

Off-Grid-Industry Yearbook

edited by Harald Schützeichel



2017

Off-Grid-Industry Yearbook 2017
edited by Harald Schützeichel

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Preface



Sun-Connect News publishes since 2012 practice-relevant articles from renowned international authors of the off-grid business. With more than 8,000 recipients of its regular newsletter, Sun-Connect News is the largest information media of this young industry.

The most important and relevant articles of the year 2016 were selected for the present anthology, covering the entire spectrum of the off-grid business. The contributions do not provide a comprehensive handbook, but give suggestions, hints and tips. Some essays are also challenging, stimulate in-depth discussion or opposition.

I hope you enjoy this issue of the Off-Grid Industry Yearbook!

Freiburg/Germany, March 2017

Dr. Harald Schützeichel
Editor of Sun-Connect News

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Market

Bennett Cohen

The consumerization of energy is just beginning

In May 2015, Elon Musk revealed the Tesla Powerwall -- a stationary battery for homeowners that features essentially the same battery technology as Tesla's cars. Energy analysts pored over the specifications of the lithium-ion technology because of the promise it has to impact both transportation and electricity markets.

For most observers, the salient detail was the Powerwall's price. Weighing in at \$350 per kilowatt-hour, all-in -- well below the industry's expectations for battery cost evolution -- the device raised a lot of eyebrows.

What intrigued us most was that the Powerwall is clearly conceived as a consumer product. While its sleek design and hyped launch felt totally natural to those accustomed to following Apple, it served as a wakeup call to the energy industry: energy is being consumerized.

It's remarkable that fans went nuts over the launch of a battery -- a technology that usually just enables something interesting (like an iPhone) rather than being interesting in and of itself. Energy, the basic foundation of our prosperous lifestyles, is moving away from centralized power plants and closer to the customer. And customers choose winners and losers in radically different ways than do utilities or the other incumbents of the energy industry.

This disruption and consumerization of energy is being driven by a number of accelerating trends:

1. The shift from a centralized to a more distributed energy system architecture
2. The global drive toward lower-carbon energy

3. The rollout of the internet of things
4. Developing countries leap-frogging conventional power grids to consumer energy

From centralized to distributed energy

As Amory Lovins and I wrote about in 2010, the power markets are clearly shifting away from cathedral-like coal and nuclear power stations toward modular, mass-producible, and highly scalable micropower technologies -- renewables, like solar and wind, and efficient combined-heat-and-power systems (mostly fueled with natural gas).

The ascendancy of micropower is democratizing the future of the energy system, enabling everyone from individual homeowners to commercial and industrial customers to quickly select and obtain a portfolio of distributed solutions, avoiding the decade-long approval processes required to build multibillion-dollar coal or nuclear power plants.

The decarbonization of energy

The Paris climate agreement made at least one thing clear -- the world intends to shift toward a lower-carbon energy system. Technologies like rooftop solar and home batteries can significantly contribute to decarbonizing the power sector. Having just committed to emission-reduction targets on the global stage, governments around the world will find it hard to side with incumbents to slow the adoption of these consumer energy technologies. In fact, governments will likely promote

them, further accelerating the consumerization of energy.

The internet of energy

The internet of things is moving out of a phase characterized by hype and uncertainty into one of scale and impact. Many sectors will be impacted, including energy. A proliferation of sensors and controls will enable an intelligent and resilient energy system made up of myriad distributed energy resources. The internet of things will also create a platform for new business models that derive additional value from distributed energy resources for both customers and energy markets.

Leap-frogging energy

In countries like the U.S., we are slowly seeing a transition from the old energy system to the new. In contrast, developing countries in Asia and Africa are more often leap-frogging the centralized power system and going straight to consumer energy. Tired of waiting for a centralized solution to reach

them, customers in countries as varied as Kenya and Nepal are choosing to purchase consumer solar-plus-battery power products from M-Kopa or Empower Generation. For many families and communities in these regions, their first experience of reliable electricity will come from a solar panel on their roof and a small battery on their wall. Though on a smaller scale, these are the same essential technologies and concepts behind Tesla's Powerwall.

The consumerization of energy is just beginning, and it represents a profound shift in the way we power society. Opportunities abound for entrepreneurs and investors, but most of all for consumers of energy.

Bennett Cohen is a senior investment associate with Shell Technology Ventures and chairman of Empower Generation.

Inga Vesper

Electricity is a means, not an end

Development workers agree that access to energy is a game-changer. To a great extent, they are right. According to the World Bank, one in five people on the planet still have no regular access to electricity. They cannot study or work at night, face danger in unlit villages and cities and cannot access vital information technologies, such as phones and the internet.

To address this situation, a myriad of NGOs are occupying themselves with bringing electricity to poor and marginalised communities, or introducing gadgets that generate their own power. The last decade has seen the pay-as-you-go solar panel, the gravity lamp and the pee-powered toilet, to cite just a few examples. -

Yet, often the introduction of such innovations will not cause a development spurt. An event at the United Kingdom's Royal Geographical Society on 24 February tried to find out why.

One of the speakers, Simon Bransfield-Garth, presented research on how households respond to getting access to electricity. Bransfield-Garth is the CEO of Azuri, a company specialising in providing solar power to poor households in sub-Saharan Africa. Bransfield-Garth told the audience that the benefit of electricity is best measured in terms of what people do with it, not in terms of the amount of power that goes to each household.

According to his statistics, people with access to 5 watts of electricity will use it to charge their phones and power one or two lights. If they get access to 10 watts they will power an additional two lights and a radio.

If people get 60 watts of electricity, they will get a television set and a fan — to improve their quality of life. When they have access to at least 90 watts, people start to use electricity to power workshops, factories or farming equipment that helps them grow their business, for example.

"When people first get electricity it extends their working day by about three hours," he said. "The real game-changer comes when people are able to step up from a position without any technology infrastructure to a point where they can essentially access the same technologies as people in developed countries."

Sarah Best, a researcher at the International Institute for Environment and Development in the United Kingdom, pointed out that industrial growth is only possible when power supply is plentiful and secure.

"Governments measure access by looking at whether someone has a cook stove or a solar panel, but that's not what it's about," she said. "It's about whether it enables people to better their lives."

As the event drew to a close, this was the final message for the audience. When it comes to electricity, size does count, and what you do with it matters even more.

Inga Vesper is global news and features editor at SciDev.Net.

Daniel Tomlinson

Africa needs more than a one-size-fits-all energy solution

Imagine yourself as one of the 620 million people in Africa living day to day in the dark next to a toxic, dim kerosene lantern. You realize a sense of urgency to improve your family's situation with an openness towards reliable solutions. Resolving energy poverty for families in Africa and across the globe where collectively over a Billion people live with no access to modern energy services means a better and more stable world for everyone. However, examining the solutions to energy poverty seems to be stuck in gridlock - which is to say, focus is stuck on the grid.

The recent bipartisan lead "Electrify Africa Act" solidified the role of the United States to both develop Africa's energy market and help bring electricity access to the hundreds of millions of people living in energy poverty. Coinciding with the Act, Power Africa released their Roadmap outlining U.S. energy ambitions, including 40 percent of new connections coming from Beyond the Grid. This step signals we have made progress out of a unilateral understanding that energy only comes from a centralized source.

The International Energy Agency, the most cited authority on global energy, seconds this stance indicating that 60 percent of African homes will be served through distributed renewable solutions, a population which today is 370 million people or more than the entire United States. As we work towards resolving energy poverty we must embrace a hard-and-fast approach to apply diversified energy solutions that make sense according to context - this isn't a "one-size fits all" problem.

For example, an average rural family in Kenya allocates 30 percent of annual income towards securing a new grid connection, and others will never see it regardless of how badly they ask. This suggests we need to check our prejudice for how an energy poor household gets service.

All of us perform practical, situation-based analysis every day, like when deciding our mode of transportation. It's time we realize that energy is no different.

Energy solutions and transportation have a lot of similarities. We use a variety of solutions in varying contexts to arrive at our destinations. I appreciate energy services from the grid just as much as I appreciate riding the subway in New York City - it's cheap, it's efficient and some might argue it's the best service in town. But if someone asked me to go to Ngarenanyuki, a last mile village in Tanzania, I'd likely sit on the back of a motor bike taxi to get there - not ride the subway. Never mind that it's too expensive to build the subway to Ngarenanyuki and there are not enough customers traveling there to make the service remotely sustainable - let alone profitable; it just doesn't make sense. No one in Ngarenanyuki is waiting for the subway.

Yet when we look at much of the current thinking and discussion to bring modern energy services into the homes of billions of people in villages like Ngarenanyuki, many still resemble building subways where as people instead need something that makes sense. Energy poor families need a fast, cheap and reliable service delivery like a motor-

bike. Something that meets the energy demand today, not decades from now.

Distributed Renewable Energy solutions ranging from solar lanterns, home systems and mini-grids are the energy access equivalent of the motor bike – they are fast, cheap and reliable solutions that makes sense today, tomorrow and for possibly decades to come. Sitting around waiting for the grid could see a couple more generations grow up and go by in the dark – still many may never see it. And yes, distributed energy solutions all provide “real electricity” at introductory levels like clean lighting, cell phone charging and power to basic appliances like radios and televisions, all of which provide huge gains economically and to quality of life that are reflected in measures of human development index.

The challenge to develop Africa’s energy market and bring modern electricity access to the continent is immense. It constitutes an all hand on deck seriousness where solutions are aligned to the right contexts. This means central grid invest-

ments, increasing sustainable production and connecting households where possible. Where the grid is not feasible it means a range of distributed energy solutions that provide high-quality, high value service.

When we have distributed solutions to power the needs of communities that otherwise won’t have anything, we need to apply the same mature analysis we use when comparing efficient modes of transportation. We need to get out of grid-lock, get out from a one-size fits all mentality and embrace a steadfast approach that includes the range of distributed energy solutions. Billions of people are counting on it.

Daniel Tomlinson is an entrepreneur, author, researcher and expert in energy access.

Peter Penar

What lies behind Africa's lack of access and unreliable power supplies

Afrobarometer, a pan-African, non-partisan research network, recently released a report highlighting Africa's electricity challenges. Power shortages can hamper socioeconomic development, but they also have implications for health and education.

The Conversation Africa's energy and environment editor Ozayr Patel spoke to Peter Penar, one of the researchers.

How serious is the electricity crisis in Africa?

One of the most glaring disparities is that across the 36 countries surveyed, 94% of urban dwellers have access to the electric grid, whereas only 45% do in rural areas.

The urban-rural divide is most pronounced in Guinea, Mali and Niger. This suggests that major cities, including capitals, have fairly good grid coverage, but the outlying rural areas remain severely wanting.

The problem of accessing electricity varies greatly across countries. Many North African and island countries achieve high rates of access. But several countries have extended the electric grid to only a third or less of the country. Examples include Burundi (17%), Burkina Faso (25%), Sierra Leone (29%), Niger (30%), Guinea (31%), Liberia (31%) and Mali (32%).

West and East African countries lag behind other regions in extending the grid. Southern Africa is a mixed picture, with many countries falling below the 36-country average (66%). These include

Zimbabwe (62%), Namibia (62%), Zambia (50%), Mozambique (50%) and Malawi (42%).

The next step is whether the electricity grid actually connects to citizens. In some instances, the electricity grid is in the area but connections to dwellings are not present.

But even being connected to the grid doesn't ensure electricity supply. This is because power is intermittent. In South Africa 14% of those with an electric connection suggest that power never or only occasionally works, with even higher proportions in Zimbabwe (44%), Zambia (33%), Botswana (23%), Namibia (19%) and Kenya (15%).

Why is providing electricity so important?

Electricity is central to the broader development agenda. Without electricity it is unlikely that development projects and public investments, such as schools and community centres, can achieve their intended goals. The expansion of technology initiatives in rural areas, such as supplying laptops to students, will not be sustainable without reliable connections to electricity. Electricity is also essential for basic things like charging one's mobile phone or powering a household water pump and heater.

It has broader implications too. A lack of electricity prevents efforts to improve election quality, as the equipment for biometric registration and identification requires a reliable connection. For example, biometric voters lists couldn't be managed in some areas in Kenya's 2013 elections

because computers ran out of battery power by midday. They were unable to be charged at polling stations.

Any similar effort to employ technology in state administration in areas without the power grid, a connection or supply will be futile under the current constraints in many African countries.

A larger concern is that many countries, even more developed countries such as South Africa, have failed to engage in long-term energy resource planning.

Would it be better to extend the electricity grid in rural areas or to pursue renewable energy initiatives?

Renewable energy initiatives should definitely be part of national energy plans. Renewable energy production is generally good for the environment and may not require large-scale infrastructural projects and investments. But some initiatives need to be complemented by traditional approaches.

For renewable energy projects to work systematically, they must provide rural dwellers and the poor the same coverage and quality as on-the-grid electricity flows.

Another consideration is who is supporting and initiating these renewable energy solutions. African citizens and states must be equal partners and innovators in the energy sector, particularly as cooperation with other countries, such as the US (through Power Africa), increases.

How have North African countries and Mauritius done so well? Are there lessons for other countries?

These countries benefit from their geography and population distribution, and higher levels of economic development.

The fact that Mauritius and Cape Verde are doing well is most likely due to the fact that they are fairly small and easy to connect to a grid system.

In North Africa one factor is that, on average, the population is more urbanised and geographically centralised than in most sub-Saharan African countries.

This means that there's no need for extensive rural electrification efforts and the focus can be on urban areas. In addition, higher levels of economic

development may contribute to electrification. Unfortunately this suggests that the solutions to rural electrification will be hard to extend to sub-Saharan African countries.

Electricity isn't high on many African countries' priority lists. Why is this? What can be done about it?

Employment, effective health care, water supply, and agriculture and farming were all rated as more pressing problems than electricity. These are all highly tangible and involve basic issues of livelihoods.

The fact is that electricity is important to all of them. For example, investments in energy have the potential to create jobs to build and maintain the energy infrastructure. In addition, advancements in health care and water management will involve technology applications, with electricity being a prerequisite.

This is why it's important that civil society and grassroots associations explain to their governments that electricity should be a pillar of national development plans and that improvements in electricity supply support investments in other development areas.

Some countries are connected to the grid but still have electricity issues. In Nigeria, for example, 96% of households are connected but only 18% of these connections function more than about half the time. What can be done to improve this?

The gaps between grid extension and electricity supply are sizable for many countries, such as Nigeria, Ghana and Cameroon.

Although it is hard to generalise, part of the problem is government mismanagement of electricity resources and the failure to develop a feasible national energy plan. This involves seeking out a diversified supply of energy to meet increasing demand.

In the case of Ghana, citizens clearly blame government mismanagement for failing to supply electricity. This is clear from the fact that the proportion of Ghanaians saying they approve of the government's performance declined from 48% in 2012 to 23% in 2014.

The neglect from government is also rooted in inequalities in the countries. For example, in Nigeria the energy supply burden is shifted from the

government to individuals. To maintain electricity, those who can afford it invest in generators run on gas or diesel. Only citizens who can afford to purchase fuel for the generator and can find time to wait in long lines at gas stations – or hire someone to wait for them – are able to maintain electricity in the house.

Peter Penar, Researcher and PhD candidate in the Department of Political Science, Michigan State University.

William Brent

Policy, not finance, biggest obstacle to scaling decentralized renewable energy: Energy Access Summit

Renewable energy companies in emerging markets in Africa and Asia frequently lament the shortage of financing as the main barrier to scaling decentralized solutions, such as rooftop solar and mini-grids. But at a summit in early June, industry leaders singled out the lack of supportive national energy policies as the biggest obstacle to accelerated growth.

The decentralized renewable energy industry, which will play a central role in solving energy poverty for the 1.1 billion people (17 percent of humanity) worldwide without access to electricity, is booming, and significant advances in policy are being made. However, much more needs to be done, according to investment, business and civil society leaders at EnergyAccessX, an official initiative of the Clean Energy Ministerial (CEM7) held in San Francisco.

"Policy and finance have to catch up with technology," said Rachel Kyte, CEO of Sustainable Energy for All and special representative for the UN Secretary-General.

Policy and regulatory changes can have a transformative effect on energy access and result in more rapid deployment of distributed renewable energy. Such changes include dedicated electrification targets, and fiscal and other incentives that focus on specific renewable energy technologies (i.e., exemptions on value added tax (VAT) and import duties).

In recent months, many national governments

have expanded existing targets and policies for decentralized renewables or created new ones, global renewable energy multi-stakeholder network REN21 said in a report released at CEM7.

According to the report, Kenya, Rwanda, Sierra Leone and Tanzania all removed VATs on solar products. India removed excise duties on decentralized solar systems, and Uttar Pradesh (the Indian state with the most people lacking access to energy) announced plans to waive its VAT on solar energy equipment, while introducing a 30 percent investment subsidy for mini-grids.

Rwanda approved a policy that included a target of 22 percent of its population with decentralized systems by 2018, while Tanzania announced a target of 1 million solar installations by the end of 2017, which is expected to supply solar electricity to 10 percent of the nation's population and create over 15,000 solar jobs. Ghana launched a home solar program to provide electricity to 100,000 households. Sierra Leone has pledged to solarize at least 250,000 homes by next year.

But despite the progress, decentralized renewable companies still have to work overtime to find capital because of perceived policy risk. This risk "gives investors cold feet," said Cathy Zoi, CEO of mini-grid developer Axess Energy.

Nicole Poindexter, CEO at Energinicity, said that "policy framework to de-risk financing is the top need" to achieve universal energy access. This was echoed by Shell Foundation deputy director Prade-

ep Pursnani, who said "policy is a massive barrier," calling specifically for a disruption in tariff setting. Besides pricing, Poindexter said more policy clarity is needed around how decentralized assets will be treated if the centralized grid is extended, and around government expectations of service quality.

Disruption is also needed in government mindsets, added Richenda Van Leeuwen, the former head of UN Foundation's energy access initiative. Van Leeuwen stressed the need for more evolved thinking not just from energy ministries, but across governments, where other ministries responsible for health, education, finance and rural livelihoods are often more receptive and proactive on energy access. Policy reform must simultaneously be undertaken at the sub-national level, not just the federal level, she added.

Tarun Kapoor, joint secretary at India's Ministry of New and Renewable Energy, told EnergyAccessX that New Delhi was in favor of a policy environment that is favorable to private decentralized renewable energy companies, but those policies must ensure sustainability of business models. "Households are very used to the government," he said. "Even if the government wanted to run away, the people won't let us."

A consensus at EnergyAccessX was that a key to

achieving policy movement is providing stronger data and success stories, and making sure that the narrative of the transformative power of decentralized solutions not only comes from the private sector and NGOs working to solve energy poverty, but is peer-to-peer, i.e. from the governments which are actually doing the work to make it happen. It was also stressed that no single policy lever is the answer.

Gemma May, advisor to the Energy Africa campaign of the UK Department for International Development, pointed out that a single policy focus is unsustainable. "It's not any one policy, it's a suite," she said, reiterating the "need to tell stories on steroids."

"There are no markets without governments," said Hal Connolly, SVP of programs at the Climate Reality Project. "Clean energy is affordable, and it's a policy decision for every country. That's the story we need to make sure governments understand."

William Brent is currently a director at Power for All.

Daniel Tomlinson

It's time to change our definition of 'real' energy in developing countries

In recent months, GTM has played host to a debate about what delivering "real" energy means in developing countries.

I have long argued for the rapid scale-up of off-grid, pay-as-you-go solar as a faster way to deliver energy and financial services to those without access to the grid or traditional banking.

In January, Katherine Wolfram, a business professor at the University of California, Berkeley, argued that this model does not deliver "real" kilowatt-hours comparable in quality or price to the kilowatt-hours provided by centralized grids in the developing world.

But it's not that simple.

"It's like comparing apples and oranges," said Xavier Helgesen, co-founder and CEO of Off-Grid Electric. "Kilowatt-hours are irrelevant for off-grid solar. What is relevant are the quantity and quality of energy services delivered."

So what is "real" energy anyway?

Real energy is the amount of energy required to do what we want -- not some muscle-car measure of inefficient excess. It's not surprising that customers in rural developing markets like Kenya entering the modern energy world feel the same; they want enough energy to do what they want without it costing them an arm and a leg. When people talk about "real" energy, they're talking about an over-engineered model for the market.

"Imagine if other industries operated in this way," said Chad Larson, co-founder and CFO of M-

Kopa. "What if the only software that was available to run any type of business was a full-blown million-dollar Oracle enterprise suite? Oracle software is right for big companies, but a small business might run their numbers just fine in Excel. This idea is the same as assuming that most homes in Kenya need the same connection as a home in Kansas -- it's just not correct," said Larson.

Here lies the irony. A centralized system seems like it would offer the greatest return on investment. But that assumption is based on outdated economic thinking that's expensive, wasteful and ignores new technology.

"Some may fail to see where the puck is going, as Wayne Gretzky famously said," said Helgesen.

Here's where the puck is going: "An industry operating at scale that captures the decreasing costs of solar, battery and LEDs coupled with innovative financing and ultra-efficient appliances. We don't have to make a great mental leap to see that solar-plus-storage solves many more energy problems for many more households than it does today," he said.

The idea that household distributed energy services are not "real" energy misses the point. Companies like Off-Grid Electric and M-Kopa have already launched high-efficiency TV sets, satellite decoders and base energy stations that power these and other appliances in a way that meets customers' needs.

Companies are also developing high-efficiency

refrigeration and other white goods that run on single-digit load percentages. These and other similar breakthroughs are examples of reverse innovation that will challenge notions about power requirements.

"This is real delivery of energy as far as the customer is concerned -- they get exactly what they need, and not more, so they do not pay for more. From a rich-world perspective, it might not seem like the 'real energy' solution, but that is nonsense. You would not say that a small business running their numbers on Excel rather than Oracle is not using 'real software,'" said Larson.

When examining how we achieve universal household energy access, it is critical to assess the use cases of households and end-use efficiencies and not just the load capability and levelized cost of energy services.

As 1.2 billion people exit energy poverty and enter into the modern energy world, high-efficiency appliances and energy access services that are engineered to meet customer demands at the right price points are necessary to accommodate power demand at scale.

It's time we break with the calcified mentality that bigger is always better. Bigger and excessive is usually inefficient and expensive. We should instead think about how to stretch a small amount of power a long, long way and yet get more of what we want. This is accomplished through designing energy solutions and approaching energy challenges with a mentality that doesn't limit us to old thinking.

"The world is very different today than when Edison created the light bulb," said Helgesen. "Technological developments in efficient appliances and distributed energy are surpassing traditional energy distribution systems. Now is not the time to fix the grid -- it is time to reimagine it."

This is the kind of thinking that will bring universal energy access to the world.

Daniel Tomlinson is Access-to-energy entrepreneur and 2012 Echoing Green Fellow.

Izrael P. Da Silva

The four barriers for the diffusion of solar energy technologies in Africa: Trends in Kenya

The diffusion of Modern Energy Technologies (MET) in Africa has been found to be very low especially for solar energy systems. The installed solar PV capacity in Africa is a major issue of concern globally. This low trend in technology adoption is of global interest because Africa enjoys some of the best solar radiation levels in the world averaging between 4-6kWh/m²/day for most of the year.

