UPSCALING MINI GRIDS FOR LOW-COST & TIMELY ACCESS TO ELECTRICITY

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>> Demand Creation and Productive Use Workshop Proceedings

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Introduction

"Achieving Sustainable Development Goal 7 is not only a question of satisfying households' basic energy needs. That in itself has valuable welfare implications, but we need to go beyond. For electrification to transform LDC economies, modern energy provision needs to spur productivity increases and unlock the production of more goods and services. The productive use of energy is what turns access into economic development, and what ensures that investments in electricity infrastructure are economically viable. But that means looking beyond satisfying households basic needs to achieving transformational energy access - satisfying producers' needs for adequate, reliable and affordable energy."

-UNCTAD Secretary-General Mukhisa Kituyi

Through the promotion of productive uses of power, such as primary agricultural processing, manufacture, or refrigerated food storage, operators, financiers, national governments, donors and impact organisations can improve the economics and social impact of rural minigrids. These in turn can provide powerful tools to engage cross sector input, stimulate economic activity, provide myriad opportunities and improve the flow of investment into the space.

Against a depressing backdrop of financing bottlenecks and investment barriers such as the perceived threat of Grid expansion, unproven business models and regulatory hurdles such as unclear national policies, the promotion of productive uses of power in off-grid settings offers a clear and positive way forward. If successful they constitute a powerful mechanism to catalyse industry, spur local development, improve operator revenues.

Why then is not more being done to address this? One of the clear issues lies in who should be doing this work. Large multilateral donors often can't engage in 'projects' because of the nature of their funding mechanisms. National Governments are usually not aware of the development opportunities available and private operators often don't realise how critical these efforts are to their bottom line. More recently however, this has been changing and we are starting to see more and more work in this space.

To discuss the topic, we brought together some leading minigrid practitioners at the "4th ESMAP/CIF Action Learning Event on Upscaling Mini Grids for Low Cost and Timely Access to Electricity" on December 4-8, 2017 in Abuja, Nigeria. Our panelists were Emily Moder from SteamaCo, a minigrid tools and data specialist, Sam Slaughter from PowerGen, an East Africa based minigrid developer, and Millicent Lewis-Ojumu who is the primary interface for UNOPS with the Government of Sierra Leone, currently working on the implementation of 90 solar minigrids.

"What follows is an edited transcript of the workshop clustered around key topics of discussion.

Workshop Proceedings

>> Privately operated minigrids are an essential electrification tool

Private organisations can, and have to be a lot more nimble and versatile than public sector actors. They are incentivised to be highly cost conscious, and to try and understand what their customers want intimately in order to deliver services efficiently, affordably, innovatively and responsively.

When groups like the World Bank and DFID try and solve the problems of energy access in Africa, they have two choices, they can choose to support the public sector or they can support the private sector. The public sector has two advantages, it has sovereign backing and scale. The private sector has three advantages; it can be more efficient with money, creating more impact per dollar, it can be a conduit for innovation, for things like smart metering or energy storage and thirdly it can be an active proponent for productive loads, helping people make the most use of their power. -Sam Slaughter

Although a national government will strive to support the creation of local economic activity, the mechanics of government are often too cumbersome and unwieldy to make the most of new opportunities and to efficiently align the efforts and commitments of different ministries and government initiatives.

In East Africa there are government programs to connect millions of people to power for the first time, but we're seeing the phenomenon of 'idle grid' emerging. There are millions of people being connected through government subsidy programs that are getting power but are not making good use of it. Either they are confused by the tariff or metering system or maybe they just don't have enough funding to buy a TV or fridge or pump to make the most use of that power.

One of the greatest arguments for private utilities in the years ahead will be that not only do they bring the power, but that they bring the tools and the ecosystem that people need in order to maximise its utilisation. -Sam Slaughter

>> Governments can also directly and immediately benefit

Millicent Lewis-Ojumu works with the United Nations Office for Project Services in Sierra Leone. They are building 90 minigrids in some of the most remote parts of the country. The minigrids are based around clinics and community health centres. The project was announced at a fortuitous time in the political cycle when many politicians were canvassing for votes. Because the proposed sites were scattered across the country, almost every party was able to generate political mileage by aligning themselves with the project.

