facilities is recommended. These places would need electricity. A current exemplary model is the partnership between Arnergy Solar, a SHS company and 54gene, a biotech company, to set up a COVID-19 mobile testing laboratory. The Nigerian Center for Disease Control (NCDC) is granting approvals to private testing laboratories to test for COVID-19 if their requirements are met. For mini grid developers you need to find these biotech companies and develop more of these mobile testing facilities in partnership with them.

Also go to hospitals and isolation centers, sign power purchase agreements (PPA) with them, and if you can get them to put up at least 10% of capital cost, please do. You can then take this to an investor or financier to raise the funds for the project. Again, use the network of your existing investors and financiers. To protect the economic viability of the PPA, ensure there is a clause dictating what would happen if the COVID-19 stops being an issue and the isolation centers, in this case, are closed down. Special Purpose Vehicles (SPV) to develop projects like this is recommended. That way you are able to contain this risk.

VII. Supply Chain — Equipment Vendors and Logistics

When the COVID-19 just became a global pandemic, there were vendors in China trying to off load their inventories, but this may not be the case anymore. Without a doubt this would affect the prices on equipment. For example, even equipment companies based in Europe and the U.S. still have their factories in China. Hence getting equipment from China may not be as easy. Although we understand that this may be changing as China continues to lift its movement restrictions. Looking for equipment in the not so common places like the U.S. and Vietnam is recommended. The ports in Nigeria are still open so it is possible to get them into the country. Shipping medical equipment like ventilators fitted with inverters and batteries is recommended. These could be sold directly to the health care facilities and you get the import duty and value added tax (VAT) exemption on critical medical supplies announced by the Federal government of Nigeria.

Moving equipment from the port to the warehouse or to the construction site will not be easy. You *must* insure these equipment before moving them anywhere. In most cases nothing happens, but if something does happen and the equipment is vandalized or stolen that could be devastating to your company. There are many insurance companies that offer this. They insure the full cost of the equipment against a myriad of calamities while they are being shipped to the warehouse or to site. Supply chain and logistic issues are evolving. Just keep note.

A final recommendation on this is to get a police officer to escort your cargo from the port to the warehouse or to the construction site, if you are able.

VIII. Mergers and Acqusitions

We are in unprecedented times and the mini grid and SHS industry is still very small and vulnerable. Hence to conserve resources and become lean there may be the need to merge companies. I believe the industry needs this now more than ever. Before you run out of cash and must file for bankruptcy, reach out to a fellow company who may be willing to merge with or acquire your company. There is no shame in this. In fact, you saved your investors from having to lose all their investments and could potentially protect the jobs of your employees

IX. Conclusion

Things may be a bit difficult for a little bit. Even of health authorities say COVID-19 is no longer harmful and we can all go about our businesses, it is not certain that people will follow suit as they did pre-COVID. We are just beginning to understand the new potentially fundamental changes this pandemic has caused. Hence, more research will be needed with respect to understanding what the post COVID-19 era would mean for the energy access space.

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