It was initially speculated that the low uptake of solar technology was associated with the continent's high poverty levels and low awareness of and limitations in technical capacity; nevertheless, the introduction of Mobile Telephony Technology (MTT) has cast some doubt on those speculations due to the rapid assimilation and diffusion of the technology in several African countries. Lack of suitable environment, lack of affordable funds, lack of awareness and lack of capacity building seems to sum up the barriers to PV penetration and thus explain the African PV paradox whereby the best served countries in terms of solar radiation are the lowest in terms of PV installations.

Introduction

The diffusion of solar and other modern energy technologies (MET) in African countries is considerably low with the solar penetration rate rising from 1% in 2010 to between 3% and 4% in 2013. Paradoxically, countries on the African continent that lie within the Sunbelt region are expo-

sed to the best solar radiation regime globally, receiving between 4 and 6kWh/m²/day in most months of the year.

The Sunbelt is defined as the region of the planet that is found within $\pm 35^{\circ}$ latitude. Incidentally, despite having the best solar resource, this region makes up only 9% of the global installed PV capacity today. Moreover, the Sunbelt region is home to 75% of the world's population and represents 40% of the global electricity demand. In essence, the region has the highest demand for electricity services today and 80% of the expected global electricity demand growth will come from Sunbelt countries.

In addition, a survey carried out by the European Photovoltaic Industry Association (EPIA) in 2010 into 66 countries within the Sunbelt region revealed that the region actually had the potential to achieve an installed solar PV capacity of 1.1TW by 2030. However, the EPIA report indicated that several changes and actions would be necessary in order for such an ambitious capacity to be achieved. This projection is pegged on significant changes in the regulatory issues in the 66 Sunbelt countries as well as significant drops in the LCOE from solar systems.

In the past, the poor diffusion of MET in the developing countries - particularly in rural or remote areas - was attributed to poverty and ignorance. However, recent market dynamics have challenged this theory in that the Mobile Telephony Technolo-

gies (MTT) industry has had great success in market penetration in the same environments and under tougher conditions due to the lack of subsidization or donor support.

In order to identify major challenges of solar technology diffusion in Africa, a review of previous documentation into the subject of the penetration of METs in Africa was undertaken. Special emphasis was placed on solar energy technologies and the limitations of adoption in the Sunbelt region as opposed to the regions outside the sunbelt zone that have had better performance in the implementation of solar energy projects, despite having limited solar energy resources.

Once the challenges on the global scope had been identified, more reviews were carried out to find out what the specific challenges were in the regional settings. These reviews saw the evaluation of factors affecting the penetration of MET in Kenya and Uganda. As it was identified that the penetration of METs was significantly surpassed by the diffusion of MTTs, a study of the factors that contributed to such a variation was warranted. For this study, a review of research carried out to investigate the diffusion patterns of the MTTs versus the METs was undertaken in order to compare the two technologies and pick out key lessons.

The four challenges facing diffusion of METs

The limited diffusion of solar technology in Africa can be attributed to a wide range of factors associated with players on every level of the value chain from the end user through to the investors. Despite the global viability and growth in the solar energy market in the developed world, African countries continue to lag behind, representing less than 1% of the market demand for solar energy.

A study carried out in Kenya in 2013 (Lay et al., 2013) sought to define the cross-sectional energy ladder as it applies to the choice of lighting fuel in Kenyan households. The various factors affecting this fuel choice were examined, and were found to include education level and income bracket of the household heads, the average household expenditure, ownership of the dwelling, potential grid access, rural/urban setting of the household and the prevalence of solar home systems (SHS) in the area.

The leading factors affecting the transition from traditional to modern fuels for lighting were found

to be the income levels, level of education and proximity to existing SHS. These results were corroborated with other studies in order to zero in on the larger factors at play in the African countries. Furthering Africa's research into the penetration of Pico PV lighting systems in rural Africa, a similar array of challenges were unearthed, including Access to Finance, Distribution Challenges, Consumer Education, Market Spoilage due to substandard products, Government Policies and After Sale Support.

Consolidating the factors listed in these reports, we found that the challenges affecting the growth of the solar energy industry in Africa can be grouped into the following four categories:

1. Enabling environment
2. Access to finance/affordability
3. Awareness
4. Access to technical support services

1. Enabling environment

An enabling environment refers to the prevalent conditions in a country or region that support the growth of the industry in question. The enabling environment is mostly a function of the national government and regulatory bodies. National policies are an effective way to gauge the viability of a business model from one country to another.

In Europe and the US, several solar energy projects came to realization due to subsidies and tax breaks as well as other supportive policies in the early stages of development. In 2012, nine of the 10 leading countries in solar power installations saw a drop in small-scale investments in the industry because their governments cut back on subsidies.

Kenya's Energy Regulatory Commission (ERC) develops new energy generation centres based on the Least Cost Power Development Plan (LCPDP). The latest version of the LCPDP, released in March 2011, covers the 20-year period from 2011 to 2031. Methodologically, the report utilizes a least-cost planning approach aimed at delivering the required level of electricity supply at any given point in time at the lowest overall economic cost.

Looking closely at the LCPDP for Kenya, it is clear that there is no provision for the generation of electricity from solar energy resources at any point in the projected 20-year period. The decision to omit solar energy sources from the electricity

supply projections was based on previous assumptions that rendered solar too expensive in this setting. The LCPDP consequently stresses the "great potential for the use of solar energy throughout the year because of [the country's] strategic location near the equator" in its current state, the plan limits the solar energy applications to SHS, solar water heating and other off-grid uses in rural areas far from the grid.

This exclusion clearly sends the message: "We are not interested in Solar Energy!" to the industry. However, this stance is changing because of support for solar energy from the European Union (Africa EU Energy Partnership) and the Powering Africa from the American Government.

2. Access to finance/affordability

Access to finance has been defined as the most significant challenge to the penetration of solar energy technology in Africa. The effects of limited financing options are felt on all levels of the distribution value chain from the manufacturer through to the importers, distributors, dealers and finally the end user¹¹. The lack of detailed information about the solar industry in African countries is a major impediment to foreign direct investment. Limited awareness of market trends and rates of return along with the fears of political instability raises the risk elements for investors.

These factors lead to the development of a 'High Perceived Risk' level that results in overall investor uncertainty. However, in 2012, investments into the solar industry in developing countries went up by 19%, resulting in the introduction of \$112 billion into the market. This was the highest ever investment in solar energy in Africa.

The limitations of Access to Finance can also be attributed to the Cost of Capital which has emerged as a major impediment to the growth of the solar energy in developing countries. Cost of capital is the cost of the funding used to finance a business and is dependent on the mode of financing as well as the policies at the firm or lending organization. It is usually determined by the ratio of the cost of equity to cost of debt capital used to finance the venture. It has been found that in Africa, high interest rates combined with the cost of technology and foreign expertise have greatly affected the cost of capital for solar energy projects.

Nevertheless, in 2012, the share of foreign investment in the African solar industry rose significantly by up to 19% with Kenya being one of the major beneficiaries. At the same time, investment in the US and Europe dropped a notch due to policy uncertainty and cuts in subsidies on renewable energy. These emerging trends could significantly affect the cost of capital in the region and further lower the LCOE of solar energy.

Furthermore, with strategic negotiations and financing models, larger solar projects can achieve a lower cost of capital in Kenya as well as the rest of Africa.

3. Awareness

Consumer education has been highlighted as one of the top three challenges facing the penetration of PV systems in rural areas in Kenya and the rest of Africa. There is a great need to raise the awareness levels of the target market of the energy generation options available and their benefits, as well as the hazards involved with using the more dangerous dirty fuels to light their homes. The shortage of entrepreneurial skills and entrepreneurial capacity in the energy sector has limited the marketing of solar products and other METs to the end user.

Finally, the aspect of awareness that is most challenging to overcome is caused by Market Spoilage. Market Spoilage occurs due to the presence of substandard products in the market. In a study carried out by the Lumina Project on LED torches in East Africa, it was found that 90% of the users experienced quality-related problems during the six-month study period. Poor-quality products, although cheap, increase the difficulty of market penetration because the end users no longer trust the technology.

In 2009, Lighting Africa began testing the quality of solar products available in the African market. The study revealed that 13 out of the 14 Pico PV products in circulation did not pass their quality tests.

A second round of tests was carried out in 2012 when the number of products in the market had risen to 120. The results were similar in that only 46 of the products passed the quality tests. Consumer education is an expensive hurdle that has to be overcome for any solar energy product to develop a client base, especially in rural Africa.

4. Access to technical support services

Availability of technical assistance in the proximity of the end users is a key factor in countering the effects of market spoilage. The presence of technicians well versed in trouble-shooting, repair and maintenance of the MET systems in the locality increases the trust of the consumers. Due to the novelty of most of the solar energy products, it is important to develop local maintenance capacity in the area where the products are being marketed. Nevertheless, the scattered nature of BOP consumers coupled with their low buying power makes the notion of setting up service centres in the distribution regions unsustainable.

Conclusion

In order to develop solutions to counter the 'African Energy Challenge', innovative approaches

towards increasing the penetration of alternative sources of energy should be implemented on all levels of the value chain. Green credit lines, tax exemptions and the introduction of concepts such as Feed-In Tariffs and net metering (both contemplated in the upcoming Energy Bill 2015), training of technicians throughout the geography of Kenya and school campaigns can help mainstream PV penetration and make Africa the next big destination for the growing PV industries of China, America and Europe.

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Jacqueline Novogratz

Solving energy poverty through an off-grid solar electricity revolution

Energy poverty is an enormous challenge that we must address if we are to ensure universal access to affordable and clean energy. More than one billion people currently live without access to electricity. Changing this fact requires us to involve the entire energy ecosystem and combat the status quo within governments, the kerosene mafias and customers. However, the declining costs of solar energy and the ubiquity of mobile technology offer a unique opportunity to rise to this challenge.

Jacqueline Novogratz argues that we can make no more important bet than building an off-grid energy ecosystem aimed at providing energy to those living in poverty without electricity.

In a world of growing interconnectedness, we are forced to face the stark inequality of other's divergent experiences – including the impact of climate change on the poor. Sustainable economic development and global peace mean not just the absence of violence but increasing opportunity and potential for humans to thrive. To ensure universal access to affordable, reliable and modern energy services by 2030, the world can make no more important bet than on bringing off-grid solar electricity to the 1.2 billion people on Earth currently living in darkness.

Imagine a world in which the rooftop of nearly every household in the developing world holds a small solar panel to provide not only light, but

electricity to charge their phones, radios, TVs, and eventually, refrigerators, small appliances, and stoves. Even the lowest-income households would have access to basic electricity, thus saving money otherwise spent on kerosene. Imagine a world in which households far from the grid can access clean, affordable electricity by turning their rooftops into energy generators. As households increase energy consumption, they earn and save more, thus contributing to a positive trajectory.

Now, imagine micro-grids with smart meters linked to cell phones that utilise mobile payments; and new DC appliances, all of which could help households, enable small business creation, and encourage other increasingly productive uses of clean electricity. In Sub-Saharan Africa alone, 621 million people are not currently connected to the existing power grid.

Despite US\$ 31.5bn already committed to grid extension through 2018, progress on reaching the poor thus far has been particularly slow, expensive and reliant on non-renewables, including diesel and coal. Daunting as this may seem, the precipitous drop in the cost of solar energy and the ubiquity of mobile technology on the continent present an enormous opportunity. Since 2009, photovoltaic solar module prices have dropped more than 75%, contributing to rapidly declining costs across the solar industry.

Our work at Acumen over the last decade has taught us that low-income customers will pay for

products that are affordable and add value. d.light alone has brought solar products to more than 54 million customers and is currently on track to reach 100 million by 2020.

Companies like M-KOPA, Mobisol, and Off-Grid Electric are proving the growing demand and financial viability of pay-as-you-go in-home solar systems. These are just a handful of the successful innovations of the past few years, both in the technology and in the business models that bring such products and services to market. In the midst of these rapid changes, it is possible to see off-grid solar energy not simply as a bridge to the grid, but as a destination in itself.

However, the accelerated evolution of this sector has revealed a number of ways in which this energy ecosystem is broken. This affords a challenge and an opportunity to rethink the ways that we can support its successful maturation. The primary obstacle is that governments are too focused on the historical solution – extending the existing grid – which is extremely expensive, and will likely take decades instead of years.

We have had some limited success in moving millions of people to the first rung of the energy ladder to solar lighting, all with a private sector approach. But the prospects of successfully scaling this model without involving the entire energy ecosystem are unclear. Large chunks of the value chain – mainly in marketing and distribution – remain missing or weak. There are too many small, mostly under-funded companies trying to do too much with too little capital.

Entrepreneurs building an off-grid energy ecosystem will have to combat an entrenched status quo in three areas: government, with a vested interest in extending the grid; diesel and kerosene mafias; and customers themselves, who know the ins and outs of working with biofuels every day. Fear of change is the greatest ally of the status quo, but intrepid entrepreneurs committed to leading the charge have an opportunity to offer an attractive alternative to the people who need it most.

The international community will need to leverage two trends – the falling cost of solar, and the advancements in mobile technology – to move distributed solar energy sharply beyond this inflection point. The falling cost of solar allows high-quality, affordable, and most importantly, scalable

solutions to be made available to consumers as they move up the energy ladder. Mobile technology advances enable access to and engagement with those same consumers through metering, billing, and payments enabled by their existing mobile networks.

There are a number of ways to accelerate this new approach, but it is paramount to take a human-centred approach that recognises the poor as customers instead of passive recipients of charity. Before we provide solutions and support demand, we must understand the energy needs of the poor, their purchasing power and how we can move them up the energy ladder and into the modern energy market.

Social enterprises are closest to these low-income customers and are driving innovation to find faster, more efficient solutions to provide the poor with new opportunities and the promise of a brighter future. But we need to bridge the funding gap by investing catalytic capital in this under-invested sector. That will require a mix of strategic grants and long-term investment capital. The more precious of the two is grant capital structured in a way that can leverage significant private investment.

To grow these companies, entrepreneurs committed to serving the market require a unique mix of early-stage start-up capital (financed by philanthropic-backed patient capital investors), working capital (which should at least in part be made available in local currencies with government guarantees, credit enhancements and other concessionary vehicles) and consumer financing. Guarantees should also be utilised as incentives for local banks to create working capital facilities in local currencies – something woefully absent from the African energy sector, particularly in countries with significant devaluations of their currencies.

Specifically, grant funding is needed to create first-loss reserves to make bets on making the off-grid market more attractive to private investors. Grant capital is also important for technical assistance, both for management (building real talent in this nascent sector, especially at middle and senior levels) and for the R&D needed to bring better, lower-cost technologies (metering and batteries) to the market to help companies build upon their models and attract outside investment.

At the macro level, governments will also have a substantial role to play in ensuring an enabling environment for early-stage energy companies operating in developing markets. Reducing tariffs on imported components and guaranteeing bulk orders for solar products can facilitate more ambitious research and design while concessionary financing and discounts can lower prices even further.

This will not be easy. Igniting a solar revolution aimed at the poor will require innovative funds that invest in and support solutions across the energy ecosystem.

Long-term investment funds combined with adequate technical assistance funding will enable a focused, accountable push not only to strengthen individual companies but to build solutions across the value chain – from marketing, financing and distribution to service/repair. Used correctly, these funds can create the models needed to show the world that off-grid solar solutions not only transform billions of lives but do so in ways that are

cheaper, more efficient, faster and cleaner than by extending the traditional grids.

The success of the full off-grid solar ecosystem will provide energy access to large communities in a financially and environmentally sustainable way. In addition to the direct impact on the lives of millions of people, a fully functioning ecosystem will prove to governments and the market the value of this model for the future.

We have a chance to solve long-term energy poverty and avert a climate crisis. There is no better way than ensuring universal access to clean, affordable electricity. We don't have dignity unless all of us have dignity, and there's no better bet we can make than this.

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Sohail Hasnie

Off-grid solar can be game-changer for electricity access in Central Asia

Solar rooftops are popping up everywhere. Many consumers in the developed world are generating and producing their own electricity, and leaving their grid connection as a lifestyle choice. Off-grid electrification is today a viable alternative to grid-based electricity.

Unfortunately, more than 700 million people in Asia and the Pacific still have no access to electricity, and a large number of them are in two Central Asia Regional Cooperation (CAREC) Program member countries: Afghanistan and Pakistan. People living in the remote mountainous areas of other CAREC countries also have poor access to reliable electricity.

Pakistanis alone spend about \$2.3 billion annually on candles, kerosene lamps, and battery-powered flashlights. Kerosene lamps cost up to 30 times more than the inefficient incandescent bulb, and 100 times more than compact fluorescent and light-emitting diode (LED) lamps. In some poor households, kerosene may account for up to 25% of their family's monthly income, and people in off-grid areas often travel to electrified towns to charge their phones for a fee. Furthermore, kerosene lamps emit toxic fumes, polluting the air inside homes and leading to lung and eye problems.

Kerosene lamps provide insufficient light for work or study, and their naked flames cause many accidents and injuries. Despite this, according to the World Bank on a global scale 1.2 billion people living without access to the power grid spend

about \$27 billion annually on fossil fuel-powered stopgap technologies.

Small (30–50 watt) off-grid solar lighting systems can be an alternative to kerosene lamps. A good example outside of CAREC is Bangladesh, where about 4.5 million households have replaced kerosene lamps with small solar home lighting systems.

Beyond lighting, modern life requires the use of mobile phone chargers, electric fans, televisions, and refrigerators. In off-grid areas, these appliances can only be powered either with electricity generated by diesel generators or a larger off-grid solar system with lead acid batteries. Both of these options are too expensive for the average household in rural areas in Central Asia. Diesel generation is an electrocution risk and requires expert knowledge to manage the generation set and a large fuel inventory for reliable supply, while lead acid batteries need replacing every 1–3 years.

Recent technological advances and price reductions in three areas—lithium-ion batteries, solar power, and energy-efficient appliances—have made larger off-grid solar systems more economically viable than extending the main transmission and distribution networks, especially in the case of expensive diesel generation-supplied grids. With this technology, millions of people may be able to stop using kerosene lamps and start producing their own electricity, leapfrogging the long wait for connection to the grid. As large solar panels have

become cheaper and suppliers of lithium-ion batteries are ready to provide guarantees for more than 5 years, it is possible to design a system that can power all basic modern conveniences in off-grid areas.

Off-grid solar may soon be preferred over grid-connected electricity, even in countries with 100% electrification. For example, a typical new connection in rural Afghanistan is estimated to cost about \$1,200 (plus regular payments for energy consumed), compared with a \$1,500 off-grid kit that includes power generation for basic appliances with no additional payment other than basic maintenance for 5 years. According to a recent World Bank report, the global market for off-grid electricity will be about \$3.1 billion by 2020, reaching about 100 million households. This is leading to a huge paradigm shift: off-grid electrification and micro-grids may no longer be a stopgap measure and even become the most affordable option in many developing countries.

ADB recently approved new funding for regional technical assistance to demonstrate the technical and financial viability of this new technology combination in the CAREC region, and encourage the off-grid community to move from basic lighting to a range of basic battery-operated appliances using larger solar panels and long-life lithium-ion batteries.

The development challenge is to create a market for low-voltage direct current (DC) appliances, quality batteries, and reliable solar panels in CAREC countries at reasonable prices. Solar panels pro-

duce DC electricity, and most off-grid systems convert DC to alternating current (AC), for which everyday appliances are designed. DC appliances are affordable and easily available in developing countries and online, but are not readily available in the CAREC region. In some cases, expensive low-quality products are preventing consumers in these countries from scaling up off-grid electrification. Other universal barriers—such as high up-front costs, lack of financing and awareness, institutional barriers, and perceived risks—will be assessed during implementation and scale-up.

The project will promote DC off-grid solar kits and equipment by demonstrating the viability of this technology, developing knowledge materials, and building capacities for mainstreaming this initiative. By using lithium-ion batteries and LEDs, the system will be safer and healthier than kerosene, produce brighter lights, extend product lives, and lower life cycle costs.

We like to hear about any similar initiatives you may know, and your ideas about our project. Off-grid solar is the ONLY way to bring electricity to all by 2020.

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Adnan Z. Amin

Off-grid renewables: the sustainable route to 100% global electricity access

For those of us living with electricity, it is easy to forget the social and economic impact of going without.

Power shortages cut economic growth by 2% to 4% annually. Households without electricity pay 60 to 80 times more per kilowatt-hour for energy-related products - like charcoal, candles and kerosene - than people in New York or London.

Health clinics without electricity struggle to refrigerate medicine and exposure to smoke from wood-fired cook stoves cause more than 4 million premature deaths each year.

Great strides have been made in recent decades to increase global access to electricity, but there is still too large a gap between the haves and the have-nots. More than one billion people - roughly 15% of the global population - still lack access, and to achieve access for all by 2030, the pace of expansion must double.

It was with this goal in mind that nearly 600 off-grid renewable energy practitioners and leaders from the public and private sector gathered in Nairobi, Kenya last week for the third International Off-Grid Renewable Energy Conference (IOREC).

The event was entirely focused on boosting electricity access through the development of off-grid renewables, as estimates suggest these solutions will provide the majority of additional generation needed to achieve 100% access.

After two days of discussions, panels and debates, it became clear that achieving universal access

through off-grid renewables has never been more possible than it is today.

We are already seeing early examples of off-grid success

In Bangladesh, a solar home system programme deployed 280,000 systems in six years between 2002 and 2008. Today, it deploys the same number in fewer than five months. The programme now benefits over 18 million beneficiaries - 11% of the total population.

In Africa, M-KOPA Solar has connected more than 375,000 homes in Kenya, Tanzania and Uganda to solar power with 550 more added daily. For a deposit of USD 35, buyers get the system then make 365 daily payments of \$0.43 through mobile money system M-Pesa. When it is all paid off, the system belongs to the buyer.

So why are these solutions booming? The promise of off-grid renewables is broadly captured by three main cases:

Thanks to dramatic cost reductions in recent years, renewable technologies are now the default cost-competitive choice for off-grid installations, both stand-alone and mini-grids, in most rural and peri-urban areas. They can be significantly cheaper than diesel-fired generation or kerosene-based conventional lighting.

In Bangladesh for example, the solar home programme replaces 242,000 tons of kerosene, saving \$300 million annually. Likewise, if Nigeria used

modern off-grid lighting solutions, it would save more than \$1.4 billion annually. What's more, costs are expected to decline even further in the coming years.

The social and environmental case

The deployment of off-grid renewables directly creates jobs, and not just for the installers and those working within the renewable industry, but also for those who gain meaningful employment through industries created from newly gained access to reliable electricity supply.

IRENA estimates that at least 4.5 million jobs can be created in the off-grid electricity sector by 2030, in positions ranging from entrepreneurs and technicians, to installers and distributors.

Efforts made to increase energy access also benefit other sectors critical to human development. Access to electricity can improve the accessibility and reliability of the water supply for drinking and irrigation. Solar irrigation solutions can help increase farmer yields by 300%. It can also facilitate extension of basic rural healthcare services and enable the outreach of telecommunication services in rural or island contexts.