The best sellers of the idea of minigrids are the parliamentarians. We suggested that they emphasise the business that their party was bringing into the local areas through the construction of minigrids. This was very successful. -Millicent Lewis-Ojumu

If there is buy-in at the highest level of government, the lower echelons can start to take the issues of rural electrification seriously, cross-sector collaboration between ministries becomes possible and the effects of a project are amplified.

The President chose this as one of the flagship projects for the energy sector. This meant that the minigrid program was able to work closely with other prioritised sectors including the health sector, the ministry of trade and the agriculture sector. We realised that what they were doing to support those sectors very much matched what we were looking to see happen in these villages. -Millicent Lewis-Ojumu

There are a number of wider benefits when momentum gathers nationally around a particular idea. In the case of Sierra Leone, the fact that politicians were all using the rural electrification gambit for their own political gain meant the project got a lot of coverage.

It also meant that renewable energy and minigrid developments become a national topic of conversation which meant we were able to bring in other topics such as efficiency and new policies. -Millicent Lewis-Ojumu

Many governments in Africa have ambitious electrification targets but unclear strategies for how to achieve them. With their access to private capital, willingness to take risks and variety of customer acquisition and service delivery strategies, the private sector is well positioned to play a role at the edges of the national grid or in areas where it does not make sense to extend a centralised grid.

Private utilities can solve this last-mile distribution problem. It's not about minigrids against the main grid, it is all part of the same holistic architecture. Our job is to get private utilities involved in that sector so that we can build that grid together. -Sam Slaughter

>> Is the private sector well placed to deliver productive use?

There are a lot of things a utility can sell besides electrons. They can sell a consumer experience, efficiency, appliances, consumer credit. -Emily Moder

The successful minigrid operator will move away from the idea of being merely a provider of energy to being more a provider of services.

SHS does this very well. They understand that energy is a service. They understand that people don't care about kWh, they care about how much light they get, can they run a radio or a TV?

Underneath this talk of productive loads is the theme that the consumer comes first. What can we do to make the consumers life better? -Sam Slaughter

For many minigrid operators bundling services other than energy provision into their offering makes a lot of sense. In East Africa there are many examples of this. RVE.SOL sell services including biogas for cooking and clean water alongside their energy services and PowerHive are adding internet services to their energy provision offering.

The bundling of services will become increasingly important. In developed markets internet companies with fibre optic lines are encroaching on the phone business because the marginal costs of adding voice telephony to a broadband service is extremely low. Similarly the incremental cost of adding an internet connection alongside minigrid power services could be very low. You could see the same being true for water. The customer ownership is what will be expensive. The cost of customer acquisition for an internet or data company is significant and if utilities can bundle both power and internet, the case is compelling. -Sam Slaughter

Because they know their customers, private companies are in a good position to be an important building block in this new energy market. -Emily Moder

>> How do you stimulate demand and promote productive uses?

It is common in a new minigrid to see underwhelming uptake and energy sales. The average revenue per user (ARPU) can be so low that it can lead a developer to question their model: if usage of power is so low, is SHS a better solution? There are at least three ways around this problem. The first is the relatively resource intensive process of initial customer on-boarding and efforts to increase the local awareness of the services being offered. The second is time:

We saw a 50% growth year on year in energy consumption with no intervention. This comes from people buying new appliances, for quality of life and income generation purposes. -Emily Moder

Lastly, direct, targeted intervention can remove many of the obstacles in the way of people consuming more power:

As part of the program we did with Vulcan Philanthropy in Kenya we discovered that people did want to consume more energy and they had the income to pay for it. The limitation was access to capital [to buy the energy using appliances). This was the most commonly cited limiting factor for people increasing their energy spending. -Emily Moder

Providing access to lines of credit can be done in many ways, working with existing micro-credit institutions as Renewable World has done with Kiva on their minigrids around Lake Victoria in Kenya or providing appliances on credit. A number of companies including SteamaCo and PowerGen have had success with appliance leasing programs.