Another compelling case for off-grid renewables is the impact, or rather lack of impact, it has on the environment. The energy sector accounts for two-thirds of global emissions. As such, any effort to reduce emissions and mitigate climate change must focus heavily on decarbonising the global energy system.

IRENA research has found that doubling the global share of renewables by 2030 to 36% - combined with energy efficiency measures - would cut emissions to the level required to stay on the two degree pathway as enshrined in the Paris Agreement.

Development with off-grid renewables offers a path to leapfrog the polluting route historically taken by developed economies -- one that is not even a feasible option for countries of certain sizes and regions of the world.

Small island states are particularly affected by climate change, and for many of the 750 million people living in the inhabited 10,000 islands around the world, the means or resources for large-scale energy production and a national grid connection are limited.

In these cases mini-grids powered with diesel

generators offer a route to energy access. Incorporating renewables into these mini-grids through the addition of solar PV, wind turbines, biogas and particularly biodiesel, is an attainable goal.

Innovative business models driving growth

Thankfully, the strong business case for deploying off-grid renewables in rural areas is driving innovative business models, which is encouraging growth in the sector.

Key market development initiatives, including the Green Mini-Grids Market Development Programme, Beyond the Grid Initiative, and the ECO-WAS Programme on Access to Sustainable Energy Services, are steps in the right direction. But to achieve scale, off-grid grid renewable energy development must transform from a project-by-project endeavour to one that is market driven, a message that resonated strongly at IOREC last week.

This will require collective efforts to create an enabling environment that supports the scale-up of energy access efforts through private sector participation. This includes adopting an effective policy and regulatory framework, along with tailored business and financing models and adapting technologies to the rural context.

If the enabling environment is appropriate, off-grid solutions can be deployed rapidly to extend electricity access for meeting basic needs but also for promoting productive uses. These enabling policies can also create a more secure environment to encourage investment. We currently invest \$9 billion a year on energy access, but five times that is needed to achieve universal access.

But this investment is coming in - in fast-increasing volumes. In the last three years, investments in the off-grid solar sector increased 15-fold, and private sector players are raising substantial financing from impact investors, private equity funds, corporates, government development finance, donors and crowd funding.

'A practical, actionable solution to today's most pressing issues'

These early examples demonstrate that, with the right policies in place to spur investment, off-grid renewables can offer a practical, actionable solution to today's most pressing economic, social and environmental issues.

This complementarity presents a compelling

case for policy-makers to adopt a more holistic approach to energy access and to include off-grid renewables as a means to stimulate economy-wide development, fight poverty and improve livelihoods, and protect the planet from the dangerous effects of climate change.

Adnan Z. Amin is the Director-General of the International Renewable Energy Agency (IRENA).

Andrew Herscowitz

4 Lessons from Power Africa

This month, dozens of African heads of state and CEOs from the United States and Africa gathered in New York for the U.S.-Africa Business Forum—three years after President Obama launched Power Africa, a U.S. government-led partnership that aims to double access to electricity in sub-Saharan Africa. Here are four key lessons we've learned since the launch of the initiative:

1. Renewable energy is cost competitive with fossil fuels.

Solar power is being offered at 3 and 4 U.S. cents per kilowatt hour throughout the world, but countries in Africa continue debating whether to prioritize the development of their sometimes vast fossil fuels or to focus on renewables to generate power.

These vibrant domestic debates regarding countries' proposed power development paths are good because there's no easy answer today. Usually, the answer is that the country should develop both.

It's true that the economics of renewables are becoming more compelling as technology improves and prices come down. As countries link to one another through transmission lines, they are better able to balance the power load shifts often associated with renewables, and the interconnections allow even small countries to harness indigenous renewable resources at scale by creating a larger market. As battery storage improves and comes down in price, the case for renewables that can

offer baseload power becomes even more compelling.

One study has suggested that more coal plants in Africa will be decommissioned than commissioned starting in 2025—less than 10 years from now, while gas and renewable generation will continue to grow. Today, solar power projects already can be up and running in less than two years, compared to the five- to 10-year timeframe for other large fossil fuel and large hydropower projects. And very large projects—fossil fuels or renewables—often are delayed and can have significant cost overruns.

What's clear, though, is that the era of renewables has arrived, and everyone should be looking seriously at these projects.

2. The best price isn't always the best value.

When developing power, quality is important. The same government officials making procurement decisions do not buy the least expensive computers, mobile phones, etc. for themselves. They buy the best products. No one should saddle a country with poor quality power projects that are not dependable and that will require expensive, unpredictable maintenance. The U.S. Trade & Development Agency (USTDA)'s Global Procurement Initiative helps policymakers make procurement decisions based on life-cycle costs and best value.

While every country should work towards competitive procurements, fairly negotiated and transparent bilaterally negotiated deals also can offer countries the opportunity to familiarize themselves

with new technologies and test the waters. Showing that a project can get across the finish line in a country will make the country more attractive to investment—driving down the cost of capital and making future projects even less expensive. Prices also will come down through competitive procurements and improvements in technology.

3. Energy is a commodity, and people will pay what it's worth.

Nearly every utility in sub-Saharan Africa is in dire financial straits. Raising electricity prices is politically unpopular, but what can be worse is when politicians heavily subsidize or even give away electricity to people who can afford to pay for it. Once someone gets something for free, they rarely want to pay for it again.

Poor people in rural areas are already gladly paying for off-grid power at sometimes several times the cost of equivalent grid power. Hundreds of millions of people in Africa pay for mobile phone services and sometimes even satellite television without subsidies. What people want is dependability. Nobody wants to pay for inexpensive power that gets cut off for hours, days, or weeks at a time. If the utilities were to charge the actual cost of power, they would have the resources available to develop a dependable power system.

4. Investments must be predictable.

Over the last year, we have seen commodity prices plummet and currencies in sub-Saharan Africa fluctuate greatly, making the investment climate more unfriendly than usual. But these macroeconomic factors can be priced into a deal. Unpredictability however, cannot.

When a government official suddenly cancels a negotiated agreement after a project developer has invested millions of dollars or when the

government insists on new requirements that will scare off investors, governments only hurt themselves. The African market comprises more than 50 countries, and investors will place their bets on countries where they have a dependable and predictable government counterpart. Among the most successful markets in sub-Saharan Africa for power investments is Kenya. Why? Because the rules of the game are clear and because investors get paid on time.

During the 2016 African Development Bank Annual Meetings, Rwandan President Paul Kagame urged everyone to take action because there is no good reason why everyone cannot have access to power. Africa has the natural resources and willing investors to help bring universal electricity access to the continent. We should all feel a sense of urgency to overcome the many unnecessary obstacles to moving deals forward and to lighting and powering Africa.

Power Africa's goals are achievable. Success requires strong, coordinated, and continued partnership. We all have a role to play to ensure that millions of people will not unnecessarily remain in the dark for decades to come. The countries that emerge from the dark will be those that offer a predictable, forward-leaning, open and fair investment climate. The Power Africa Tracking Tool (PATT), which is available for download on your Apple device, shows that there's real deal flow and real money willing to invest.

Andrew Herscowitz is the Coordinator for Power Africa (@aherscowitz).

Shamshad Akhtar

Energy access and a light-bulb moment: How stronger collaboration on renewables will benefit the Asia-Pacific region

The emergence of new ideas, technological advancements and innovative market-driven financing solutions has lent confidence to the idea that universal access to energy services is attainable. This is particularly good news in the Asia-Pacific region, where, despite making significant contributions to global growth and poverty reduction since 2000, nearly half a billion citizens still have no access to modern energy, principally in rural and far-flung areas. Three-quarters of these people live in South Asia alone. Some 70 per cent of the Pacific island households are un-electrified, a level similar to sub-Saharan Africa. The lack of electricity and clean cooking options marginalises predominantly remote and slum communities who are trapped in energy poverty, preventing them from stepping on the first rung of the ladder to prosperity.

There are a range of approaches, options and sources which, if effectively exploited, can help the Asia-Pacific broaden energy access. One of the game-changing elements for energy access is Asia's emergence as producer and provider of renewable energy technology, with investment in renewables reaching \$160 billion in 2015, accounting for over half the global total.

Renewable energy options are poised to reshape the energy access challenge. In particular, solar power with its low-cost advantages and wide-

spread applicability will play a major role, as it offers both grid-based centralised solutions as well as decentralised applications such as solar lanterns, solar home systems, and solar-powered mini-grids.

This year, three large-scale solar proposals in the Middle East and South America have contracted their solar-generated power for US three cents per kilowatt-hour, which is cheaper than any other source of energy. The marketability of solar energy further benefits from technological advancements in energy storage, driven by utility power and electric vehicle markets. These developments will have positive spillover on the energy access sector.

In many countries of Asia and the Pacific, the decentralised power option offers lower costs than extending the grid into remote locations, which influences long-term energy planning scenarios of countries. These options include mini-grids, hybrid systems, biogas and micro-hydro power, depending on costs, local geography and resource availability.

Reliability and scalability require an enhanced role of the private sector to find the most suitable local energy access solutions and to mobilise innovative finance and business models. Energy access solution providers already promote creative solutions, however, the private sector's role in the provision of energy access has been limited, accounting for only 18 per cent of total investment. To bring

private capital, technology and expertise to energy access, partnerships between public sector and multilateral financing agencies need to offer the right enabling policy environment and a combination of incentives including risk mitigation frameworks, loan guarantees, and other supportive credit enhancements.

The potential of private investment to promote energy access should not be underestimated. The so-called “bottom of the pyramid” energy users currently spend \$37 billion on energy services such as kerosene, batteries, or candles, which are often inefficient and more costly than clean alternatives. Many pioneering private sector firms have developed low-cost energy systems at household or village scale such as solar lanterns, biogas or micro-hydro systems, and are rolling out business models with product, process and distribution innovations. Across the Asia-Pacific, rural micro-credit is funding energy access, including Bangladesh’s Grameen Shakti which has funded half a million solar home systems. Development of indigenous technology capacity in Nepal has lowered equipment costs for biogas and micro-hydro systems. India has leveraged public-private partnerships in its rural electrification efforts, bringing electricity to 32 million households over the last decade. Local provision of energy can have a catalytic effect, leading to economic growth and increased demand for other

products and services that can be met by these companies, leading to growing business opportunities.

Achieving the goals of poverty eradication is critically linked to enhancing energy access for the poor. The recent adoption by G20 Ministers of the Action Plan for Enhancing Energy Access in Asia and the Pacific, supported by the UN Economic and Social Commission for Asia and the Pacific (ESCAP), will assist the region in adopting the appropriate policy framework to scale-up the private sector’s role in enhancement of energy access. As a follow-up to the G20 Action Plan on Energy Access, ESCAP, with the Energy Market Authority of Singapore, is co-organising an Energy Access Forum at the Singapore International Energy Week in October 2016. The Forum will provide insights on the challenges and opportunities for countries to enhance energy access.

Shamshad Akhtar is an Under-Secretary-General of the United Nations and Executive Secretary of the Economic and Social Commission for Asia and the Pacific (ESCAP).

Peyton Fleming

Africa's green energy challenge: Mega projects, off-grid or somewhere in between?

November 4, 2016 — A 310-megawatt wind farm sprouting up in a remote, barren landscape near Lake Turkana in northern Kenya has the clean energy world buzzing — and for good reason.

Africa's largest wind farm, with 365 towering turbines, is creating more than 500 stable jobs in an impoverished area where goat herding is often the only work available. It will boost Kenya's electric grid capacity by about 15 percent, at a far lower cost than the imported oil the local utility now uses. And when it begins producing juice next year, it will signal to investors and companies that big clean energy projects like this are viable in sub-Saharan Africa.

"The impact we're having makes me feel quite proud, frankly," says Philip Leferink, general manager of Lake Turkana Wind Power, who was all smiles when I met with him because the 142nd turbine had just been installed.

Megaprojects like these are deeply important for solving sub-Saharan Africa's colossal energy access challenges at the pace governments there want. But they are not the complete answer. They are often expensive, take years to build and can't reach everyone. In fact, the US\$700 million Turkana project has been in the works for nearly a decade and the exact timeline for finishing the key 270-mile (435-kilometer) transmission line is still in question. Moreover, all of the electricity is going to southern Kenya; none will end up in the power-

starved north, where high-polluting kerosene and charcoal are used for cooking meals and getting light.

So what is the best path to get electricity — preferably, modern green electricity — to the more than 1 million people in northern Kenya and 620 million people in all of sub-Saharan Africa living in the dark?

I recently spent 12 days traveling in Ghana and Kenya trying to find the answer. I was most interested in understanding the extent to which large, grid-scale renewable projects like the Turkana project can meet the region's vast demand for power and whether more attention should be focused on off-grid renewables and other decentralized green energy efforts, which are smaller and not linked to the electric grid. The extent to which the countries can grow their economies with renewable energy — instead of costlier fossil fuels, a huge contributor to climate change — was another key question.

One thing is clear, according to government leaders and non-governmental organization experts: Plummeting costs for off-grid renewables — over 80 percent since 2010 for solar photovoltaics — are a game changer. Look no further than the remarkable rise of M-KOPA Solar, a Kenyan company that has seized on Africa's mobile phone/mobile money phenomena (more than 90 percent of Kenyans use mobile phones and more than 70 percent are mobile money customers) to bring

off-grid household solar to 425,000 customers across East Africa.

A recent study from the public-private collective Power for All, which aims to accelerate rural clean energy globally, shows these off-grid technologies can be installed in half the time and at one-tenth the cost of large utility-scale projects. Yet despite this vast potential, off-grid power is being impeded by a lack of access to capital, particularly from the World Bank and multilateral development banks, which have long been predisposed to funding big-ticket projects.

"I have no doubt, this is a millions-of-homes proposition," M-KOPA founder and managing director Jesse Moore told a packed crowd of 500 at the recent International Off-Grid Renewable Energy Conference in Nairobi hosted by the International Renewable Energy Agency. "But we're still very much a sideshow."

Kenya: Leader in Renewables

Kenya is widely seen as a leader in Africa in pursuing renewables — both grid and off-grid projects — to tackle the energy access challenge. Three years ago, fewer than 30 percent of Kenyans were getting electricity from the country's meager 2,000-MW power grid, which was powered primarily by fossil fuels. (New England's population is less than one-third of Kenya's, yet its grid is about 31,000 MW.) To attract power plant developers, the government adopted policies like risk-protection guarantees, standardized power purchase agreements and feed-in tariffs — all of which help ensure satisfactory payments for power that is produced. The government is especially eager to tap the country's bountiful clean energy resources such as geothermal. A 280-MW geothermal power plant came on line in December in the Great Rift Valley, where the continent is gradually tearing apart and so providing easy access to hot water and steam below the surface, and several more geothermal projects are in the works. A new 55-MW solar plant was also announced in late September.

Government officials are pleased with the progress. "In just three years, we've doubled connected customers to the grid," Kenya's top energy secretary, Charles Keter, told the off-grid renewable energy conference audience. But he concedes Kenya will never achieve its universal energy ac-

cess goal by 2020 without off-grid renewables. "In areas far from the grid, such as northern Kenya, we have to find other solutions in the near future."

Companies like M-KOPA, Off-Grid Electric and Mobisol are already stepping in — all using pay-as-you-go business models to deliver off-grid solar services to millions of rural customers.

With a US\$30 deposit and daily 50-cent payments, all via the ubiquitous M-PESA mobile money transfer system, M-KOPA's customers get a solar panel, a couple of lights, a cellphone charger and a solar-powered radio. After a year of payments, customers own the system. Customers also develop a credit history enabling them to finance larger solar equipment that can run bigger appliances such as televisions and, M-KOPA hopes soon, small refrigerators.

As I walked with two sales representatives through Bandani, a poor neighborhood of mud huts, dirt roads and charcoal stoves in Kisumu in western Kenya, half a dozen people ask for M-KOPA brochures. Several others were already using the service. One of those customers, Consonlata Andhiambo Odero, lives in Bandani with four children in a tiny shack and runs a shop selling charcoal, eggs and bread. Discouraged by the constant power outages, she bought an M-KOPA system a month ago. Now she has two lamps for her shop and pollution-free light so her kids can read at night. "I'm very much excited," she says with a big smile.

In just five years, M-KOPA has hired about 1,000 workers who are pitching and servicing customers in three East African countries. The company's model is also being expanded to West Africa. But despite the company's growth, a number of Africans can't even afford the up-front costs. "The [US\$30] deposit, that's the biggest block," said Edwin Amollo, a field sales manager for the company in Kisumu.

Ghana: Catching Up

About 4,000 miles (6,400 kilometers) to the west, Ghana is adopting many of Kenya's strategies in expanding energy access. It lags a few years behind, especially when it comes to renewable energy. But the country is working to catch up.

Ghana's government is expanding its electric grid with new power plants, using feed-in tariffs, competitive bidding and power purchase agree-

ments to attract outside developers and investors. The biggest ones so far have been natural gas plants, which are being fueled by the country's first offshore natural gas field developed last year. Solar projects are also being added to the grid, but they're smaller — including a 20-MW solar PV project that went on line in April and a second 20-MW project awarded to a South African firm in September. Several more renewable energy projects are in the works up north, including a US\$4.5 million solar installation for an agriculture venture in Yagaba Basin.

Meanwhile, off-grid solar provider PEG-Ghana launched two years ago using M-KOPA's business model: It targets regions where people have no electricity or are dissatisfied with constant power outages, known locally as dumsors — and where mobile money is in common use.

"The reason we invested (in Ghana) was nobody was tackling West Africa at all," said Lauren Cochran, director of private investments at the Blue Haven Initiative, a Massachusetts-based investor that helped PEG-Ghana raise US\$7.5 million this year to expand its business in West Africa.

Forsaking northern Ghana — "It's too poor," says PEG-Ghana country manager Simone Vaccari — the company has set up 29 service centers in southern Ghana that have signed up 14,500 customers to date. Sales are growing 20 percent a month, and PEG-Ghana plans to expand to the Ivory Coast soon. "We're in a good space," says Vaccari, who hopes to have 100,000 customers across West Africa by 2018.

Expanding commercially viable clean energy mini-grids — small-scale, off-grid networks that supply power for individual villages or businesses — is a clear priority in Kenya and Ghana, both at the government and private sector levels.

Officials at the U.S. Agency for International Development's Ghana office say there's a lot of interest and potential with grid and off-grid solar, and they credit the government for setting renewable energy goals and enacting policies to encourage foreign investment. But it remains to be seen if the country can replicate Kenya's success with renewables.

Expanding Decentralized Mini-Grids

There is another huge hole that Kenya, Ghana and other sub-Saharan Africa countries must fill to

achieve their ambitious energy access and clean energy goals. While household solar systems like M-KOPA's show promise, what about businesses, manufacturers and entire villages looking for bigger renewable systems instead of relying on a spotty or nonexistent power grid? (Due to Kenya's unreliable grid, more than half of the country's businesses operate their own diesel-powered generators.) And what about food suppliers who lack refrigeration due to power outages and no electricity at all?

Expanding commercially viable clean energy mini-grids — small-scale, off-grid networks that supply power for individual villages or businesses — is a clear priority in Kenya and Ghana, both at the government and private-sector levels. And, again, Kenya's efforts are further along. This summer, the country's president, Uhuru Kenyatta, announced plans to install 23 solar mini-grids with 9.6 MW of capacity in remote northern Kenya.

Companies such as CrossBoundary Energy are building solar mini-grids for shopping malls, safari lodges and remote hospitals. "In Kenya, 70 percent of electricity consumption is businesses," says managing partner Matt Tilleard, who is also expanding the business to Rwanda. "That's our niche."

In Ghana, Black Star Energy is building solar mini-grids serving seven small communities in the country's Ashanti region. The company's first solar-powered mini-grid, in a cocoa farming area, launched last fall. CEO Nicole Poindexter says a key advantage of these systems is that they can run refrigerators, which are critical for solving regional food security challenges. Lack of refrigeration is a big reason why Africa loses enough food annually to feed 300 million people, according to the U.N.'s Food and Agriculture Organization.

A Money & Policy Issue, Not a Tech Issue

For all of their early promise, off-grid renewable solutions are still in their infancy. "We have miles and miles to go. Companies like M-KOPA are doing amazing things, but their market share is still de minimus," says Christine Eibs Singer, director of global advocacy at Power for All.

So what will it take for off-grid renewable solutions to seriously start filling the region's energy access gap? It's less a technology issue than a money issue.

Broadly speaking, Africa is not attracting nearly

the investment dollars it needs for energy projects of all sorts. Current energy-sector investments in Africa are about US\$8 billion a year; that's less than one-sixth the US\$55 billion a year that is needed to achieve universal energy access by 2030, according to a 2015 African Progress Report.

And, of the limited money that exists, very little is going to off-grid renewables, such as household solar and mini grids. From 2011 to 2014, only 11 percent of World Bank energy access funding and 1 percent of African Development Bank funding went to decentralized renewables, according to a recent Power for All report.

This funding gap was a clear sore point for participants at the Nairobi off-grid renewables conference.

"If 5 percent of that money went to our sector, you'd see millions more customers getting power far more quickly," says Graham Smith, senior director of new markets at Off-Grid Electric, a solar

start-up with over 100,000 East African customers that is relying mostly on private investment funds and venture capital to expand its business.

Power for All's Singer says aligning government policies and key financing institutions behind more balanced grid and off-grid renewable strategies will be critical in bringing green power to Africans more quickly and at less cost.

"For overall economic growth in these countries, you're going to need new large-scale power, but you can't see that as the only solution," she said. "There needs to be more deliberate and conscious integration of both centralized and decentralized solutions."

Peyton Fleming is Senior Director at Ceres (US).

Courtney Wisenbaker-Scheel

How solar can benefit emerging economies/countries

Economic growth differs vastly from country to country, with roughly 20 percent of the world's nations—home to 80 percent of the entire global population—being classified as an emerging economy.

Solar power, though, is starting to prove to be one of the great economic equalizers, and governments across the world are starting to notice. In fact, solar technology is now being installed twice as fast in emerging economies as it is in the rest of the world, and for good reason. Solar power is able to provide them with a cost-effective solution that is both stable and independent from outside influences, making it truly beneficial for any growing economy.

Energy Stability

When a country is struggling financially, there are only so many funds to divvy out and usually infrastructure tends to be neglected. That's why most citizens experience brownouts—a severe restriction on electrical access. Even worse, many communities will experience complete blackouts that can last for months at a time. In fact, according to a European Commission report from the Joint Research Centre, the number of people in Africa without consistent access to energy reached 589 million in 2008.

Many emerging countries have large regions that are so remote that finding way to provide energy for them is simply impossible. But solar power solves both of those issues. When solar farms are constructed—or when solar panels are

installed on homes or businesses—then spotty coverage becomes a thing of the past and location is irrelevant.

Competitive Costs

In economics, price all comes down to supply and demand, and thankfully, independence from fossil fuels is putting a high demand on solar manufacturers and making it an ideal industry to be in. Competition within the market has driven down prices enough in the past decade that solar power is now a far more attainable option for many households.

Considering that many of these families are spending 10 percent of their income on kerosene in order to light their home, transitioning to solar power has a dramatic impact on their life.

Energy Independence

Unfortunately, expense and supply consistency aren't the only major issues for emerging economies. Generally, these countries have been plagued by poverty and war for generations—which has made it challenging to maintain an open, central government, let alone a functioning energy market.

As demands for fossil fuels has grown internationally, it has become far more difficult for struggling economies to be able to maintain open access to fossil fuel driven energy supplies. Converting to solar power, however, flips that dialogue on its head. No longer is a government, business, or residence going to need to be reliant on outside

sources to meet their needs. Instead, economic independence and growth can be spawned internally and naturally.

We at Home Improvement Leads value sustainable energy practices like solar power and know what an extraordinary impact they can have, not just for a family's finances, but for the betterment of developing countries. And with the implementation of solar on both such a small and

large scale, the well-being of our environment looks sunnier every day.

Courtnei Wisenbaker-Scheel is author for Home Improvement Leads.

Sabi Magyari

Market development trends in the African solar PV off-grid sector

On the 20th of October 2016, Solarplaza organized the webinar “Market Development Trends in the African solar PV Off-Grid Sector”, as a preparation for our upcoming event: The Solar Future of Nigeria in April, 2017. The webinar featured a wide spectrum of experts who shared the most important current trends in Africa ranging from Itamar Orlandi, from Bloomberg New Energy finance, and Laura Sundblad, from GOGLA, to Eliza Hogen, from Lumeter; and also included Sam Slaughter, from PowerGen Renewable Energy, who gave insight into the possible future development of off-grid trends. The entire

video recording of the webinar and the speakers’ slides can be freely accessed here.

Out of the roughly 1.2 billion people in the world who do not have access to electricity, half live in Asia and the other half in Africa. However, while the number of Asians with no access to electricity has halved over the last 15 years, in Africa things have been getting worse, with an additional 211 million people who have gone off-grid since 1990 (Figure 1). This means that closing Africa’s energy gap has become imperative.

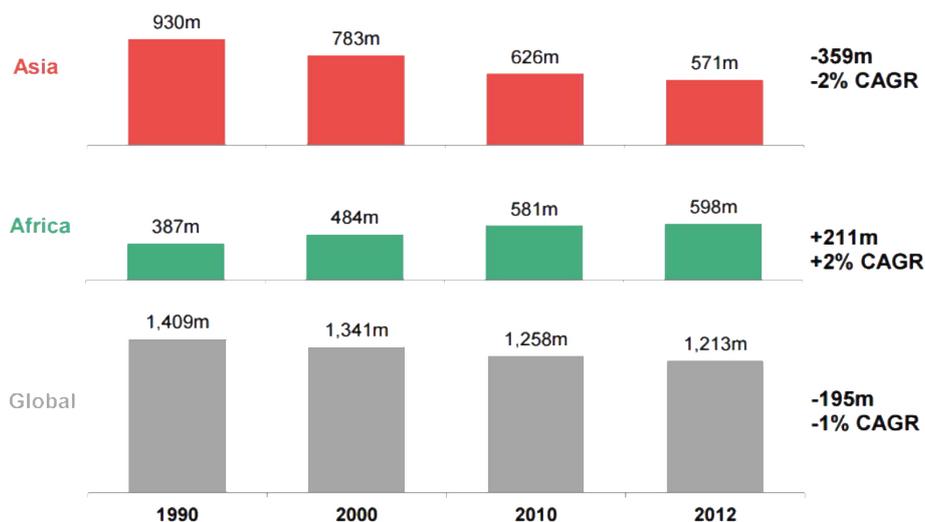


Figure 1. The off-grid population by region between 1990 and 2012 (millions of people)

1. Lower-income households are willing to pay premium tariffs for solar solutions

One of the most interesting take-away messages of the webinar, was that consumers are willing to pay premium tariffs for off-grid solar appliances despite the relatively low average household incomes in Africa. Itamar Orlandi, the head of applied research at Bloomberg New Energy Finance,

points out that non-renewable lighting devices such as torches and candles have remained to be less costly light sources than their solar counterparts, yet consumers are willing to pay up to \$6.5/month for solar appliances as they deliver better quality and more reliable light than their non-solar energy source alternatives (Figure 2).

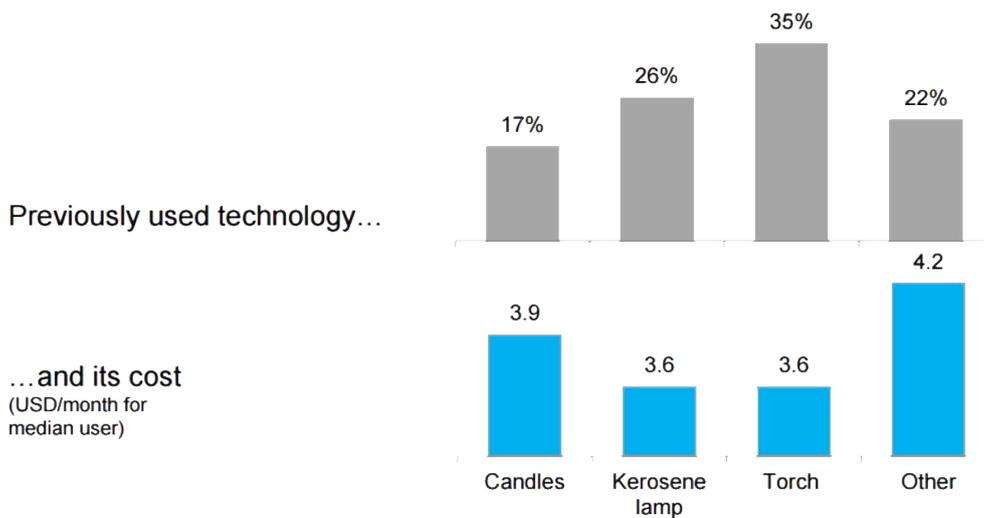


Figure 2. The prevalence of previously used energy sources and their corresponding prices in Rwanda.

2. Smaller is better. Small-scale off-grid products dominate the market in Africa

Another key finding regarding off-grid solar trends in Africa, is that small and medium, stand-alone solar energy appliances tend to dominate the market in terms of both sales volume and revenues.

In terms of volume sold, smaller products (0-10 Wp) are the most frequently sought products whereas in terms of revenues the medium product size category (3-10Wp) tends to be the most successful (Figure 3.) says Laura Sundblad, program adviser at GOGLA, an independent not-for-profit association supporting lighting initiatives in Africa.

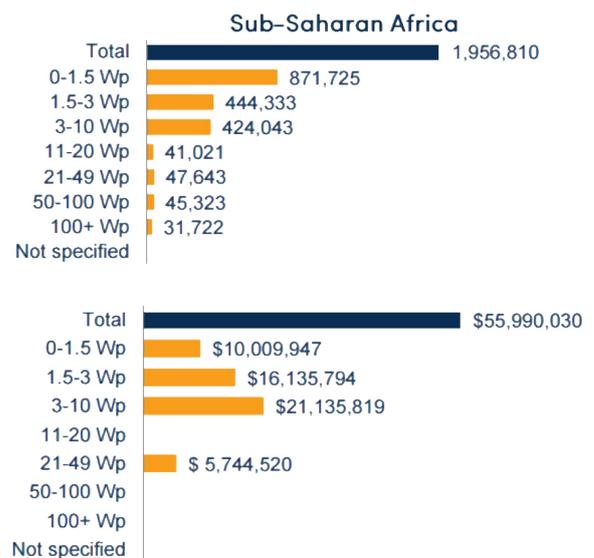


Figure 3. Volume and revenue sales figures in sub-Saharan Africa.

3. Despite its popularity, the PAYGO model still requires significant capital investment

One of the most remunerative business models for solar stand-alone systems is the Pay-as-you-go (PAYG) payment, where customers only pay for the actual electricity consumption. This model enables consumers to lease stand-alone products in return of periodical payments (Figure 4). While the model

fits the needs of low income African households, it requires significant initial investments from providers' side. As a result, the primary challenge for off-grid solar energy is the constant need for capital, identifies Eliza Hogen, CEO of Lumeter, a company that provides financing for off-grid products.

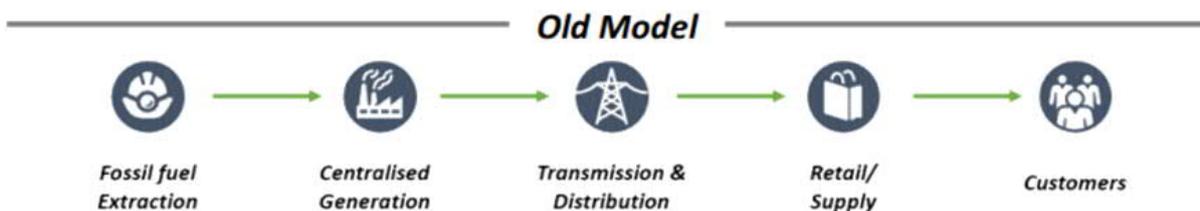


Figure 4. Business scheme of the PAYGO model.

4. Off-grid and on-grid solutions need to converge to create a successful energy structure in Africa

Sam Slaughter, CEO of PowerGen Renewable highlights the need for convergence of global power system architecture. He envisions the future power grid as a mesh of distributed storage, generation, and consumption nodes rather than its current mono-directional version (Figure 5). He

also emphasizes how Africa's power system cannot take on existing grid architecture of the West or take on a completely new one that is unique to Africa and unknown to the rest of the world. Instead of pursuing such extremes, Africa's power system has to combine on and off-grid solutions to be successful.



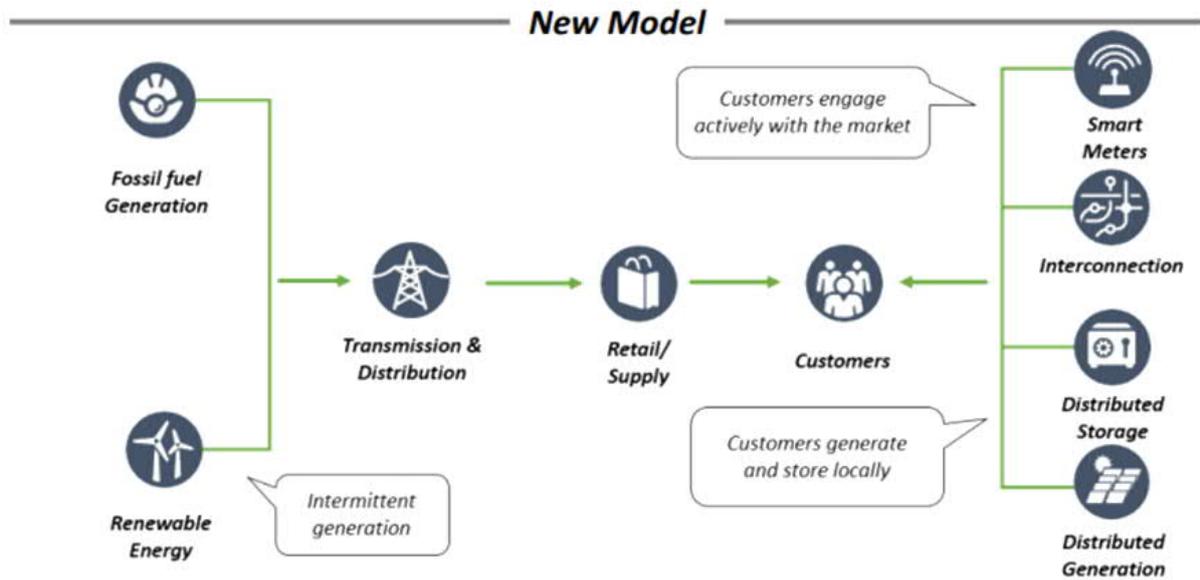
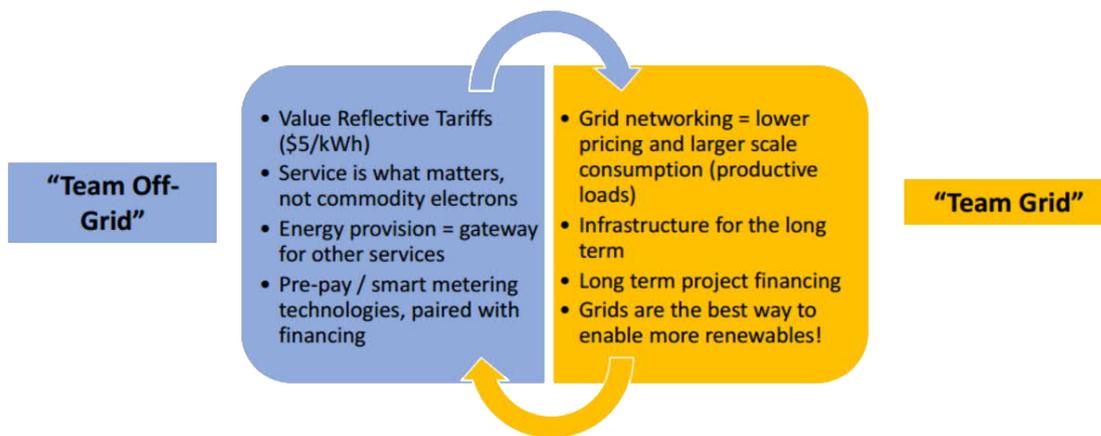


Figure 5. Future scheme of the global power system.

5. On-grid and off-grid worlds need to talk

Finally, Slaughter points out the importance of realizing that the real issue to be addressed is providing energy access for those that lack it, instead of analysing the problem in terms of “on-grid vs off-grid”. If the efforts of both on-grid and off-grid power supply solutions could be aligned, both

parties could benefit from each others’ know-how and infrastructure. As an example, grid supply could benefit from the pre-pay and smart metering technologies which are widely adopted among off-grid solutions and off-grid solutions could use the long-term project financing experience of their grid counterparts (Figure 6).



Main advantages of on-grid and off-grid solutions.

Figure 6.

Szabolcs Magyari is Research Analyst at SolarPlaza.

Off-Grid Living

Daniel Anthes

Development should be about happiness, not GDP growth

GDP only tells us half the story (at best). Maybe it's time we start looking at other things...?

End of January Davos was host to the World Economic Forum (WEF) Annual Meeting. 2,500 top international political and business leaders, as well as selected intellectuals and journalists from all over the globe met in Switzerland's Alps to discuss the most pressing issues facing the world.

Joseph Stiglitz, Nobel Prize winning economist, was one of them. Claiming that GDP is not a good measure of economic performance and not a good measure of well-being, he stressed a fundamental misbelief in our today's world – (economic) growth indeed tells us nothing about the quality and sustainability of development. Let us take a look at the story behind the problem.

For the past 70 years, the world was driven by a central paradigm: growth equals development. And the best measure to quantify progress in this context is a country's gross domestic product (GDP). Serving as an estimate of the total value of goods and services it produces, growth in GDP was meant to create more jobs, more money, more well-being, more development.

But even when the concept was first developed back in the late 1930s by Simon Kuznets, he warned that it was not a suitable measure of a country's development. On the contrary, he understood that GDP is not a welfare measure, but only counts the things that people are buying and selling – and that it's quite possible for the GDP to go in the opposite direction of societal welfare.

This brings us to today and the main problem that essentially lies within: it's simply not working. Since 1980, the global economy has grown by 380%, but the number of people living in poverty on less than five US-Dollar a day has increased by more than 1.1 billion – that's more than every seventh person on this planet. So much for the trickle-down effect and general well-being.

But it gets worse. Just recently Oxfam published a report where it finds that the 62 richest people are as wealthy as the poorest 3.6 billion. And the gap keeps growing. The fortune of this ultra-wealthy group of individuals grew by more than half a trillion US-Dollars in the last half-decade, while the world's poorest half lost about 41 percent despite an increase in global population of 400 million.

Simultaneously we are overshooting the planet's ecological limits. In fact, we are currently demanding environmental services such as forest land, fishing grounds or carbon dioxide absorption of one and a half earths. If we look at the reasons for that, we again find a vast gap. The average European needs 4.7 hectares per year – or nearly seven football pitches – to satisfy his or her consumption pattern of natural resources. This is about five times more than the ecological footprint of the average person in a developing country such as Malawi or Cambodia, who consume just under 1 hectare annually.

Whether it be climate change, resource scarcity or loss of biodiversity, our impact on the planet and its ecosystems is exceedingly omnipresent and

extremely alarming. But given the underlying inequalities and widening social gap, what does this mean for our growth and development paradigm?

We must start focusing on happiness, and not on GDP growth. People more and more have the feeling there is something wrong with the dominant model of economic progress. That's why they're hungry for an alternative narrative. We need to move beyond GDP as the major measure of progress and fashion a sustainable development index that puts people and the planet first.

If we look at measures of overall happiness and wellbeing, quite a few developing countries rank highly – even without a GDP per capita of 50,000 US-Dollar. One such an approach is the Happy Planet Index, ranking countries according to their experienced well-being, life expectancy and ecological footprint. Costa Rica is leading the way alongside several developing countries in Latin America, sustaining the highest happiness indicator globally with a per capita income one-fourth that of the US. By comparison, Denmark and Switzerland may be countries with high scores on experienced well-being, but are screwed by their ecological footprint. And not just since last year's COP21 we know that this overconsumption of the global North is putting our planet at risk.

According to consumer research, 70% of people in middle and high income countries share worry about the impact of their consumption patterns. A similar majority also believes we should strive to buy and own less, and that doing so would not compromise our happiness. The rising sharing economy as a smarter and more discerning consumerism is poised to significantly alter our economic models. Also shorter working weeks and

basic incomes are approaches attracting further attention, all of which that could possibly improve our lives while reducing consumption.

The unprecedented speed of change, as well as the breadth and the depth of many radical changes unleashed by new technologies, is having major impacts on what and how we produce and consume. And since the world is changing at such a rapid pace, so too should the way we measure progress. In order to do so, we must learn to redefine our concept of growth for the 21st century. There has to be some looking beyond the conventional economic terms and consider questions of security, equality, health and quality of life - as well as environmental sustainability.

Bottom line is: what we measure informs us what we do. If we are measuring the wrong thing and continue to solely focus on GDP growth we are going to do the wrong thing. It's as simple as that. Herman E. Daly und Joshua Farley in their book *Ecological Economics* got to the heart of this dilemma: "Even if we can never quantify satisfaction or happiness as precisely as we currently quantify GDP, perhaps it is better to be vaguely right than precisely wrong."

Let's start to be happy.

Daniel Anthes is a qualified economic geographer, who has worked in the field of natural resource management.

Justus Bahati Wanzala

Solar-powered farming, built in Kenya

Chris Muthoka is a farmer in Machakos County, about 43 miles [70 kilometers] southeast of Nairobi along Mombasa Road, the main highway between the country's two largest cities. He grows capsicum—pepper plants—across four acres of land. An extremely water-intensive crop, keeping the plants hydrated used to be a challenge in a country with erratic rainfall and frequent droughts.

But Muthoka is one of many farmers across Kenya turning to solar power to help irrigate crops. He uses an AgroSolar Irrigation Kit, a cheap, easy-to-install, and low-maintenance drip-irrigation system produced by local NGO Sunculture. During the day, the solar panel collects sunlight and uses the energy to pump water from a reservoir, river, well, or other water source into an above-ground storage drum. Then, whenever the crops need water, farmers can just release the valve, day or night, and let the water trickle out through tubes across their fields.

The kits are bespoke and can be scaled up to handle as much as 40 acres of farmland, but they certainly aren't cheap. A complete installation—covering the irrigation system, the solar panels and pumps, a 5,000 liter storage tank, and labor—to supply a single acre of land can cost in the region of 380,000KSH [\$3,736]. Still, Muthoka said it's worth it. "Although the initial capital outlay might be a challenge to some farmers, once bought it needs no running costs," he pointed out. "I'm able to supply fresh produce throughout the year to my customers."

Sunculture's Kathryn Weichel told me that while the alternative—diesel pumps—are more affordable to start, they make irrigation a costly affair in the long term, especially for single-family farms.

"Our aim is to make irrigation affordable and [of] quality," she explained. The organization has a highly trained technical team involved in research and development, and is training farmers in the use and maintenance of the kit.

With climate change creating more and more erratic rainfall, farmers in Kenya are trying to figure out how to keep their fields watered consistently. Only around 17 percent of Kenya's land area can sustain agriculture on rainfall alone—elsewhere, farmers have to tap into other water sources to feed their crops.

This has spurred demand for affordable and easy-to-run water pumps across the country, and environmentally friendly pumps (which don't contribute to climate change) even more so. Another organization working on the problem is Kickstart—a Kenyan nonprofit specializing in irrigation technology specifically for poor farmers.

Kickstart was founded in 1991, originally as AproTEC. In its 25 years, the organization's manual irrigation pumps have left a mark on millions of people in Kenya and elsewhere in Africa. They've alleviated poverty, improved food security, and made it easier for people to adjust to climate change.

Mosses Odongo, head of sales and distribution at Kickstart's headquarters in Nairobi, showed me

one of their first models, powered by pedaling. It's heavier, larger, and less efficient than today's main model—the "MoneyMaker Max," an upright pump that costs farmers \$70 each. (Its name refers to its ability to increase the incomes of the farmers who use them.)

He explained: "[It's] found a market not only in Kenya but the entirety of east, south, and west Africa. It can draw water from a depth of 23 feet and pump it to a height of 46 feet, and 600 meters horizontally, and irrigate an acre of land." Even though the pumps require physical strength to operate, Odongo claims that part of the success of the MoneyMaker pumps is that people of all ages and genders can operate them.

But, like SunCulture, Kickstart has also developed its own solar-powered pump. It costs \$400 and, according to Titus Wafula, head of the technical team involved in its development, it can pump 4.5 gallons [17 liters] per minute from a depth of over 16 feet [or exactly five meters].

On a good day, with plenty of sunshine, it pumps somewhere between 800 to 1,050 gallons [3,000–4000 liters]. There's also an extra tool available, a solar boost converter that uses a technique called Maximum Power Point Tracking (MPPT) to improve the efficiency of each unit on days with less sunshine.

Seventy units have been sold since the launch and, perhaps unsurprisingly, women farmers have been even more receptive to the solar pumps than men.

"It has come to our realization that apart from irrigation purposes, in most homesteads with shallow boreholes, women are the ones who draw water using buckets tied on ropes. The availability of a solar pump relieves them the burden of drawing water," Wafula noted. Each pump can irrigate a quarter of an acre of land, and comes with an automated irrigation system and storage tank.

Importantly, the technology behind the pump was developed entirely in-house at Kickstart. "We started exploring ways of designing a solar pump, because we thought they could be affordable to farmers, unlike the fossil fuel-powered ones," Odongo said. Kickstart's technologies, he explained, are developed by Kenyans for the African market. "Due to investing in research and development, we have been able to satisfy the needs of our clients while still ensuring they are affordable."

Wafula reiterates his colleague's comments, saying that they hire graduates from local universities and offer them further in-house training. Kickstart also has a devoted technical team that works on prototype design and testing.

Plus, Odongo is elated by the impact of the technologies on the lives of poor farmers. He says data from their monitoring and evaluation team indicate that among households and communities that have embraced their technologies, poverty is declining. "Households using our pumps, for instance, have improved nutrition and are able to take their children and meet medical expenses," he said.

Kickstart is also branching out into other areas, including housing—or, rather, housing supplies, in response to frequent shortages of things like bricks in Kenya. The nonprofit has invented a press that uses soil mixed with cement to produce building blocks that don't need to be cured in an oven before use.