When you offer appliance financing, people most often use it for income generating activities rather than lifestyle choices. -Emily Moder

These income generation activities will also directly and indirectly improve the business case for the minigrid operator as the local economy is stimulated.

>> The other benefits of productive loads

There are other benefits for the minigrid operator with increasing the proportion of energy that is used for productive uses. An important one is shifting energy use more towards daytime usage. This is key as power that is being generated directly from solar panels is essentially free for the grid operator, whereas delivering stored energy, as would be the case at night, puts strain on expensive battery banks that have limited cycle lives and roundtrip efficiency losses, where the amount of energy you push into a battery is less than you can subsequently pull out.

On one of our sites, [once we started actively stimulating productive use] day time use shifted from 50% to 70%. This is much better than generating demand at night. This is extra money for developers and means they can sell cheaper energy to consumers. -Emily

Private operators are uniquely positioned and particularly incentivised to innovate strategies that can increase the capacity usage of their installed equipment as in the case above, diversify their incomes and provide their customers with high levels of service. The fact that most operators will use internet connected smart meters and remote control systems also gives them a powerful set of tools to achieve this.

Four important things that these distributed utilities have are PAYG control, the ability to remotely switch lines on and off, the data that can approximate a customer's credit worthiness and the ***ability to change tariffs dynamically.*** *These are fundamental business building blocks. -Emily Moder*

The best way to use these tools is nuanced and will depend hugely on the business model of the operator and the geographic and cultural contexts of the site. There are many variables to be balanced to optimise revenues, improve utility and increase customer satisfaction.

Offering customers a TV that is twice as efficient, but charging them double per kWh means no change for the customer, it is exactly the same for them and is better for the minigrid operator. Likewise, you can sell them a TV that is twice as efficient but charge them less than double and everyone benefits. So there are interesting ways of figuring out what matters to your customer and give them those opportunities. Your business model will also benefit. -Emily Moder

One of the most fundamental levers available to the minigrid operator and one that has the most dramatic effect on energy consumed and customer satisfaction is the price of energy.

It is not enough to just drive demand on a site. As you drive demand, the tariff considerations change significantly. For instance you might be able to charge a dollar or two per kWh for someone to run a TV, but to someone running a light commercial load, you're going to have to charge 50 cents. You'll have a lot less margin on each unit of energy, but you'll sell a lot more of it. What does that mean to the economics on a grid? -Sam Slaughter

>> Utility of energy

One of the most important concepts under-lining this question is that of utility. People will value a kWh of energy differently depending on what they will use it for.

It is not just a matter of maximising kWh consumed, it is the blended economics of maximising kWh and what those kWh are worth to your consumers. Blending consumer experience with the theory behind what tariffs should be given certain loads is a very big challenge. -Sam Slaughter

A rural householder, for example, might be using energy from a minigrid to power lights in the home, replacing kerosene lanterns. This user will experience much better utility from the electric lights as they are safer and not so polluting. They will also provide a much better quality of light than kerosene lanterns at a fraction of the cost. Thus, to the householder, who is offsetting harmful and expensive kerosene, the value of a kWh of electricity is relatively high and she would be willing to spend more on that kWh than a grid connected city dweller or a light industrial user who might otherwise be using a petrol generator.

>> So how much should you charge?

Be very skeptical if a public utility tells you that you are charging your poorest consumers too much. They are doing the same thing. Everyone charges the smallest consumers the most, up to dollars per kWh if you consider the monthly service charges that utilities use to hide their high kWh prices. -Sam Slaughter

This puts into question the idea of a Universal Energy Tariff, an idea often promoted by politicians eager to garner political support. minigrid operators should be allowed to charge a cost-reflective tariff and rural end-users should be allowed to pay what they are willing to pay for this clean, reliable energy. This is especially true if the other option is no access to electricity at all. A relatively light regulatory touch allowing minigrid operators to charge a cost-reflective tariff has shown to be a successful approach in many parts of the world, including Cambodia and Uttar Pradesh/India, where schemes were put in place to catalyse private sector minigrid investment and effective compensation schemes were put in place to reduce the long term risk of operators. For example, if the national grid was expanded into an area with a minigrid, the national utility would either buy the assets from the private utility or allow the private utility to buy the energy from the national grid at a wholesale price and sell it on to their existing consumers at a price that ensured they were still able to generate income.