Or there's the oil press, for farmers to get the most out of their sesame or sunflower crops—it can make over a hundred gallons [hundreds of liters] of oil a day, if necessary. Or, there's a hay baler, which can manage more than 200 bales (each weighing around 44 pounds, or 20 kilograms) per day. In drought-ridden climates, bales are vital for saving up feed for livestock.

Kickstart also works with both NGOs and governmental bodies to try and sell its products—but success brings with it a new challenge: falling water levels in Kenyan rivers, springs, and ground-water sources.

"We are compelled to assess the customer's water source to advise them accordingly. This is to spare them from buying a pump, and failing to use it [because of the] unavailability of enough water," said Odongo.

The scenario has forced Kickstart to liaise with organizations involved in rainwater harvesting and conservation to ensure that farmers don't use more water than they should. His main concern, however, is that the government has failed to offer tax concessions that could cut down production costs. "Underlying our initiative is service to small-holder farmers. We don't want to add misery to them. Unfortunately the government has started taxing our products, thus pushing the burden to farmers," he lamented.

As climate change makes rainfall increasingly more inconsistent, solar irrigation will surely not be the final frontier for companies like Kickstart and SunCulture questing to solve the problems of Kenyan dependent on farms across the country.

Justus Bahati Wanzala is a freelance contributor for the Thomson Reuters Foundation, based in Nairobi.

Sevea

Chbar Chros: outlook of the first solar village and mobile payment system of Cambodia

In Cambodia, where according to the Cambodian Ministry of Mines and Energy (MME), only 55% had access to electricity in 2015, developing the electrification of rural areas is a huge task, which requires, from the involved stakeholders, innovative methods and solutions. The experience lead in 2015 by the Stiftung Solarenergie and its local partners, which consisted in electrifying a whole village with solar and in introducing a mobile payment system, SunControl-Payment-System, to traditional Solar Home Systems (SHS), is a shining example of a path to pursue.

This “Solar Village” concept, first introduced by Stiftung Solarenergie foundation in 2004 in Ethiopia and then replicated 4 times in Africa & Asia, aims at showing that, through the sustainable solarization of an entire village (households, public buildings and areas..), decentralized solar technology is able to foster economic and social development. To ensure the long-term success and contribution towards alleviating poverty of such projects, the foundation approach usually consists in partnering, defining and implementing the project with like minded local partners also striving for the sustainability of their actions. In the case of Cambodia, these actors were as followed:

- NRG Solutions, a Cambodian social enterprise providing sustainable and affordable energy to rural areas while focusing on both quality solutions and reliable after sales services. For this first Cambodian Solar Village, NRG is playing the role of the

local installer, the trainer and the one in charge of after sales service;

- Camkids, a Cambodian NGO helping children in Cambodia who are either poor or whose parents are not there for them. Their modus operandi consists of focusing on understanding the needs of a few communities and identifying how to integrate, in a holistic way, long term solutions within these communities. Chbar Chros village in Kampong Speu was selected for this Solar Village because of Camkids long term involvement and trust with the community.

- Sevea, a Cambodian consulting company offering strategic and operational support to Corporations, Organizations, Projects & Social Entrepreneurs that seek to develop their impact strategies in the Water & Energy sector and/or engage with BOP markets. In this project, Sevea has been in charge of defining an appropriate methodology for the monitoring, evaluation and impact assessment of the solarisation of the entire community.

In order to follow the impact of such a project, Sevea conducted, prior to the installation of the solar systems, an initial exhaustive assessment to understand the electric situation of the village of Chbar Chros. Following is an overview of this initial situation:

Similarly to many Cambodian villages, Chbar Chros will not be connected to the grid before a few years. Most of the households of the village

were considered as a Tier 1 on the Energy ladder of Sustainable Energy for All, the lowest level in terms of access to electricity supply. This meant that the households had access to a basic source of light and a phone charger but no general lighting, TV and fan. For their electricity supply, households were using car batteries to power around 2 fix lighting bulbs in the house and a mobile charger. These batteries had to be charged in average once per week taking around 1.3 hours per recharge to those in charge of it.

In addition to “fix lighting solutions”, 90% of the villagers were also using electrical mobile lanterns to walk in the village or for their fishing activities. Dry cell batteries used to power these torches, needed to be changed very week and were usually, once used, thrown away around the houses or in the forest.

On the community level, 3 public infrastructures (the school, an accommodation for the staff of Camkids and a clinic) were already powered by reliable energy, since Camkids had identified this need as an urgent one and had started solarizing the buildings in 2013.

First positive feedbacks have not been slow to arrive: Just a few weeks after the official launch of the projects and the installations of the solar systems, families could just not stop to explain what an improvement it was for the village to have this

project; not only with regards to the expanded possibilities to work in the evening or early in the morning but also thanks to the fact that the very time-consuming transport of the car batteries to the charging station is no longer necessary. In addition, they mentioned that they were particularly happy with the quality of the trouble shooting services, rarely seen in such villages.

As one of the objective of the Solar Village project is to be in a position to really follow-up and understand these outcomes, Sevea will conduct two more assessments, one after 6 months and one after a year. This thorough process of impacts measurement will give a more accurate idea about what the solarization of such rural area villages can bring in term of economic and social development. Furthermore, this project will provide first feedbacks about the advantages and disadvantages of the usage of mobile payment technologies in Cambodia.

Sevea supports entrepreneurs and organisations to build and scale sustainable solutions leading to social, environmental and economic impacts.

Elias Ntungwe Ngalame

Solar power, text messages fight maternal deaths in rural Cameroon

A combination of solar energy and a new mobile phone platform are making healthcare easier to access in Cameroon.

Julianna Senze, 40, had been in heavy labour for eight hours when she arrived at the Idenau Health Centre in Limbe, on the southwest coast of Cameroon.

Like many women in the country, she had had no prenatal care, so what should have been a routine delivery was now a high-risk medical procedure. The nurses, looking worn and tired, rushed her to the delivery room.

"We had to get her here quickly from Batoke village, some eight kilometres away, after receiving an SMS message from the doctor on duty," said her husband, his voice strained with worry. Less than an hour later, Senze safely delivered a healthy baby boy.

Only a few years ago, Senze's story could have had a more tragic ending.

Cameroon has one of the highest maternal mortality rates in the world. More than 7,000 women die due to pregnancy-related causes and 58,000 children under the age of 5 lose their lives every year in Cameroon, according to the United Nations Population Fund in Cameroon.

Most of them live in rural parts of the country, where health services are weakest.

But a combination of solar energy and a new mobile phone platform, which gives women access

to important health information, is changing that.

New renewable energy projects are giving more people the electricity they need to access health information, and giving hospitals power to deliver essential care, experts say.

The message that may have saved Senze's life was sent using Gifted Mom, a mobile platform founded by Cameroon engineer Alain Nteff in 2012.

The text-messaging service and app gives women in out-of-the-way rural communities free health advice, sending reminders about prenatal check-ups and children's vaccinations. It tells users when and where to get the treatment they need, and gives them access to doctors who can answer health-related questions.

According to Nteff, Gifted Mom is now used in all 10 regions of the country.

"The project expects to help reduce the number of Cameroonian women who die during childbirth and the number of babies who die at birth by at least 70 percent by 2020," said Nteff, talking to the press in Yaounde.

But Gifted Mom's success would be impossible if it weren't for the other projects tackling another issue that blights the lives of those living in rural Cameroon: lack of electricity.

Solar and wind step in

According to the World Bank, nearly 600 million people in sub-Saharan Africa - most of them in

rural areas where poverty is high - still lack access to energy, and electrification is barely keeping pace with population growth.

Limbe, a big coastal town in southwest Cameroon, runs on hydroelectricity provided by ENEO, the country's lone energy provider. But even residents connected to the grid can't rely on having electricity when they need it.

Prolonged droughts have caused a severe drop in the water levels of the Sanaga river, which feeds the area's hydropower plant, resulting in crippling power outages.

"We suffer from persistent blackouts on a daily basis," said Motanga Andrew, the government delegate to the Limbe city council.

In Idenau and Batoke, two fishing villages about 12 kilometres from Limbe city, there are pretty beaches and vast tracts of unspoiled mangrove forests that bring in the tourists.

But, until recently, the communities couldn't access enough power to meet the most basic needs of running their businesses and health services.

The recent arrival of solar power, however, is already improving the lives, health experts say.

In 2015, a renewable-energy expert from Canada began using homemade wind turbines and solar panels to build a network of renewable energy electrical stations to supply power to homes and medical clinics in the area.

The networks are also used to charge motorcycle batteries, which residents take home to power their lights and charge their cell phones, which they can then use to conduct business and access health information.

Also last year, the African Resource Group Cameroon (ARG-CAM), in collaboration with the Limbe city council, built mini-electrical grids to

provide light, cooking energy and phone-charging stations to the people of Limbe, Idenau, and Batoke.

According to the non-governmental group's director general, Edmond Linonge Njoh, the initiative, funded by the African Union's New Partnership for Africa's Development, aims to reduce the fishing communities' dependence on fuel wood and kerosene, both of which come with significant health risks.

"The coming of alternative and cheaper energy to our council area is a welcome relief," said the government delegate to Limbe.

In Idenau, storekeeper Njombe Ikome said the provision of solar energy to the community has changed the lives of people there.

"Our children can now do their homework at night and they are doing well in school," he said. "Idenau is a business community and so the use of cell phones for communication with business partners is very important."

According to Rose Agbor, assistant warden of the Idenau Health Centre, the facility used to help fewer than 15 pregnant women and nursing mothers each day.

Now, with solar energy providing a reliable electricity supply and the Gifted Mom platform raising awareness of the availability of prenatal care, the centre sees over 50 patients daily.

"The arrival of solar electricity here has changed everything," she said.

Reported by Elias Ntungwe Ngalame; edited by Jumana Farouky and Laurie Goering for Thomson Reuters Foundation.

Jean Chemnick

How women are reaping benefits from Africa's solar revolution

For girls in Berta Massawe's Tanzanian village of Kibosho, every day was a race against the clock -- or, more accurately, against the sun.

When it was dark in this village on the slopes of Mount Kilimanjaro, it was dark. There were no streetlights or headlights to break up the night. Work and study were impossible except by candle or kerosene lamp -- when they were available. If thieves came to steal livestock, and they did, there was little a family could do to stop them.

Boys like Massawe's two brothers had chores to do, too, but they usually involved moving their families' goats and cows from one pasture to the next and feeding them. They were finished before the sun went down and had more hours to study. Ritha Tarimo, director of M-Power Academy in Arusha, Tanzania, said it's a common story.

"It is really a struggle, especially for female children," said Tarimo, who grew up in much the same kind of Kilimanjaro town herself before moving to the city as an adolescent. "Because they have to really help with the house chores. So by the time they finish, it is 9 at night and it's hard to sit down to study."

Renewable energy deployment in Africa is still very new, and it's still a story told more in anecdotes than statistics. More than 600 million Africans -- or 60 percent of people on the continent -- still have no access to electricity. In countries like Massawe's Tanzania, that number climbs to 80 percent or higher. Even Africans who do have power fre-

quently don't have it 24 hours a day, or don't have enough to maintain the kind of lifestyle the Western world takes for granted, like householdwide lighting. In areas that remain underserved, the gender implications are clear. The World Bank says 70 percent of those suffering from energy poverty are women and girls, who experts say are less likely to migrate to urban centers -- where electricity is more available -- in search of work.

But those who work in Africa see grid-connected as well as mini- and off-grid solar beginning to penetrate into new areas of rural Africa, where women and girls spend a greater share of their time. Solar is a particularly good fit, they say, because the resource is abundant in Africa and because it does not require the expansion of transmission infrastructure that would be needed to support larger fossil-fuels-based facilities.

"This means that people who live way off the grid and will probably not in their lifetime see that wire go over their roof are able to immediately today get access to electricity that opens up this transformation for them," said Katherine Lucey, co-founder of the social enterprise Solar Sister. She said access to power can be particularly transformative for women.

"It's women who manage the energy in the household, it's women who walk the miles to fetch the wood for cooking, it's women who go to market to buy the kerosene to use at night for cooking," she said.

For girls like Massawe, having even a single light bulb in the house means they can study after dark. Social life doesn't have to end when the sun goes down, and women can start small businesses that require refrigeration or evening work.

The new industry is also an opportunity for women to work outside the home.

"It's a new industry that allows new participants to show up shoulder to shoulder with everyone else," said Kevin Smith, CEO of SolarReserve, a California-based utility-scale solar company that operates three solar photovoltaic utility-scale plants in South Africa. "Everybody's at the same skill level. Everyone has the same training requirements."

The 'Avon of solar power'

In South Africa, much of the country's solar energy supply is from commercial-scale facilities, thanks in part to the Renewable Energy Independent Power Producer Procurement Programme, which gave private investors a stake in renewable energy while fossil fuels plants remain state-run.

But other countries in less developed parts of the continent aren't connected to the grid, and growth in the solar sector is mainly off-grid. Women have found employment selling and installing rooftop-to-rooftop solar equipment, either as employees of larger enterprises or as independent contractors.

Neha Misra, who co-founded Solar Sister with Lucey, said she tries to cultivate village women to play the dual role of solar evangelist and "mobile Best Buy" in their communities.

"We're deliberately including women as part of the clean-energy chain, and really changing the narrative from 'oh, these poor women, they're victims' to women as change agents," she said.

Solar Sister's model is to recruit, train and mentor African women -- they currently operate in Uganda, Tanzania and Nigeria -- who earn a markup for selling a catalogue of solar energy and clean cookstove equipment. Solar Sister negotiates with the manufacturer on behalf of the women and offers what Misra calls "ongoing mentorship" and sustained training.

The product line is tailored to the consumer base. A new addition in Uganda, for example, is a light that attaches to a fisherman's net to help increase the catch.

It's often the first job for these entrepreneurs, who now number 2,200, Misra said, allowing them to pay a child's school fees or supplement the proceeds of a family farm. "Think of us as the Avon of solar power," said Misra. "Instead of selling lipstick, we're selling solar and clean cooking technologies. Which I think is another way of being beautiful -- instead of lipstick, you can see your face," she said, referring to the smoke and fumes from traditional kerosene lamps the products help avoid.

Favoring action over negotiations

Misra has some limited experience with energy insecurity from growing up in Delhi, India, where brownouts in her middle-class apartment building forced her to study by candlelight. But she says she didn't know what living off the grid was like until she visited the Sundarbans in eastern India as a young energy economist researching the effects of rural electrification in South Asia for a think tank.

Misra's work as an economist and researcher eventually brought her to the United States, where she found herself splitting time between attending high-level events -- including meetings of the U.N. Framework Convention on Climate Change -- and visiting villages "where people do not have a single light bulb."

The dichotomy between the two began to wear on her, she said, especially as the high-stakes round of U.N. talks in 2009 in Copenhagen, Denmark, approached. The world seemed to be investing so much in a search for what Misra calls a "boomerang" solution to climate change, and not nearly enough in using existing technologies to help the world's poor transition out of poverty while safeguarding the environment.

"I was absolutely disenchanted with the lack of progress on the international climate negotiations from the perspective of injustice," she said. High-level dialogue is not doing its job, she said, "when we are on the verge of sending space tourists and a woman in a village does not even have a light bulb."

Misra said she became more interested in getting the woman her light bulb than in preparing for Copenhagen. She left her job at a U.S.-based energy economist and joined Lucey, a former investment banker, to form Solar Sister.

The two started the organization with their own savings, but sales help sustain it. It also has

received backing the U.S. Agency for International Development and the State Department's wPOWER program, which aims to expand opportunities for women in renewable energy. They say it costs about \$500 to train a woman and get her started as one of their entrepreneurs.

"If you don't have access to electricity, you really can't move forward; you're stuck in this cycle of poverty," Lucey said. "Our lives are powered by electricity, and when that's missing, so much of your time and energy is consumed by that lack."

Inclusion from day one is key, experts say

While renewable energy is broadly seen as a win for African women, those who work in the space emphasize that it matters how programs are structured.

Development banks, U.S. foreign aid agencies and international nongovernmental organizations are tailoring their African electrification programs to involve women, and to ensure that traditional African power roles don't reassert themselves in the programs they fund.

Anne Kuriakose, senior gender specialist with the World Bank's Climate Investment Fund, said a concerted effort is required from the very beginning to ensure women are involved in projects and have access to their benefits.

If you're not systematically including women in consultations, you might not end up with the sorts of exploitation uses that they're interested in," she said. For example, women might benefit from having a village mill or an obstetrics clinic powered by renewable energy, but if they're not included in decisionmaking, their needs might not be considered.

Developed-country support for projects to electrify Africa through renewable energy has increased sharply over the last few years.

The Obama administration launched its Power Africa initiative in 2013, with the aim of doubling power access to Africa. The administration says it is already responsible for bringing power to 60 million people.

Though the overall employment story remains murky, those who work in off-grid energy say that's more a failure by agency-backed researchers to keep up with the trend than a reflection of conditions on the ground. The latest report by the International Renewable Energy Agency states that

"renewable energy-related employment remains low in Africa except in a few countries, like Kenya, Morocco and South Africa, where deployment growth is creating domestic value and jobs."

Her time to be a superhero

Back in Arusha, Tanzania, Tarimo says she applied for her current role running the M-Power Academy for a household solar equipment retailer called Off Grid Electric because she wanted to make a difference.

"The rate of unemployment in our country is actually heartbreaking, and I thought if I joined, I could play a role in reducing unemployment," said Tarimo, who ran a language and cultural school in Arusha before taking the M-Power Academy job. "I have always wanted to be a superhero, and I thought maybe it was my time."

Tanzania's official rate of unemployment is 11 percent, but that includes even very sporadic seasonal employment. And women are particularly disadvantaged when they leave home in search of work.

Massawe, who would eventually become a student of Tarimo's at the academy, struggled to find employment after graduating from Mzumbe University in eastern Tanzania.

"For us women in Tanzania, we are not given priority in many places," said Massawe. "When you go to interviews and there are males and females, males are given priority more than females."

After a string of fruitless interviews, she answered an ad for Off Grid Electric, traveling the 80 miles from Kibosho to Arusha for the interview.

She was hired and sent through a one-month professional development training course at the academy Tarimo runs before beginning work at its call center, where she has been now for more than a year.

Massawe says her training and the work she has done since have given her confidence. She hopes to one day become an Internet technology manager. "I want to become a person who can help others," she said.

Jean Chemnick is an international climate policy reporter for E&E News.

SciDev.Net

'Suitcase lab' in the fight against kala-azar

Bangladeshi scientists have developed a solar-powered portable test kit that promises cheap, quick and accurate detection of visceral leishmaniasis, the disfiguring and potentially fatal disease caused by *Leishmaniasis donovani*, a protozoan parasite.

The 'laboratory in a suitcase' is considered a breakthrough in field testing for the disease which is spread by the female sandfly and is known as kala-azar in the Indian subcontinent. According to WHO, 90 per cent of all cases of kala-azar occur in Bangladesh, Brazil, India, Nepal and Sudan. Bangladesh reported some 600 new cases in 2014–2015.

On infection, the patient develops irregular bouts of fever, substantial weight loss, swelling of the spleen and liver, and serious anaemia which, if not quickly treated, is fatal.

Dinesh Mondal, principal researcher and senior scientist at the International Centre for Diarrhoeal Disease, Bangladesh (icddr,b), tells SciDev.Net, that his team's endeavour was to come up with a portable kit capable of "confirmed diagnosis of new kala-azar, kala-azar relapse, dermal leishmaniasis and asymptomatic risk for development of disease."

Developed in collaboration with the University of Gottingen, Germany, and funded by WHO-Tropical Disease Research, the kit is described by Mondal and his colleagues in *Parasites & Vectors* published May.

Conventional methods of diagnosing kala-azar rely on antibody tests and clinical symptoms.

Molecular diagnosis is more accurate but requires using the real-time polymerase chain reaction (PCR) method to detect the DNA of the *L. donovani* parasite in the blood of infected people.

In contrast, the new kit uses recombinase polymerase amplification (RPA) to detect *L. donovani* DNA. Unlike PCR, RPA does not require repeated cycles of heating and cooling and yet provides 100 per cent accuracy. Furthermore, the new kit takes 30 minutes to run tests on eight samples simultaneously against the laboratory method which requires over three hours to test a single sample.

"PCR is the most sensitive test for detection of leishmania DNA, but it needs a specialised lab and highly trained personnel. It also costs about US\$ 30–40 per test, while tests using the new kit costs just US\$ 6 per test," Mondal says.

"If the device proves effective in the next phase of field trial it could play a significant role in vector control strategies and surveillance capacity of the disease elimination programme in countries where the disease is a major burden," Shamuzzaman, director at the communicable diseases department of Bangladesh's directorate of health services, tells SciDev.Net.

SciDev.Net is a source of news, views and analysis on information about science and technology for global development.

Ned Tozun

Reducing energy poverty not only for solar and impact investors

One day, a friend of Bala Suleman, who lived near Kano, Nigeria, was raving to him about a new portable solar light he'd started using. Suleman, a chicken farmer, was skeptical but open to learning more about his friend's new acquisition.

"When I saw the way it was constructed and the quality of the plastic, I was completely convinced of the great value it can bring and bought two lamps straightaway for my stall," Suleman recalled.

With his new solar-powered light lamps, the output of Suleman's chicken farm grew by 30 percent. The light scared away predators and allowed him to feed his chickens in the evening. He was able to produce 15 more eggs a week from the same flock.

Suleman is one of the 2.3 billion people living around the world in energy poverty, who lack access to reliable electricity or live off the grid completely. Of this population, over half spend about \$27 billion annually on mobile phone charging and lighting with kerosene, candles, flashlights, or other fossil fuel-powered technologies.

Burning kerosene to light homes and businesses has serious drawbacks. Breathing kerosene fumes is equivalent to smoking two packs of cigarettes a day. Structural fires and severe burns are common, resulting in fatalities 13 percent of the time. Meanwhile, kerosene fuel costs 40 times what the average American pays for energy, ma-

king it a significant hindrance to economic advancement for individuals and communities.

Studies from India indicate that electrification, from anything from solar lighting to microgrids, increases incomes up to 38 percent and literacy rates as much as 74 percent. As the burden of high kerosene costs are removed and families have access to reliable energy, significant economic potential is being unlocked globally. Yet we've only begun to enable this growing market.

Over the past decade, social impact investors and entrepreneurs have provided solar energy solutions to people at the base of the economic pyramid and generated financial returns on par with conventional investments. But, for the vision of economic development in emerging markets to be fully realized, the industry needs more conventional funds and large investors to finance companies improving energy access in emerging markets.

This is why Catholic Relief Services and the Pontifical Council for Justice and Peace highlighted the significant impact solar solutions have made around the world its recent Vatican II Social Impact Investing Conference. The Vatican is interested in how lifting developing world families up the energy access ladder can tap into their under-realized economic potential. The answer needn't be complicated or expensive; access to energy can begin with one small, low-cost solar-powered task light.

The widespread adoption of mobile phones in Africa in the mid-1990s provides an apt analogy.

Mobile phones didn't take off until telephone providers developed inexpensive handsets and operators began selling airtime in smaller, more affordable units. Once products matched their needs and budget, people throughout the continent adopted mobile phones, bypassing centralized infrastructure and opening up new opportunities for communication, business, and trade.

Today, solar products are doing the same with energy access. As of mid-2015, over 13 million brand-quality portable solar lights had been sold worldwide, budding into a \$300 million market.

Social Impact: Real Markets, Real Returns

The market of off-grid families and businesses is ripe for opportunity. In this space, businesses and investors can make strong returns and have a tremendous impact on the quality of life and economic futures of individuals, villages, and entire countries.

In its Impact Investing Benchmark research, Cambridge Associates and GIIN found that fully realized and closed impact investment funds outperformed their conventional peer group by 10 percentage points. Later funds that were not yet fully realized also showed returns on par with conventional investment strategies.

The University of Pennsylvania Wharton Social Impact Initiative found that impact investing private equity funds (both realized and unrealized) yielded approximately a 13 percent return between 2000 and 2014. When the social or environmental mission of the company persisted after the investment exit, returns were comparable with non-mission-aligned exits.

These and other studies are debunking the myth that strong financial returns and social impact are incompatible. Investors with financial returns as their guiding principle no longer need to wait for real examples of international social-benefit companies that are scaling successfully and providing commercial-level returns. The evidence is clear and continues to mount.

As the market grows exponentially, more working capital from traditional funds is needed to provide greater numbers of people with energy and economic opportunity. Historically, sizable investments in energy have funded centralized infrastructure like government-backed grid expansion. However, in today's emerging markets, the most efficient and scalable model is decentralized energy delivery. Small, individualized solutions are more affordable and empower families to control their own energy usage.

Many solar energy businesses are leading the way with cutting-edge technology and comprehensive distribution networks, and millions of families in developing countries are poised to adopt these new, truly life-changing solutions. But the industry needs more institutional investors to provide working capital to take advantage of the rapidly approaching inflection point.

The story of Bala Sulman and his chicken farm is just one of many entrepreneurial stories in the developing world, where a few solar lamps significantly improve the bottom line. Imagine the economic prosperity that could be realized if more people in Suleman's village or the surrounding community made the same transition. Growing numbers of successful entrepreneurs can burgeon into a small business sector, raising untold numbers of households out of poverty and into greater economic mobility.

Investments in off-grid energy today will have a ripple effect for generations to come, delivering returns to investors and collectively improving macro-economies. The opportunity is at hand to power the arrival of these markets onto the global stage.

Ned Tozun is the co-founder and CEO of d.light (US).

Rudi Bressa

Maasai women are leading a solar revolution in Africa

Maasai women are travelling to the country's remotest villages to bring renewable, affordable energy and improve people's living conditions.

Poverty can (also) be defeated through energy independence. Having night lights, the opportunity of charging electronic devices and storing energy for the night can change lives, literally.

This is what's happening in some rural villages in Kenya, where more than 200 Maasai women go from one village to another riding their donkeys. They bring solar panels, rechargeable batteries and lighting kits. It's a real revolution both for women who now have access to economic activities and for the inhabitants of those villages that don't have access to the national electricity grid.

The project realised by the Green Energy Africa allows Maasai women to sell solar panels, rechargeable batteries and lights at 300 Kenyan shillings (about 3 dollars) per unit. This makes them earn some money to buy other kits, becoming a perfect green economy model.

Maasai women bring energy to rural villages

"For us, the impact of solar technology is unparalleled," said Jackeline Naiputa, head of Osopuko-Edonyinap, one of the five-women groups bringing energy in the area. Naiputa's son was forced to stay up at night to protect their goats from wild

animals. "Light scares hyenas, so my son is now able to sleep soundly inside," she added.

Clean energy accessible to all

One of the United Nations' Sustainable Development Goals is ensuring access to affordable, reliable, sustainable and modern energy for all by 2030. Renewables can play a determining role in achieving this goal even if one out of five people currently don't have access to electricity. Yet, thanks to projects of this kind is possible changing villages' lot in developing countries.

Another important environmental aspect has to be considered. The access to technologies like solar energy and energy storage allows ever more people freeing themselves from fossil fuels and firewood. Not only solar power protects forests, but it also improves the health of women and children who often get sick for inhaling smoke.

Being located close to the equator, Kenya has a huge potential in developing solar energy, and Maasai women did understand that.

Rudi Bressa is a professional environmental journalist.

Victoria Slater

Living off the grid in the 21st century

When I think of living off the grid, a lot comes to mind, specifically, living sustainably and self-sufficiently while using renewable energy to provide electrical power and water. But what does living off the grid actually mean?

“The grid” refers to the electrical grid that provides us with electrical power, water, and sewage and trash removal. Living off of it refers to a disconnect of this power, perhaps by using no power at all or using renewable energy you produce yourself. Some people choose to do this so they can live life simply and sustainably, while others want a new experience and a unique place to live.

The truth is this: Completely living off the grid isn't that realistic, particularly in the 21st century. Who really wants to move to the middle of nowhere, use a composting toilet and forgo the Internet?

We spoke with individuals living nearly off the grid, to get some tips and tricks to help you live more sustainably and reduce your reliance on electrical power.

Solar Panels as an Alternative Energy Source

Truly off-grid homes are built with only sustainable resources and use no electrical power. Typically, they're easier to build in rural areas where you have more land. If you want to keep your home in the city and still use electricity, purchasing or making solar panels can allow you to reduce or completely eliminate your reliance on the electrical grid.

Solar panels work by absorbing the sun's energy and converting it into electricity. They can be

installed on the roof or near the house and convert energy to the inside of the home.

One of many alternatives to using the electrical grid, solar panels are a cost-effective and green way to bring energy to your home. Even if you don't live in an area where the sun shines all the time, a generator allows you to store energy for future use, so you can capitalize on the sun when it's out and still have energy when it's not. Dede Cummings, founder of Green Writers Press tries to live sustainably in all aspects of her life. She doesn't consider herself a true off-gridder (she still drives a car, for example), but her passive solar home is just about as energy efficient as it can get.

She recommends using solar panels as a first step to living off the grid; it has allowed her to heat her home and water efficiently, completely eliminating her reliance on outside electrical power for these comforts. In order to heat water, she installed solar hot water pipes connecting the roof to a water tank used for storage.

You can save the power your solar panels generate for your future use, or because some utility companies will pay you for your excess energy, you can convert this power into a small stream of additional income. Cummings says using alternative energy sources isn't all that challenging if you budget correctly and take advantage of state and federal government tax credits and rebates.

Solar Water Pumps and Water Storage

Solar water pumps are powered by solar panels, allowing you to access nearby water in a cost-

effective, sustainable way. Small amounts of water can move over a longer duration of time, perfect for residential consumers who don't need mass quantities of water.

Sia Mohajer from Ontario Solar Panels recommends solar water pumps, as they are great even in low sunlight conditions. Plus, the solar output remains constant throughout the day, so you receive a steady output of water. In order for solar water pumps to be effective, you'll need to be near some sort of water source, such as a well or lake where you can retrieve water. To further reduce your need for outside water sources, purchase an additional water storage tank to collect rainwater. You can store water either above or below ground.

Growing Your Own Food

Maintaining your own garden to grow fruits, vegetables and herbs can drastically decrease your reliance on outside food sources. Not only can your garden be healthier than processed foods, but often it's healthier than alternative fruits and vegetables because they're fresher and have less pesticides.

Most of our food travels thousands of miles from farm to table, requiring tons of energy. By growing your own food, you reduce your reliance on outside vendors and reduce your green footprint versus had you purchased all of your food from an outside source, like a grocery store.

If you live in an area where you can't grow food year-round, consider purchasing or building a greenhouse that uses solar energy to heat itself. You can grow food regardless of the season or local weather conditions.

Reduce, Reuse, Recycle

If you truly want to live off the grid, you can hand-wash clothes instead of using an electric washing machine and burn candles instead of using light bulbs, for example, but this isn't realistic for all people. You can make small changes to reduce your overall energy use, which will decrease your reliance on energy in general. Running the dishwasher in the evenings, washing only full loads of laundry, lowering the temperature in your home while you're at work and purchasing energy-efficient appliances are all ways to help reduce your energy usage.

Americans represent only 5% of the world po-

pulation yet consume 24% of the world's energy, and a lot of this energy is wasted on things we don't even use, such as appliances plugged in but not in use. Before you leave the kitchen, make sure to turn off the lights and unplug that blender – it will save you a lot of energy, and money, in the long run!

True off-gridders are minimalists: They make do with what they have or go without; they recycle and reuse everything from glass containers to building materials. They're creative and find ways to reuse everything. When they need something, they purchase used items online or at local thrift stores. All of these items required energy and power to make, so by purchasing used items, you're reducing the energy required to make new items.

Composting is a great way to recycle greenery. By decomposing unwanted food and greens, the nutrients of food waste are returned into the soil. This is the ultimate reusing tip because you can then reuse this soil to fertilize your garden. You can also compost items you probably never considered eating, like flower petals.

You don't need to purchase fancy or expensive composting bins. Composting can really be done anywhere in your backyard, no bins required. The ultimate off-grid goal is to have zero waste so you don't have to rely on waste removal services. Reducing your waste in general is a great first step.

Green Technology

Green technology can be expensive, but don't let the cost deter you. Costs have gone down in recent years, and you can save thousands of dollars on electricity bills over the course of their lifetime. A small cost upfront can allow you to live sustainably for years to come.

The government offers some rebates and incentives to encourage green technology usage, which can help to partially offset the high costs. If it's still too expensive, you can even build your own solar panels. Think long term: green technology increases the assessed value of your home, and they are increasingly in high demand due to rising energy costs.

Victoria Slater is copywriter at QLCredit.

Rafiqul Islam

Pay-as-you-go irrigation aims to cut water use in Bangladesh

Farmers will receive smart cards they can use to pay for their water use, instead of paying a fixed cost to middlemen.

Elias Ali has been picking weeds and waste for hours from his paddy field in southeastern Bangladesh, preparing it for irrigation. Every week, he walks half a kilometre to collect the water he needs from private pumps.

Ali and fellow farmers currently pay 4,000 taka (\$51) each per year to middlemen in exchange for irrigation on their one-acre plots in Feni district. But water frequently seeps out of the earthen canals that supply the pumps, wasting significant amounts, Ali said. "The waste increases our costs, as pump owners also charge us for water that's leaked," he told the Thomson Reuters Foundation.

"When we experience a loss in crop production due to floods or droughts, we can no longer afford the high price of irrigation, which fuels tension between pump owners and farmers," he said.

Water is a precious commodity in Bangladesh - abundant during the monsoon from June to October, but scarce in the dry season from November to March.

Abul Hye Bhuiyan, a farmer and president of the Pathannagar Water Management Group, said many farmers simply cannot cultivate crops in the dry season due to the high cost of irrigation.

Sometimes they have no choice but to sell stored crops to pay for water, Ali said. But Bhuiyan and Ali are hopeful. The Bangladesh government

plans to install water meters across the Muhuri Project, a 60,258-hectare irrigation area supplied by the Feni, Muhuri and Milenia rivers, to reflect farmers' water costs more accurately.

The scheme is part of the Irrigation Management Improvement Project, a government-led initiative to modernise irrigation systems, including the Muhuri Project, from 2015 to 2019.

The scheme has financial support from the Asian Development Bank and the Bangladesh Water Development Board. About 800 water meters will be installed, as well as new water pumps, with water supplied through underground pipelines.

Farmers will receive rechargeable smart cards they can use to pay for their water use, instead of paying a fixed cost to middlemen.

Humayun Kabir, extension overseer at the Water Development Board, said around 2,000 hectares (4,942 acres) of land would be brought under the irrigation scheme initially, with some 80 pumps due to be installed by 2017.

He expects middlemen to gradually remove their own pumps. The board estimates the renovation will be finished by 2019, when all 60,238 hectares will be equipped with meters and pumps.

Rafiqul Islam is a freelance contributor to the Thomson Reuters Foundation.

Paul Gubbins and Julie Zollmann

Beyond the pricetag: The real benefits of off-grid solar

Exploring the affordability and value of solar home solutions.

If you've ever handled kerosene or set it alight, you'll know it is disgusting. If you use it the way most of Kenya's low income families use it—in a tiny tin with a small wick—for lighting your home, you'll inhale a lot of smoke, the entire place will reek of gas and smoke, your children will strain to read under its dismal light, and if light is needed in another room, you'll need to precariously tote around the tiny lamp, hoping not to spill kerosene all over the floor.

We repeat, kerosene is awful. But at around KSh 60 – 75 (USD 60 – 75 cents) per liter [1], illuminating kerosene (or paraffin) is also really, really cheap, which explains why three quarters of Kenya's poorest households use it as a primary energy source for lighting their homes[1].

It's the disgusting part—not the savings—making many Kenyans increase their energy expenditures to acquire solar home solutions. We have seen some claims that solar lighting solutions like M-KOPA and BBOX make sense to users because they save money. For example, BBOX estimates that its clients save \$2 per month on average.[2] Stephan Faris writing for Bloomberg referenced a widely-quoted study (also referenced on M-KOPA's website):

"According to a 2014 survey, an average off-grid household in Kenya spends about 75¢ a day on energy, or \$272 a year—\$164 on kerosene, \$36 on charging their mobile phone, and \$72 on batteries. M-Kopa estimates a customer saves about \$750

over the first four years by switching to its basic solar kit." [3]

But our work on the Kenya Financial Diaries made us sense that these estimates of budget savings were off for low-income households. Very few of our off grid respondents ever paid to charge their phones or buy batteries. In fact, when we looked at Diaries households' total expenditures on all energy—including lighting, phone charging, and cooking (energy that is not replaced by a solar unit)—we found the median household was spending only KSh 262 per month (or about 4.2 percent of median total consumption expenditure of KSh 6,223 per month), equating to about just \$32 per year.

Since the Diaries sample is small and focused on low income people, we also looked at available national datasets to get a more representative estimate of Kenyans' energy spending and to model just how long it would take for different income groups to achieve net savings by only shifting their existing expenditures. For expenditure data, we referenced the nationally representative 2005 Kenya Integrated Household Budget Survey (KIHBS) and the 2008 and 2015 panels of a large survey led by Tavneet Suri and Billy Jack to assess the impacts of M-PESA.

Though some of this data is quite old, kerosene prices remain in a similar price range, though they fluctuate regularly with the price of oil and actually declined in 2011 after a reduction in kerosene taxes. To assess the financial attractiveness of solar lighting solutions, we compared estimates of kero-

sene spending to the pricing models of two leading off-grid solar solutions:

- M-KOPA's basic home kit, which requires a deposit of KSh 3500 and payments of KSh 50 per day for one year to own the system;
- BBOXX's "LIGHT" product, which requires a deposit of KSh 590 upfront and monthly payments

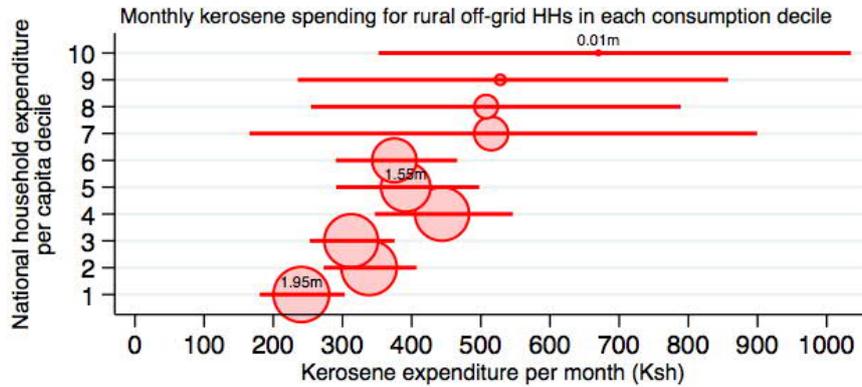
of KSh 590 for the first three years (after which accessories, like lights are paid for) and Ksh 440 for the next seven years which covers maintenance and payments towards full ownership after year 10.



The first plot in Figure 2 below shows survey-based estimates of monthly kerosene spending for rural off-grid households at each national consumption decile, from those living at consumption per capita levels among the poorest 10 percent to those living at consumption levels enjoyed by the richest 10 percent. We draw primarily on the 2008 representative M-PESA panel survey for this data, since it is our most recent source. Though still a bit

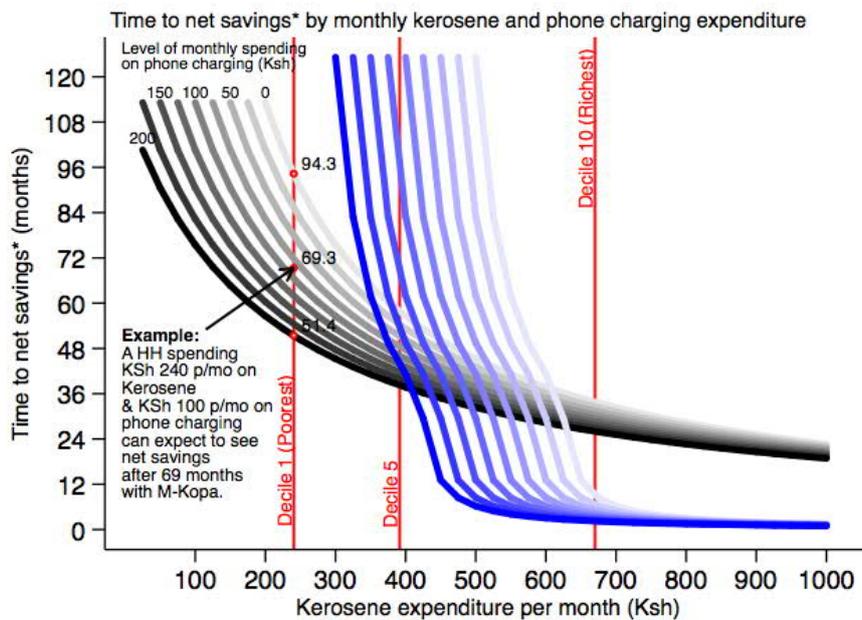
outdated, as noted above, kerosene prices today are quite similar. The second plot shows the number of months to net savings for all levels of kerosene spending in the range of KSh 50 and 1000 per month for the M-KOPA and BBOXX systems, with vertical lines referencing the mean kerosene spending levels for rural, off grid households in deciles 1, 5 and 10.

**Solar systems in Kenya:
How fast do they generate savings for rural, off-grid households?**



• Mean kerosene spend per month for **Rural, off-grid** households, by consumption decile
 Markers sized proportional to estimated 2015 rural, off-grid adult population in each decile
 Source: Round 1 Mpesa panel survey (2008), KIHBS (2006) and FinAccess (2015)

— 95% Confidence interval



M-Kopa time to net savings
 Deposit: Ksh 3,500
 Monthly cost: Ksh 1,500 (Ksh 50 daily payments)
 Own after: 1 year, Estimated cost to own: Ksh 22,634

BBOX time to net savings
 Deposit: Ksh 590
 Monthly cost: Ksh 590 (first 3 years), Ksh 440 (after 3 years)
 Own after: 10 years, Estimated cost to own: Ksh 70,418

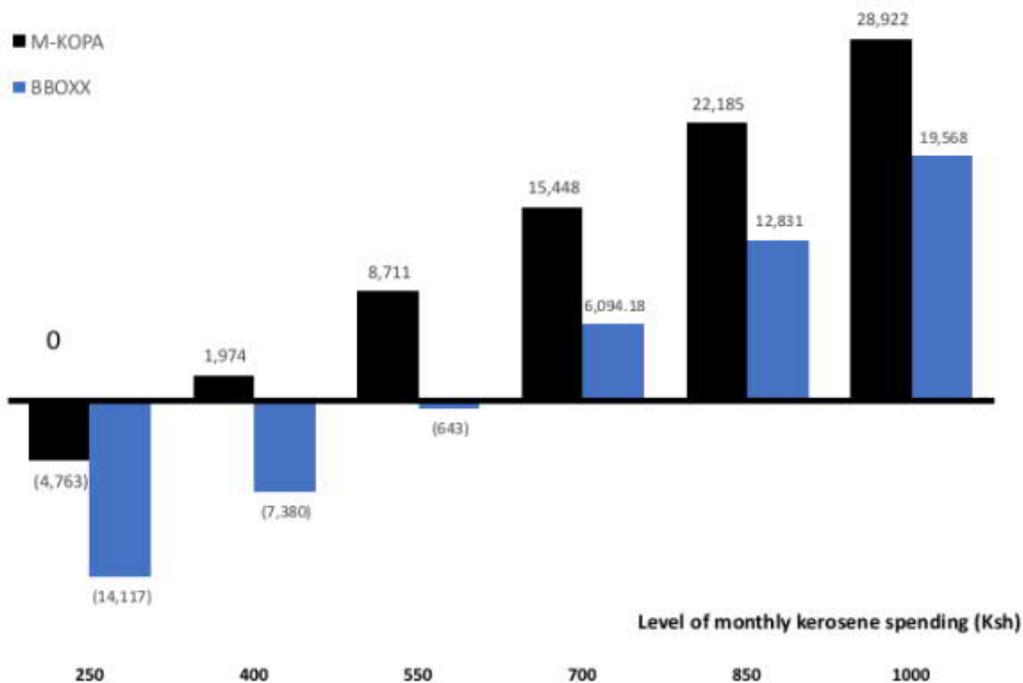
*Time to net savings is defined as the time it takes for cumulative kerosene and phone charging savings resulting from solar panel use to surpass the value of the initial deposit

According to most recent estimate from 2008, the mean rural off-grid household spends around

KSh 370 per month on kerosene[1]. Presuming that household spends around KSh 100 on phone charging per month[2] and purchased a solar home system to replace both kerosene and phone charging costs, they would only achieve net savings on M-KOPA in 48 months and on BBOX they would not generate any savings as its monthly financing cost of KSh 590 exceeds their kerosene spending. Rural off-grid households that classify in the poorest 30% of all Kenyans, spend around KSh 295 per month on kerosene and at this spending level, investing in one of these solutions is an even greater stretch. With M-KOPA, they would only be able to achieve net savings in between 45 to 76 months (depending on how much they currently spend on

phone charging).

Another way to compare the financial benefits of the M-KOPA and BBOX systems is by computing net present value (NPV). Figure 3 below, shows the NPV of a solar home system investment after 5 years of ownership at 5 different levels of monthly kerosene spend (and assuming the household spends KSh 100 per month on mobile phone charging). The NPV can be interpreted as the cumulative savings that are generated over the 5 year period time discounted by the central bank rate of 10.5% (cash flows farther in the future are discounted at a higher rate than cash flows nearer to the time of purchase).



Based on these models, it's unsurprising that these kinds of solutions are not yet ubiquitous among the poorest. Recent estimates suggest that only 5.7 percent of the poorest 40% of all Kenyans

are using a solar solution as their primary source for lighting[3]. But, even in the middle of the income distribution, many are willing to pay more for solar than they spend today on dirty and inconve-

nient sources of energy. Solar units provide cleaner, better quality light. They are more convenient, reducing trips to shopping centres to buy kerosene. They allow users to potentially listen to the radio with more regularity and charge their phones with more convenience, even if there is no cost saving for many years. More convenient charging can even entice some to upgrade their phones to smartphones knowing they have a reliable way to charge every night. All of this value means that even some very low income Kenyans have found a way to pay for solar solutions (See our blog, Solar Stories to understand their experiences).