Another key enabling tool available to national governments is to extend to private utilities the same subsides that are available to national operators. Most successful examples of rural electrification in the past (for example the electrification of rural America in the 1930's) was made possible through forward thinking legislation and the provision of subsidies to independent organisations.

We don't want rural users to be punished for being rural, so we do want to bring prices down. To do this we need to embrace subsidies for rural distribution networks, but not let them preclude immediate construction.

[We need to] encourage the private sector to build grids where they can and charge cost reflective tariffs as they need to, but make sure we're pushing for subsidies to bring the price to consumers down. Without subsidies the African rural consumer will be unique, they will bear the full cost of their power which has never happened on any other continent in the history of electrification. -Sam Slaughter

>> Build it and they will come

As the UN Secretary General pointed out at the launch of the UN's SE4All (Sustainable Energy for All) initiative, access to energy is a 'prerequisite for development'. Once again, thinking about minigrids in isolation is counter productive. They need to be considered as part of a holistic, development ecosystem: lights in the dark around which people and activity can gather.

We were interested to find out, from the Ministry of Agriculture that there were SME's and international companies looking to establish factories, looking for locations. They wanted to find out what would help support their factory. Access to power was a key part of this. We were very quickly able to identify that these businesses could be factored into our planning. -Millicent Lewis-Ojumu

International and domestic industries looking to set up manufacturing facilities in a rural area require some fundamental infrastructure. Minigrids can provide this, opening up a great deal of potential for rural development. It is also important to have a supportive local and national regualtory and politacl climate to catalyse the process.

We worked with the Ministry of Local Government who connected us to the local chiefs. They are now working on bylaws to make sure that there is collaboration across all the players and that this opportunity is realised. -Millicent Lewis-Ojumu

This cross sector collaboration facilitates processes on many levels and lifts many of the barriers in the way of electrifying rural areas, as does the appreciation for how access to reliable electricity is a fundamental building block for all sorts of development and fundamental catalyst for growth. Political gesturing however is not enough. Tangible commitments need to be made and adhered to.

We had a memorandum signed between the Ministry of Energy, the Ministry of Health and the Ministry of Local Government. In it we listed the obligations of each ministry and we followed that down to the level of the community. -Millicent Lewis-Ojumu

The notion of 'build it and they will come' can also be readily applied to the regulatory space. Progressive, evidence based policy making is often all that is needed to create conditions that attract the private sector, reduce perceived risk and unlock external investment. Nigeria's recent declarations of support for the off-grid energy sector are promising. As the Nigerian Minister of Power, Works and Housing, Babatunde Raji Fashola said at the ESMAP event:

"I see only opportunities in Nigeria, and not challenges, and policies have been developed to help entrepreneurs fast track energy access for underserved populations."

This was supported by comments from Damilola Ogunbiyi the Managing Director of the Rural Electrification Agency:

"With the current regulatory landscape, Nigeria is the best market to do mini-grids. The off-grid will be treated as importantly as the on-grid in Nigeria."

He also stated that the agency aims to roll-out 10,000 minigrids. The international minigrid community is watching closely. If this rhetoric is borne out in practice and these efforts prove to be successful, an enormous new market will open up and it will be a shot in the arm for the industry.

The Nigerian government has seemingly done an excellent job of creating a fertile environment for private utility companies to help solve the significant electrification challenge in the country. With the government a ready and willing partner, we hope that the funders will be able to learn from prior experiences and deploy their support in such a way that is readily usable by the private sector. We hope that sector funders will learn from successful light-touch subsidy approaches like those taken in the US and Germany for the solar industry and which catalyzed massive scaling of private sector activity.

The goal must be to cultivate companies who can develop, build, and operate utility projects in a scalable way. This company-centric approach is fundamentally different than power sector funders' traditional project-centric approach (and the onerous tendering and bidding processes that generally accompany projects), and we hope that they can adapt their strategy to fit the needs of the market. - Sam Slaughter

>> Utilise local networks

Having willing, cross-sector partners at the highest level is fundamental, but so too is a plan for implementation. As Millicent's experience with Ataya Base in Sierra Leone shows, there is often significant value in leveraging existing, grass-roots networks.