This analysis highlights some key takeaways that go beyond solar alone:

1. When talking about delivering exciting technology in low income markets, we need to be realistic about affordability and continue to seek lower cost solutions to make them accessible for the poor.

2. For solutions that deliver new and better value, what people spend today tells us a bit about their budget capacity, but it is not a reliable indicator of willingness to pay.

3. For solutions that offer a new and better service, cost savings is not the most important metric of value

[1] Kerosene prices from Energy regulatory committee

http://www.erc.go.ke/index.php?option=com_content&view=article&id=162&Itemid=666. Kerosene prices reached a high of about KSh 95 in 2011. Population kerosene use for lighting obtained from 2016 FinAccess household survey. The estimate

presented here corresponds to the FinAccess 2016 estimated proportion of Kenya's adult population (ranking in the bottom 40% of an asset-based wealth index) that uses kerosene as the primary energy source for lighting their home.

[2] <http://www.bboxx.co.uk/customers/>

[3] <http://www.bloomberg.com/features/2015-mkopa-solar-in-africa/>

[4] This is based on data from the 2008 M-PESA panel rather than the 2005 KIHBS, allowing us to get a more recent data point. But, since the M-PESA panel combines kerosene, charcoal and firewood, we use the KIHBS ratio of expenditure on kerosene to these other estimates to arrive at this figure. This is a higher end estimate, given that only Kenya locations with at least 1 M-PESA agent were included in the M-PESA panel sample and so the resulting sample was more urban than the national distribution.

[5] None of the publicly available national household surveys that we reviewed separately tracked spending on phone battery charging. Very few Diaries households paid for charging, usually charging with friends or at a workplace. Those who did pay occasionally paid KSh 5 per charge. Few without electricity have smartphones requiring frequent charging.

[6] 2016 FinAccess household survey

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Christopher Koulouris

The rise of off the grid communities

The idea of enjoying a totally self-sufficient lifestyle, while still making use of all the conveniences of modern life, once seemed like a far-fetched dream, and you'd be forgiven for thinking it still is.

It may come as a surprise, therefore, to learn that the opportunities for self-sufficiency have been steadily growing, so much so that off-grid communities are springing up everywhere. Here are a few reasons why their popularity is increasing all the time.

Financial benefits of living off the grid

During the last few decades utilities have become more and more expensive, while energy companies continue to reap higher and higher profits. Opting out of water, sewerage and power charges certainly requires an initial outlay, but the virtual wiping out of ongoing energy costs more than makes up for that.

For example, the Three Rivers Recreation Area is roughly a one-hour drive from Bend, Oregon and covers some 4,000 acres. There are about 500 homes there, all of which are off the grid. Solar panels and wind turbines supply the electricity and the inhabitants also use back-up generators. Water is sourced via local wells and also through haulage service operators.

Other benefits

Besides financial benefits, you'll find that many of these communities grow around ideological policies and systems. For example, The Way Inter-

national operates as an off-grid community spread over a multitude of locations throughout the United States and worldwide. With their headquarters in rural Ohio this is a non-denominational group attracting those with specific interests in biblical research and teaching.

Over in Earthaven the people of this aspiring eco-village near Asheville, North Carolina are interested in developing a sustainable, holistic culture that is kind to the Earth. Natural materials are used for building homes that are solar powered and those working on the land adopt permaculture principles.

Challenges of off-grid living

You could be forgiven for thinking it's time to pack up and move to one of these wonderful communities right away, however, living off the grid brings risks as well as rewards. Your home is more hands on when power, heat and water don't necessarily arrive instantaneously. Sometimes things go wrong and it's down to you as a homeowner to understand why and to put it right. You may be restricted in terms of what you can do and when. For instance, if there is insufficient power because there has been less sunshine than usual you may not be able to run a washing machine for a while.

On balance, however, there are more advantages than disadvantages to living off the grid. People have to think harder about their impact on the environment, often they learn new skills if they are growing their own food and begin to live more

responsibly in terms of what they consume and how they recycle. A good tip is to try living in one of the communities for a short period of time – some homes are available as vacation rentals and provide a genuine taste of the off-grid living experience.

Christopher Koulouris is Editor in Chief at scallywagandvagabond.com.

Elizabeth Littlefield

Off-Grid energy for rural communities: bright promise and caution lights ahead

At the global climate change conference in Marrakech this week, big issues about the political winds and worries about the progress of climate finance will be high on the agenda. But one of the good news stories is happening just below the radar of the climate talks and that is the revolution in distributed, small-scale, off-grid clean energy.

Off-grid renewable energy for rural areas is booming. It has captured the attention and investment agendas of aid and development finance organizations along with the imagination of socially responsible investors and techno-optimists.

The off-grid energy sector is now proving itself to be commercially viable and scalable. The business models range from a solar home kits that provide a single panel that can produce enough power to power a light and a cell phone charger and a fan to larger biogas digesters that provide a network of poorer villages with power by extracting gas from agricultural waste.

The Overseas Private Investment Corporation (OPIC) is the U.S. government's development finance institution. Since 2009, our off-grid energy portfolio across the developing world has grown to more than \$140 million, bringing light to families and villages located far from their nation's electricity grids.

For example, Greenlight Planet, an OPIC investee, makes affordable solar lighting and phone charging devices and is now expanding its network

in Africa and Asia.

Furthermore, in Nigeria, an OPIC loan to a small company called Txtlight Power Solutions, doing business as Nova Lumos, is helping to finance the expansion of their solar rooftop business. Lumos' solar home kits consist of a solar panel, battery, LED lights and a mobile phone charger and are small enough to be carried by foot or bicycle, are simple to install, and allow customers to buy solar-powered electricity on a lease-to-own basis. To date, Txtlight has successfully deployed over 20,000 systems to customers in Nigeria. With OPIC support, Lumos will be able to provide access to reliable electricity to some of the nearly 90 million Nigerians who are not connected to the electricity grid.

Our team is proud of the agency's pioneering role, and excited about the road ahead. However, several sources of uncertainty are evident.

A technological revolution has brought an exciting profusion of clean energy devices into the market within a very short period of time. Between 2010 and 2015, investors poured more than \$500 million into off-grid energy businesses, and nearly 89 million people currently use at least one solar off-grid lighting product in their homes.

Some of these products will prove to be reliable, efficient, durable, scalable and capable of garnering loyalty among end users and confidence among investors. However, many will fail, and we should view those failures as drivers of advance-

ment and competition. So managing expectations will be key, and developing international quality standards for these new technologies will be a powerful means of concentrating efforts on the most promising models.

The finance and economics of energy provision is likewise undergoing a revolution. Massive, fossil-fueled grids operated by regulated utilities have balance sheets, time horizons and regulatory challenges that are far different than off-grid renewable projects. In the off-grid sector, entrepreneurs and governments are only beginning to experiment with business models and regulatory systems to govern them. The sector is mostly made of young companies struggling to find necessary equity capital to fuel their growth.

Fine-tuning a business model that is attractive to both equity and debt providers is difficult. Some companies earn revenue from equipment sales, or long-term leases. Others, from usage fees. . Still others take a franchise approach, expanding village by village. Each of these models has had some accomplishments and some setbacks, which means that lenders and investors are steadily honing in on the ingredients for success. Ultimately, this will create a strong foundation for commercial financing in the medium term.

The local regulatory contexts in which these companies are seeking to thrive will be highly consequential, too.

Each developing nation has a unique profile of energy endowments, infrastructure and needs. The major fluctuations that the world has witnessed in demand, supply and prices of oil, coal and gas in recent years will undoubtedly affect the future of off-grid renewable energy supply. Rural populations in some nations, for example, are still heavily reliant on diesel generators for electricity. The market for diesel generators in Africa is estimated to be an astonishing 60gw installed per annum.

Despite the current low fossil fuel prices, many governments continue to subsidize diesel (directly or indirectly) which will undermine the growth of their off-grid energy markets. Fossil fuel subsidies worldwide are estimated to be between \$500 billion and \$650 billion annually. Subsidies for renewable energy are estimated to be one quarter of that. Put simply, off-grid technology now has enough momentum to get one step ahead of the fossil-fuel world, but it is not free of its shadow.

Finally, it is worth recalling that the business of power (electricity) is deeply intertwined with the business of power (politics). The electrical grids of poorer nations are legacy assets that -- at least at the edge of the existing electrical grid where power supply can be unreliable -- may soon find their monopoly threatened by these new and sometimes more reliable off-grid alternatives. Established fossil fuel-based companies and government agencies may stand by idly in the face of gradual obsolescence. Backlashes will come.

OPIC will continue to support off-grid renewable energy companies in the developing world. With a conservative balance sheet, expert staff and mandate to take a long-term perspective, the agency is uniquely qualified to survive the ups and downs ahead. It is crucial that we do so. There are still 1.2 billion people across the globe who have no access to the power grid, and millions more with unreliable power. We can bring them clean, affordable, reliable power and light, and we will.

Elizabeth L. Littlefield is President and CEO of the Overseas Private Investment Corporation (OPIC), the development finance institution of the U.S. Government.

Kagonda Njagi

As solar power expands the work day, incomes rise in eastern Kenya

Violet Karimi spends her days as she always has, attending to household chores and working on her farm.

But when the sun goes down, she now has a second job, thanks to the arrival of solar lights in this town in eastern Kenya.

Each evening the widow leaves her three children studying at home by the light of a solar lantern and takes fruit and vegetables harvested on her farm to sell in Embu's open air market.

"I collect my stock and head to the market where I trade until late in the evening," said the 36-year-old. "This is possible because the solar lights in the market and the rest of Embu town are switched on the whole night."

On a good day, she said, she can bring home as much as \$30 - at least three times as much as she could sell in a shorter evening, before the lights made longer trading hours possible.

"Customers want to shop in the evening because that is when they leave work," she said. "The solar lighting has encouraged them to stay and buy as long as they like."

Solar energy - for lighting and to power businesses - is gaining a foothold across rural Kenya. In towns like Embu it is opening the way for new businesses, or new business hours, and giving families a chance to boost their incomes.

Safer, richer
Karimi says the solar lights that shine over the

Embu market each evening have other benefits as well. Even after working late into the evening at the market, she feels comfortable hiring a motor-bike taxi to take her home.

"The streets are well lit with solar energy and so I am not afraid of traveling at night because there is security," she said.

Others in Embu County have seen benefits for their businesses from the installation of the small solar grids, which collect solar energy, store some of it in batteries for use at night, and distribute it to customers.

Joe Njiru pays \$10 a month to the Embu County solar micro grid, but makes five times as much from his bar business, he said.

The bar's eight light bulbs and satellite TV help keep customers chatting, debating local politics, and buying his beer past midnight.

Two years ago, few customers would stay past 8 pm, he said. The bar had a power connection to the national grid, but was often beset by power outages.

"Every day there were blackouts in the evening because that is when people with illegal connections would interfere with electricity as they tried to switch on," said Njiru. "Customers could not stay long because they feared to be mugged on their way home."

Energy company officials also sometimes visited to disconnect his power, saying he had not paid his monthly bill, Njiru said.

Now he uses a mobile phone banking system, M-Pesa, to top up his monthly credit.

"For us, investing in the solar project is a double win," said Embu County Governor Martin Wambora. "Solar energy is cheaper to maintain in the long term and puts us in solidarity with the world's push for a global green economy."

High costs for mpower hungry

That's not to say solar energy is working for everyone. Susan Muthoni, for instance, would like to invest in a laundry business.

But to power a washing machine and a refrigerator for serving soft drinks to customers she would have to pay as much as \$150 every month in energy costs to the Embu County micro grid because of the large amount of energy the items consume.

A typical solar energy customer, who uses the power to light up their home and run a welding business, pays about \$10 a month, said Francis Muchiri, the communication and knowledge management officer with Advocacy for Gender and Energy in Kenya.

"This is where development partners should come in and support solar micro grids with finances so that they can be able to expand their generation and storage capacity," said Lois Gicheru, the chief executive officer of Solafrique Ltd., an enterprise that works with African communities to help them access renewable energy.

Solar advocates say that with solar lighting established, Kenya's counties should now focus on generating enough power to run businesses.

Mendi Njonjo, the regional director at Hivos East Africa, which works on sustainable energy issues, said Kenya's counties are diversifying into manufacturing, and will need to cut their energy costs by investing in cheaper sources of power.

Kagonde Njagi is a freelance contributor for the Thomson Reuters Foundation, based in Nairobi and writing on climate change issues.

Christabel Ligami

Pay-as-you-go solar model brings security to small Kenyan communities

Deep down in the small village of Tikoishi, in Kajiado county about 100 kilometers off Nairobi city, both men and women are leaving to tell stories of their sleepless nights and battles with the wild animals to protect their livestock.

Living on the edge of Nairobi National Park, located in Kenya's capital city, Nairobi, the Maasai communities have been battling consistent attacks by the wild animals that kill and eat their livestock in the night.

The marginalized Kenya Community entirely depends on livestock for their livelihood as they live in arid areas but for the past years the men have been spending the nights outside in the cold to keep wild animals from eating their livestock.

It has been entirely the men's work to keep off these wild animals in the night using all possible means including lighting fires the whole night near the cattle bomas (cattle enclosure), using lantern light, chasing the animals away using the spotlights. This has been very risky to their lives as they are instead attacked by the wild. Women in this region have lost their husbands and sons who are on some occasions attacked by the wild animals in the night while guarding their herd and some have sustained serious injuries in the process.

But a solar project being spearheaded by SunTransfer is changing lives in this region and men are now starting to spend more time in their houses.

SunTransfer's related companies for distribution and/or assembling, like the one in African, are in Kenya and Ethiopia.

In Kenya, the company has installed over 3,000 solar panels to individual rural homes and five to dispensaries.

The project consists of a pay-as-you-go financing model that enables families in rural off-grid areas to purchase a solar home system via an installment credit. With the money otherwise spent on fuel for kerosene lamps, the credit can be paid off within three years.

According to Samuel Wanjiru, SunTransfer manager in Kajiado, the pay-as-you-go model offers its solar systems either on cash or credit terms, depending on what suits the customer most.

"Depending on the package, the interest rate is 1 percent for a period of between two and three years if the customer opts for the credit mode of payment," Wanjiru said.

The project in Kajiado is being spearheaded by women, who are helping in the marketing and awareness creation about use of affordable renewable energy to the homesteads — a unique occurrence in the region, since Maasai women are highly discriminated and are known to stay at home looking after their families.

Beatrice Marpe, 55, is a women leader in Tikoishi. Although her main role is to help women in this village solve their marital issues, she is now the ambassador of renewable solar power in this region.

Her role became complicated after women started complaining about losing their husbands due to the attacks by wild animal and/or complains that they are not spending much time with their husbands because they are out the whole night guarding their livestock and the whole day grazing them.

"When SunTransfer approached me in July 2014 with their solar idea and how I could use it to protect my livestock against the wild animals — although not sure of it — I took it," the mother of four said. "I was not sure that it would work as they explained because I had not seen it work anywhere else before." She said that she had just lost her husband and was desperate because his role of guarding our livestock had now been entirely taken over by her younger son.

She took the home solar system package that has both the lighting and a television system for use both for the livestock and in the house.

"With the solar energy, the light not only scares away the wild animals and keeps off our worries about losing our cattle at night, it has enabled my sons to spend the nights in the house with the rest of the family members," she said. "Compared with kerosene and firewood, the cost is now low and it is more convenient. We are also able to watch TV unlike before — something that is rare in this area."

Before installing the solar power, her household spent at least US\$0.50/day on kerosene alone to light outside in the animal bomas where her 172 cattle sleep. "Since installing the solar, I have not had a problem with the wild animals," she said.

As women visited her home, she would explain how the solar energy works and encourage them to take it up too. A majority of the women were interested, but the challenge was convincing their men to agree to the idea.

"I realized very few women would convince their men to take up the solar energy, and with the Maasai tradition, a woman cannot overrule the man's decision, so I decided to change tact and encourage them to combine efforts," she explained. She formed a group of five women willing to take up the initiative and encourage them to contribute at least \$5 or whatever they could afford to a central fund.

"Once the money is enough to give the first instalment based on what package they wanted,

they go ahead and pay and start contributing for the other family in their group," she said. "This has been working very well and the men are now even getting more involved."

One such family that has benefited is that of Sikampe Kotikash, who lives in the same neighborhood with Marpe. They have installed the solar power only for their livestock. "We needed the light for the livestock more than for our household use," Sikampe said. His two wives, Sylvia Sikampe and Purity Sikampe, teamed up to contribute to the first instalment for installing the solar power.

"We make beaded bracelets and sell to people in the village or sometimes at the market," Sylvia Sikampe said. "After being introduced to the solar energy idea, we decided to actively sell the beads and install it. Our husband, after seeing it work, got more interested and has now taken over the decision to pay the remaining amount."

She said that her husband no longer has to sleep outside, and their livestock is safe.

"The solar light, scares the hyenas away, so we don't have to worry about losing our animals at night," Sikampe said. "All my brothers and most of my friends have installed the solar power after me because they have now seen the benefits."

SunTransfer Kenya was established in 2009 to provide full power access to off-grid areas. "Our main target is to install power for families in rural off-grid areas," Wanjiru said. The lifespan of the SunTransfer solar is 20 years, enabling the families to significantly reduce their lighting expenses.

The solar systems come in different packages — ST20 comes with four light bulbs, a 20-watt solar panel, 12-volt battery, and phone charging kit. The ST50 comes with five light bulb, a 50-watt solar panel, and 38-volt battery system. ST100 has six light bulbs, a 100-watt solar panel, 24-inch digital TV, phone charging kit, and DC/AC inverter.

Installation and maintenance of the solar is done free of charge. "The logistics however can be very challenging — villages in Kajiado in particular do not have good roads so delivery of the solar panels to the people and access to some homes is difficult," Wanjiru said.

Christabel Ligami is freelance journalist in Nairobi.

Business

Ann Brown

Rwandan entrepreneur's solar-powered mobile kiosks charge phones, create jobs

Mobile phones are essential in Rwanda. More than 70 percent of the population owns a one and many people own two or more. Yet, just 22 percent of people have access to electricity, meaning they have trouble charging all these phones, according to the Rwanda Utilities Regulatory Authority.

This is where entrepreneur Henri Nyakarundi saw a niche. His business, African Renewable Energy Distributor (ARED), consists of solar-powered charging kiosks that provide phone charging as well as airtime and mobile money transfers. He has developed a franchise system where people run his kiosks as their own businesses.

Nyakarundi won the American Society for Mechanical Engineers' Innovation Showcase which recognizes entrepreneurs for hardware-led social ventures.

The son of Rwandan refugees, Nyakarundi was born in Kenya and grew up in Burundi. He went to Rwanda for the first time in 1996 on vacation after the war ended. Moving to Atlanta, U.S., in 1996, Nyakarundi attended university, earning a degree in computer science from Georgia State University. In 2012 he returned to live in Rwanda full time.

Nyakarundi spoke to AFKInsider on why he left the US to venture into the solar business in Rwanda.

AFKInsider: Why did you leave the U.S.?

Nyakarundi: I had built a successful trucking business in Atlanta, but it can be really hard to

maintain a business in the U.S. Your life is all about work. And during the economic crisis I started to reevaluate things. I didn't just want to only make money. I wanted to do something that would help people. I was at a crossroads and I wanted to do something more meaningful with my life.

AFKInsider: The Rwanda you came home to must have been a very different Rwanda.

Nyakarundi: Of course. Even though I grew up in Burundi, we would try to visit Rwanda and at that time Rwanda was going through a lot of problems. It was nothing but a desert. When I left, I told myself I would never come back but in 2008 I really started looking into coming back. I really didn't like the social life of the U.S. Everything is about money, so I was really considering moving to Africa. Today, Rwanda is developing into a great country full of opportunities.

AFKInsider: How does your company, African Renewable Energy Distributor, work?

Nyakarundi: It is a mobile solar kiosk platform I created to promote entrepreneurship at the base of the pyramid using a low-cost franchise business model. We offer solar-powered mobile kiosks, through which people can make money by letting people charge their phones, among other services.

AFKInsider: Why the phone charging kiosk?

Nyakarundi: When I came back to Rwanda I realized renewable energy was a fast-growing sector

and there was a lot of space for innovation. And it was important for me to create something that catered to the African market. Cell phones are growing rapidly in Africa, yet electricity is still a problem for so many, especially in Rwanda.

And I knew this would be challenging. For me that is the most exciting thing about this. There are so many challenges, and I love overcoming challenges.

AFKInsider: How did you fund your startup?

Nyakarundi: I have self funded the whole project. It took two years to develop the kiosk but I initially came up with the idea in 2009 while still in the U.S.

AFKInsider: Is the Rwandan government helpful to small business owners?

Nyakarundi: No, and I don't expect them to be. Of course they have programs for small businesses and are starting an innovation program, but it is my belief that governments should focus on other things besides innovation. Like all governments, the government in Rwanda moves too slowly to truly support innovators. Innovations is something that has to be acted upon immediately and the government is just too big, too slow to do that.

AFKInsider: What have been some of challenges you have faced?

Nyakarundi: Getting people to understand the importance of innovation, as well as the usual start-up challenges such as funding, development, and finding employees.

AFKInsider: How has business been?

Nyakarundi: We're growing. Right now we ha-

ve 25 kiosks, 30 percent of which are run by women, and 5 percent are run by people with disabilities. We plan to have 100 more kiosks this year and 500 total in Rwanda.

AFKInsider: Why should someone franchise run one of your kiosks?

Nyakarundi: We take care of all the back end for them, so all they have to do is plug into our system, take the training, and then find a location.

AFKInsider: What are you looking ahead for 2016?

Nyakarundi: To finish the development of a new, updated kiosk and (development of software that provides content) — M-Shiriki. With M-Shiriki, content providers will be able to use the new kiosks to conduct surveys, provide educational content and even conduct campaigns. Artists can even upload content on to the server for purchase by the end user. Content providers load their content on African Renewable Energy Distributor's centralized hard drive. Users will have access to the content. And we currently have a partnership with the Red Cross and have already put these kiosks at all of the refugee camps where a majority of the refugees are kids. The camps have a problem educating these kids, and now they can access educational content from our kiosk. We also want to expand our coverage to Uganda, Kenya, and South Sudan over the next year.

Ann Brown is journalist, working for AFK Insider.

Amy Bainbridge

Trading solar-generated power between households to change the way consumers buy electricity

The concept of bypassing major energy retailers to trade rooftop solar-generated electricity between households, small businesses and community groups is inching closer to reality.

This month's arrival of the Tesla battery in Australia is slated as a major shift in favour of consumers taking charge of their energy storage.

One Sydney entrepreneur has devised a system that would allow consumers to set up a virtual shop to trade their surplus energy with other households, small businesses and community groups in their grid.

Jitendra Tomar, from the Sydney-based start-up Local Volts, said it was about changing the way consumers buy electricity. "Anybody, whether you're big or small, whether you're a farmer or residential person, whether you're a high school or tennis club, can become an energy farmer," he said.