Ataya Base for Boys is an organisation comprising of men and women that exist in virtually every village across Sierra Leone. There are over 7,000 members and counting.

They are interested to become the guarantors [of minigrid services], the distributors. They will get the customers connected, they will encourage those with business opportunities and make sure people pay. They even have the ability to pay up-front for additional equipment or services, for example fridges or the equipment for barbers or hair salons.

The Rural Electrification Association are not spread out across Sierra Leone so cannot provide the follow-on [minigrid] technical support, so Ataya Base are filling this gap. They were recently trained by a Nigerian company to become technical support to these types of organisations. -Millicent Lewis-Ojumu

>> Utilise local opportunities

It is also vitally important to have a clear picture of what is happening on the ground; which areas and villages offer the most opportunity and which do not. A lot of the leg-work for this can be facilitated with geo-spatial tools that leverage satellite imagery and algorithms to characterise potential off-grid sites. These tools can only go so far however.

Out of 250 communities that were identified geo-spatially as off grid, only 114 were actually off grid. This shows the importance of on ground data verification. We have gathered a lot of high quality data - Lolade Abiola, Head of Renewable Energy at the Nigerian Rural Electrification Agency, 2017 ESMAP Conference

Some of the key indicators to determine the suitability of a site for a potential commercial minigrid are the presence, diversity and seasonality of economic activity and existing productive uses of energy that could be better catered for with power from a minigrid.

The best case scenario is to go to sites where people are already using power and offsetting the use of generators. Your job might not be so much about creating new businesses but rather how do I offer this generator user better value than they are getting from diesel. That turns into a challenge of really understanding how their business works, not just how much power they are using, but what are they getting from it? -Sam Slaughter

A lot of the local benefits of access to reliable and affordable power will be realised a great deal further than the extents of the power lines. For local unelectrified areas, services that were once many hours travel away will now be available in the neighbouring village. For example Millicent has seen local entrepreneurs starting new businesses selling water and ice to surrounding villages.

The ability to feed and supply a network of local water sellers is very key for the communities. -Millicent Lewis-Ojumu

>> Rural Access - Outreach

As we've seen above, central to the concept of 'demand growth programs' is the idea of bundling services as this affects the bottom lines of the private minigrid operators directly.

As we show in our paper with Vulcan, if there is a minigrid developer out there who is not looking to make demand growth programs an integral part of their business model then think again. It is really critical and changes what the future looks like for minigrids in a substantial way. -Emily Moder

There are however many aspects of bundling services and stimulating productive uses that benefit from the appreciation of rural minigrids as being part of a much larger ecosystem.

One very important consideration is that of access. With the steady improvement of satellite technologies and the falling costs of both terrestrial and space based data transmission it is now possible to affordably provide internet services anywhere in the world. The prerequisite of course is availability of electricity.

One company built on the idea of bundling services alongside energy provision is SolarKiosk which, alongside selling products and business services,
"…provides the means for continuous communication and information exchange, with Internet access and the ability to stay updated with the latest news on the local, national, and international level. Access to information creates access to education and awareness; whether it is education on solar energy, water conservation, personal health & hygiene, disease prevention, environmental protection, or social awareness" -solarkiosk.eu

Research by Harvard University suggests that people retain five times more knowledge in up to a third of the time when trainings are delivered in an interactive manner engaging sight, sound, touch and repetition as delivered via multimedia technology. Clearly then, the modern technologies of a computer interface supported by an internet connection can deliver an effective channel of education. There is however the issue of connectivity.

One of the criticisms levelled against provision of internet services in rural areas is that because of the lower bandwidths available, the quality of service is inferior to that in well-connected areas. This does not always have to be the case however. There are a number of organisations such as TouchToLearn from South Africa that build technologies that allow access to rich content services in low-band width settings. The concept is very simple: rather than each user downloading content from the internet afresh, content (for example an interactive, video rich secondary school maths lesson) is downloaded onto a local server. Users can then 'download' the content they want directly from this local server at high speed and for no cost over wi-fi. This way rich content can be consumed, trainings delivered and examinations carried out remotely and without reliance on high bandwidths.

This conduit for information and interaction opens up many possibilities. Health organisations now have a channel to deliver first line services or medical advice and communicate with, train and supervise community health workers without the costs of having to send rural extension staff into the field. They can even pay people to take part in surveys or submit health information.

Local and national governments now have an outreach channel to promote rural inclusion, inform rural populations about central government issues or even conduct census activity.

When we went out to some of the villages we discovered that they had never been counted. Some of them had not been registered to vote. -Millicent Lewis-Ojumu

Rural development programs can be advertised and most importantly delivered. Aspiring teachers, nurses or even solar technicians can receive their first trainings in the places they live and organise and schedule trips to urban centres for follow-up training or examinations.

As a source of project income, the private sector can pay to deliver targeted advertising or conversely can deliver paid for services such as news or entertainment.

>> Rural Access - Inclusion

Occasionally there is a disconnect between the areas national government prioritise for rural electrification and the areas deemed to be the most suitable by the private sector. The national government might want to prioritise the most marginalised communities, whereas private developers might understandably, want to build projects in economically vibrant albeit unelectrified villages. It is a lot easier to build a commercially viable minigrid in an area with the obvious means to pay for your services.

Occasionally the non-minigrid private sector can be encouraged to provide services that are not core to their offering as a means of supporting local development and fuelling economic activity.

Recently got a mobile operator signed up to install five sites. They will provide not only mobile services, but specific mobile applications to enable the communities to trade. -Millicent Lewis-Ojumu

One of the more provocative ideas behind rural access is the idea of inclusion. With an internet connection, a rural village can contribute to and be a part of the global marketplace. Websites like Etsy allow users to sell their products or handicrafts to a global audience and there have been some success stories built on this model. However an idea that was discussed on the panel and that is garnering increasing attention is the opening up of entirely new, internet based revenue streams for villagers. Sites like Amazon's Mechanical Turk, ClickWorker or Microtask allow users with fundamental computer literacy to access the global marketplace, pitching for small pieces of basic work like data entry. For a drought stricken farmer with no social support structure, access to this alternative source of income could be life saving. EXPAND

Likewise, this new-found source of revenue in a village without access to year round income generation resources or activities might provide the income necessary to support a basic minigrid project.

>> Looking to the future

The world is moving away from a model of centralised power generation and large, one way distribution networks. This is not just a function of the falling costs and increasing availability of modular energy generation technologies. Increasingly consumers, both residential and commercial are attracted by the idea of energy independence, securing their supply and insulating themselves from utility price hikes. There are also significant efficiency gains to be made from generating and consuming energy locally.

There are already many examples around the world of the emergence of small scale localised energy markets. One example is the block-chain enabled Brooklyn minigrid in New York. Another is the Sonnen community in Germany which connects a number of battery and solar equipped houses with each other and the national grid. As well as generating revenue from selling excess power to the grid they play the very valuable role of buffer for the grid, absorbing peaking wind generator output during stormy weather for example.

We can talk a lot about the medium term challenges affecting our sector and there are many, but it is really exciting sometimes to zoom out and look at what we can achieve over the next couple of decades if we do this right.

We're seeing power all over the world change. We're seeing the old paradigm of one way shift of electrons being generated by big fossil fuel plants to consumers on the edge of grids change. We're seeing that the future grid look most likely like a multidirectional mesh network between consumption, generation and storage nodes. We see the future grid looking like a stock-exchange for electrons than a pipe for carrying commoditised kWh.

In this future grids, the consumers will be the main nodes. Not the power plants that sit upstream in some far away place. We're seeing this from big utilities in developed markets with big players making explicit strategy shifts away from large scale fossil generation to models that focus on distribution and consumers.

In Africa we have the opportunity to see where these trends are going and to reach them faster than the rest of the World. -Sam Slaughter

Utilities are changing everywhere in the world. As we are developing this new energy sector, we want to skate to where the puck will be, not where it is now. -Emily Moder