"If I'm buying electricity, I can say 'well I just want to buy for next month' and I have a preference for rooftop solar coming from Manly, and if that's not enough for me, I will take something from New South Wales as long as it's rooftop solar, and if that's not enough, I'll go for windmills.

"And if you're people living in an apartment and you want to buy from your tennis club, because you like the price, you have a special price for tennis club members, you say 'yeah, I'll buy electricity from my tennis club'. So finally we're going to have a choice."

CitiPower and Powercor owns more than half of the poles and wires in Victoria's power network. The company is installing 18 test sites for solar battery storage as part of a three-year trial to look at the network impact of solar batteries.

Glen Thomson, from CitiPower and Powercor, said he could see a future where traditional power generation was bypassed. "There's no doubt that over time, the centralised model will come under greater threat, as home-based generation grows," he said.

"We see our grid as ultimately [being] the spine of allowing that to occur, as micro-grids are formed, as home generation technologies are rolled out over the next decade or so. "We are looking at what is the best way to enable our grid to use innovative technologies and enable customer choice."

Homeowners, community centres jump on Tesla trial

Homeowner Louise Holthouse had a battery installed as part of the trial and said she was keen to see the results. "We've really noticed that over the 10 years we've been here, that power prices have increased, and our family is not a large family with only two children," she said. "We've been given a password and a module that we can get to on the internet to check our consumption and also to check our storage in the battery."

The Institute for Sustainable Futures at the Uni-

versity of Technology Sydney is conducting virtual trials of local energy trading at five sites along the eastern seaboard. The Footscray Community Arts Centre in Melbourne's Western suburbs is looking to become the first organisation of its kind to be powered by solar.

CEO and director Jade Lillie said the centre was running a crowdfunding campaign to combine with philanthropic donations to buy the panels and a battery. "We're putting 30 kilowatts of solar panels on this roof, which is the warehouse, and 10 kilowatts of solar panels on Henderson House, which is the heritage-listed building," she said. "What we'll be able to do is actually through the Tesla battery is store that energy during the day as well and then use it in the evening so we're less reliant on mainstream grid-based power sources."

Ms Lillie says the centre aimed to save \$15,000 in power bills each year. The project will also fund LED house lights for its performance space. The Australian Energy Council, which represents retailers and generators, said it was early days, but there was work underway to study the implications of solar trading within the electricity grid.

With a large component of energy bills made up of network fees and charges, it remains to be seen how much cheaper energy bills will be if consumers are able to trade between each other.

Amy Bainbridge is the ABC's Consumer Affairs Reporter.

Energy4Impact

Business mentorship gives entrepreneur a choice

Mkirya Magera was a small-scale farmer who depended on proceeds from cotton to provide for his family. However, the returns were poor because farming costs were high and there were no government subsidies. So he started to look for other ways to make a living.

In September, 2013, Mkirya, a resident of Mwanzabuliga village on the eastern shores of Lake Victoria in Tanzania, decided to invest the meagre earnings from his harvest into a new business. Having seen how he and his fellow villagers had to travel up to two kilometres just to power their mobile phones, he decided to set up solar phone-charging venture. He built a small structure where he installed a 60-Watt solar panel at a cost of TZS 450,000 (\$ 206). The business grew and he was soon charging 20 phones a day.

In 2014 as he was striving to grow his business, Mkirya came to hear about GVEP and the work it was doing with businesses to increase access to clean energy. He was offered mentorship on financial, technical and business skills from GVEP under the Capital Access for Renewable Energy Enterprises (CARE2) programme which supports solar phone charging businesses. Importantly, the mentorship helped him identify more business opportunities in his area.

As his business started to attract more clientele to the area, the ambitious entrepreneur felt the urge to expand. Through GVEP's financial linkage Mkirya obtained a TZS 1,000,000 (\$ 459) loan from Tanzania Postal Bank in August, 2014, which he used to buy a 200- Watt solar system. He then

ventured into a hair cutting business alongside phone charging. The barber shop picked up momentum and within days he was attending to at least five clients a day. His flourishing business enabled him to clear the loan in a short time and soon Mkirya was making an average of TZS 360,000 (\$ 165) a month, up from TZS 180,000 (\$ 83).

"The financial assistance I received enabled me to meet the growing need for phone charging services in this area. The initial solar output could not sustain many clients at a go. Acquiring more capacity meant more and happy customers," says Mkirya.

His hair cutting business also registered remarkable growth as his income leaped from TZS 75,000 (\$ 34) per month in the few weeks of business start-up to TZS 225,000 (\$ 103) per month.

"The business has immensely transformed my life. Besides educating my children, I have been able to plough the profits back to other economic activities," says the father of four. His two children are in secondary school while the rest have completed school and are civil servants.

Mkirya has also bought four bulls that he uses to till his eight-acre field, from where he grows a variety of crops. He also offers ploughing services to neighbours at a fee. He has also bought four dairy cows and makes money by selling their milk. "Initially, I only had three acres of land, but which I managed to increase as my farming business expanded," he says.

His family life has also transformed. He has

bought a motorbike that he uses for transport and has constructed a hygienic modern pit latrine for his home. He plans to set up a bigger shop in the area later this year.

He says GVEP's intervention has seen him overcome several obstacles in his business including the competition he faces from upcoming similar businesses in the area. Improved marketing and customer care skills have given him an edge.

"GVEP's sustainable and impactful mentorship to entrepreneurs like Mkiryia has made it possible for them to provide energy and related services in

off-grid areas. We identify market opportunities in respective areas and advise entrepreneurs to venture into them for maximum returns," says GVEP's Tanzania Country Manager Adam Mbwambo.

Energy 4 Impact is a non-profit organisation working with local businesses to extend access to energy in Africa.

Tim Nixon

5 signs sustainability is the new engine for global economic growth

Strong crosswinds are in the global economy. The Fourth Industrial Revolution is here, with pervasive transparency, unlimited information access and accelerating disruptive technology and change.

Rapid adaptation never has been more important as corporates spread globally, facing new regulatory and environmental challenges across their operations and supply chains. Security and immigration concerns are everywhere.

Climate change poses not only an environmental threat, but has become a disruptive change agent for business, driving new requirements for growth with lower carbon footprints. What is new in all this is flux the enormous economic opportunity created in the emerging global response to these challenges.

But sustainability is the transformative economic catalyst which also happily aligns with our own basic self-interest. Specifically, it's about "sustainable growth," by which I mean increasing prosperity while at the same time improving environmental and social performance.

Why does this "sustainable growth" matter so much? The answer is because the great movers of our global economy are orienting towards it, rewarding better performance and punishing risk. Here is how they are concentrated:

1. Customers

Customers everywhere, of all sizes, increasingly

are asking about sustainability performance when making purchasing decisions. On the business-to-business side, large players with even larger supply chains are requiring increasing disclosure and performance around greenhouse gas reduction, diversity, labor rights and anti-corruption. On the consumer side, as transparency and reporting get better, consumers are increasingly able to make informed decisions to buy products which cost the same, but do less harm to the world.

2. Regulators

New regulatory frameworks around carbon, diversity and many other sustainability related factors are emerging and growing. Examples include the new European requirement that corporations report on sustainability risk, and the U.S. Clean Power Plan, coupled with the corresponding double digit growth in the global consulting industry to advise on these trends.

These "impact economy" frameworks are emerging, and will mandate that companies innovate in incredible new ways, to grow without doing social and environmental harm. These frameworks will unleash a torrent of adaptive innovation, creating unforeseen and surprising technological advancement, and new potential for human prosperity.

3. Investors

Investors are increasingly seeking less carbon-

intensive and more environmentally and socially friendly portfolios. Global bank HSBC recently reported that around 30 percent of all assets under management are using some kind of sustainability strategy or filter.

This trend is up from almost zero 10 years ago, and all of this money seeking new sustainable business models will create opportunities for new entrants in the marketplace, and older players who can adapt and thrive. It's a capital rules reset, with an accidental but happy ethical bias. New fortunes will be made for those who adapt, and the rules don't necessarily favor the current economic and political oligarchies.

4. New energy

New energy-infrastructure build-outs are booming, especially in the developing world. The COP21 gathering of global policy-makers, corporations, investors and innovators points more than ever to this enormous opportunity for economic growth.

The consequence of all this capital flowing into energy infrastructure not only will be economic growth as these systems are built out, but also new capacity for access to the information and innovation which comes from reliable energy.

The end game is a developing world with ubiquitous, cheap and renewable energy, and a huge new economic powerhouse with its human

capital no longer inhibited by the daily struggle to eat and stay alive.

5. Values

With all of this movement towards finding and enforcing sustainable growth, we inadvertently are finding a common language across cultures, religions and even politics. The headlines are full of news about what divides us ideologically and spiritually, but these belie the great areas of commonality shared by the vast majority of human beings. I'm talking about the instincts we all share for preservation of those we love, and the desire to see subsequent generations enjoy meaningful and healthy lives.

Sustainability and sustainable growth will help to make these ethics transparent and explicit. It will celebrate them. Sustainability taps this common spiritual and psychological space, and creates a common ethical language around which the world's innovators, investors, regulators and consumers can rally. And in this common space, we can find a new global prosperity.

Tim Nixon is Managing Editor of Sustainability at Thomson Reuters.

Kassahun Y. Kebede

Co-opetition: A way forward for solar actors in developing countries

During my PhD study on the diffusion of solar energy technology and associated technological innovation system building for enhanced diffusion in developing countries, I came to learn that there has been less engagement with the business strategies we often see applied in other business areas.

Random list of factors were being mentioned as barriers to the successful diffusion of solar PV systems to electrify the rural communities throughout the globe. Also, NGOs and NPOs have been the main actors and few market oriented approaches were introduced to the solar market in developing countries like that of Ethiopia.

There have been many promising initiatives that lived for a while and proved unsung success. Unfortunately, lessons learnt locally from such efforts and upscaling of those efforts have been a rare phenomenon. The local government, supposed to scale up effort, may not even know what has been going on around; in some worse cases, pertinent offices/officers were found to be ignorant of what is going on in their own field. As a result, local recognitions were reported after international media and organizations acknowledged the efforts.

A seemingly funny encounter I had during a field research in Ethiopia was that three actors (Government, NGO, and private sector) were fighting for supplying solar home systems for a village in three different ways: subsidy, donation, and market sale; it may look healthy to see such

options available for the villagers but it would be unhealthy to see this redundant effort while the play-ground is so wide, having dozens of un-electrified villages in the vicinity.

Moreover, all of these 'competing' actors have got no closely available center for maintenance or after sales service delivery. Many of the solar home systems in the village were not functioning for mere maintenance problems.

In order to have successful adoption of solar PV systems in developing countries, there is a need for co-opetition among the solar actors! Co-opetition has been a prevalent business concept that emphasizes the simultaneous competition and cooperation between firms (actors). It was first introduced in the 1980s by Raymond Noorda (Luo, 2007), and the concept became popular after the study presented by Brandenburger and Nalebuff (1996).

Individual firms may cooperate for different reasons; it could be: to learn more about their rivals' competencies; to solve common problems and; to influence rules and regulations (Tether, 2002).

Solar actors can co-operate for having a common service center very close to the rural community (for maintenance and after sales service provision); they can co-operate for influencing rules and regulations related to solar market, and lobby together for creating conducive environment for faster adoption of the technology. Then, they can compete in this untapped market potential

through delivery mechanisms, quality and price of their products, etc.

The idea of co-opetition among solar actors seems well practiced in very few developing countries such as in Bangladesh where NGOs, NPOs, and the private sector work closely with Government organizations in creating local Solar PV industry and enhancing faster adoption of the technology among the community, and at the same time competing for the solar market share.

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Shweta Maheshwari and Jeanne Finestone

Lighting the way to women's economic empowerment

The women of East and Northeast India no longer need to fear the dark. ONergy, an award-winning social enterprise, has developed a number of innovative energy solutions that not only address the dearth of electricity in the region – improving safety in their communities – but also light a path toward economic empowerment for women.

ONergy's innovative solar power solutions are providing energy to meet India's development and social challenges. To promote solar as a clean and reliable source of energy, the company is training women entrepreneurs in its products' technology, usability and special features. By partnering with local grassroots organizations – microfinance institutions, NGOs and women's self-help groups – the company is imparting product know-how while also enabling these women to serve as company distributors – providing both income and empowerment.

"Lack of energy is an important bottleneck to development. And women are the central force in the development of their families and the shaping of the next generation," says Piyush Jaju, CEO of ONergy. "ONergy's products provide environmental benefits by reducing the use of diesel generators, kerosene and other harmful energy sources – and empower women to help shape a brighter tomorrow."

Sandhya is a living example of how ONergy's entrepreneurship programmes are creating change among India's poor people. Prior to working with ONergy, Sandhya, 24, and her husband could

barely make ends meet financially. With the organisation's support, she acquired a small loan from a local microfinance institution and began conducting demonstrations on the advantages of solar power, the uses of ONergy's products and the ease of buying them through microfinance institutions. She is now able to light up her home, which allows her child to study more easily. She occasionally accompanies her husband to the fields, which utilize an ONergy solar-powered irrigation pump. By being the first to electrify her house, and by taking the initiative to spread awareness of the benefits and opportunities of solar power, Sandhya has become an inspiration for many women in her village.

But ONergy's solar products are not just helping the women who market them. Tumpa, an embroiderer, was also struggling to make ends meet. Her village in Sunderbans – the largest Mangrove forest area in India – is also home to many wild animals, which made night time visits particularly dangerous. And without light in her home, she had to stop working at sunset. Tumpa and her husband invested in a solar light that not only illuminates their home, but is also light and powerful enough to carry outside, making it easy for her to use in her travels. Since then, Tumpa has doubled her output, her children can study in the night and she travels from one place to another without fear of being attacked by animals.

To date, ONergy has provided training to more than 2,000 women and aims to reach 50,000 in East & North East within the next three years. The

company has developed products for solar irrigation and micro cold storage (for agriculture), low-cost solar computer systems (for education) and solar microgrids (for livelihoods). It has built an ecosystem that connects technology, finance and grassroots organizations to manage the needs, aspirations and resources for undeserved customers at the base of the economic pyramid. To date, ONergy has impacted 350,000 lives, and working with its microfinance and NGO partners, the company plans to brighten the lives of 1 million women in the next two years.

In 2015, ONergy joined the Business Call to Action (BCtA), a global initiative supported by the United Nations Development Programme and other international organizations that encourages

companies to fight poverty through innovative business models, with a pledge to scale up its successful product distribution network in order to bring reliable solar-powered products to India's poorest and underserved regions. The expansion is expected to provide solar energy to 1 million people by 2017 and reduce CO2 emissions by as much as 100,000 tons.

Shweta Maheshwari works for ONergy (Kolkata), Jeanne Finestone for UNDP.

Justin Guay

Who will serve the world's missing middle?

Diesel generators are the world's most ubiquitous distributed energy technology - they're also ripe for displacement.

Around the world a growing number of distributed clean energy technology start-ups have aimed their sights at ending energy poverty by serving a vast untapped market - the 1.2 billion unelectrified people around the world. Their efforts begin by getting people on the first rungs of the energy ladder as quickly and cheaply as possible with pico solar devices that power basic entry level services like lighting and mobile phone charging. Over time they will, in theory, move these populations up the ladder by providing them with ever expanding levels of service. Whether ultimately connected to stand alone home systems with storage, mini-grids or even grid extensions (if or when they arrive) there is only one direction to head - up.

Up the ladder they go

In many ways we see concrete examples of the ladder at work. Several of the beyond the grid (also known as off-grid) industry's leading companies began by meeting their customers where they were - wasting relatively enormous sums of money on heavily polluting and inefficient lighting powered by kerosene. They displaced this expensive fuel by serving their customers with a combination of the world's most sophisticated clean energy technologies - solar PV, LED lighting, and Li-Ion Batteries. We now regularly see and hear of companies that started at low rungs of the ladder expanding

their product lines to help them shift from selling things their customers need (lights, mobile phone charging) to things they want (TVs).

At the other end of the ladder, many nations have made tremendous progress connecting populations to the centralized grid - the very top of the ladder. Perhaps the best example is China which has connected 1.3 billion people to a centralized grid thanks to its economic transformation. The beauty of a centralized grid is that once connected you can power whatever you want from day one - you get the kitchen sink. However, for a variety of reasons including the cost of serving low population densities in rural areas and poor economic and political governance the progress of expanding the centralized grid has been uneven for many of the world's poorest countries. Worse in sub Saharan Africa population growth threatens to stall or even reverse the progress.

Chutes and Ladders?

But while both camps - grid extenders, and those operating beyond the grid - relentlessly focus on moving populations up the ladder a quiet crisis has conspired to thwart their efforts. That's because we have all assumed that once a population gets a grid connection the job is done. 24/7 power for an endlessly growing array of devices and demands. The reality is however much starker.

Some have estimated a population roughly the same size as the purely off-grid world suffer from chronic and prolonged blackouts. These are the 'under-electrified.' The regular blackouts they

experience don't just affect household energy demand, they reverberate throughout the economy as industry and manufacturing can be shut down for hours at a time - an enormous cost for poor economies where people get by on dollars a day.

The Missing Middle

That creates a perverse situation where poorly functioning grids send people the opposite direction we are all headed - down the energy ladder. When they do, they force people and enterprises to rely on the world's most ubiquitous distributed energy technology - the diesel generator (diesel gen set). Where these two flows of people meet is a vast poorly served market ripe for intervention. It's the missing middle.

IRENA estimates the market at 400 GW of installed diesel gen sets globally. A market that Navigant sees growing from 62 GW of annual sales to 103 GW in the next ten years coupled with \$538 billion in revenue all driven by poorly functioning grids in sub-Saharan Africa and South Asia. With some countries like Nigeria seeing capacity factors as high as 60% the diesel bill for backing up poorly performing grids is big. By comparison, the beyond the grid market, is dominated by roughly \$27 billion in annual kerosene consumption. Despite their differences the same economic principle holds - people are paying through the nose for expensive, polluting fuels that dirt cheap solar can displace.

Top down or Bottom up?

Eliminating energy poverty is a noble goal but there are a number of important reasons to tackle the missing middle. The first and most important is that these are also energy poor citizens whose economic productivity as well as potential outco-

me is stifled by a lack of power. At the same time thanks to its sheer size the market is bigger (though not more carbon intensive) than the US coal fleet which makes it a potential opportunity for driving carbon reductions. Last, and most important from a business standpoint, this market has one big upside - the population has had a taste of electricity and now values it so much they're willing, and able, to pay large amounts to keep the lights on.

That's why a race to serve the middle may be coming. On one side beyond the grid solar firms who began at the base of the ladder are moving up as the populations they serve expand their demand for energy services. On the other, large energy firms operating in utility scale markets are developing product offerings to move down the ladder. Firms like Gamesa for example now offer a hybrid solar, diesel, and storage product aimed at diesel displacement.

The strategic question now is who best understands the missing middle? It's a population that has largely been ignored because it's assumed that centralized grids function. But where they don't an enormous population has emerged that has proven distributed generation can flourish in emerging markets. For those operating in the shadow of dysfunctional grids the direction of travel is clear - it's time to move from kerosene killers to diesel displacers. Because the pot of gold may not be at the end of the energy ladder - it's in the middle.

Justin Guay is the Program Officer covering climate at the Packard Foundation.

Kizito Makoye

Solar panels power business surge - not just lights - in Tanzania

Samwel Nyakalege's life has recently become more of a grind - and that's a good thing.

The 33-year-old miller from Bwisya village, on Lake Victoria's Ukara Island, is one of the first to benefit from a project to bring solar power to residents and business-owners.

The entrepreneur, married with four children, has worked grinding millet, maize, rice and beans since 2007, but the high cost of fuel for his diesel generator made it hard to turn a profit.

"I used to buy a litre of diesel for up to 3,000 Tanzanian shillings (about \$1.40) and I needed at least 50 litres every week to run the generator. My business could hardly grow," Nyakalege told the Thomson Reuters Foundation.

But with the arrival of the first-ever solar-powered mini-grid at Bwisya, launched by JUMEME, a rural power supply company with government backing, Nyakalege has enough energy to run his power-hungry business - and no longer needs costly and polluting generators.

Cheaper power, in fact, means that he can expand his company.

"Solar power is a blessing to us as we can now serve more customers quicker and efficiently," he said. "I don't spend a penny to buy diesel. My motors work very efficiently using solar electricity."

Solar steps up

Around the world, as the costs of solar energy plunge, it is increasingly being used to power in-

dustry and businesses, a huge step forward from simply supplying lighting and basic electrical power in places like Tanzania, experts say.

Nyakalege, for instance, now uses solar power to operate his three milling machines simultaneously. He has employed three people to help him and has seen his customer base rise to 600 a day.

His income also has grown as a result, from less than 100,000 shillings a day on average (about \$45) to 400,000 shillings now.

He is now contemplating getting a bank loan to expand his business, he said.

Processing grain in Ukara, until recently, was a costly activity because the island was not connected to the electrical grid. Those who couldn't afford diesel-powered grain-milling services often had to grind their staple foods of cassava and maize by hand, a time-consuming activity.

The solar system at Bwisya is part of a project to provide reliable and affordable electricity to the nearly 2,000 households and more than 200 businesses on Ukara, in order to boost opportunities to earn an income.

It is the first of 30 such systems JUMEME plans to install over the next two years. They are expected to supply power to around 100,000 people, company officials said.

The company has even bigger plans for the longer-term, they said.

"Our goal is to set up 300 systems and serve up to 1 million people in rural areas across Tanzania

by 2022, making JUMEME the largest mini-grid operator in the country," said Thadeus Mkwama, one of the company's directors.

The project, jointly funded by the European Union and private investors with political support from the Tanzanian government, has a total budget of 38.4 billion shillings (\$17.6 million), Mkwama said.

Pre-paid solar power

In Bwisya, the largest village on Ukara, 250 customers are due to be connected to a hybrid power station consisting of a 60-kilowatt (KW) solar photovoltaic system and a 240 KW-hour battery bank. A diesel generator provides back-up.

The system will be extended in the second half of this year to connect the other villages on the island, Mkwama said.

The installation charges for individual homes and business are repaid by customers in instalments. Consumers pre-pay for their power, with costs per unit depending on the amount of electrical equipment they use.

JUMEME is working with GVEP International, a nongovernmental organisation, to train people on Ukara to use electricity for business purposes, such as producing wood and metal crafts.

Hamisi Bujeje, 30, has dreamed of owning a big carpentry workshop since he helped his father build canoes and dhows as a boy. But he said he has so far struggled to turn a profit in the business

he started in 2011. "My business has not been doing very well because of lack of power. I was incurring huge operational costs. I used to travel 29 km (18 miles) to the nearest island of Nansio to access electricity and have some items fixed," Bujeje said.

But along with cheaper solar power, he has access to new carpentry equipment, business coaching from GVEP and a loan scheme offered to entrepreneurs by JUMEME.

"I am looking forward to expanding my business and attaining my dream in the furniture industry," Bujeje said.

Domestic customers of the new solar power supply are also pleased with the change.

"The system is very good and so helpful," said Kulwa Mwenguo, a resident of Ukara "I have access to lights, charge my phone and I listen to the radio."

Mwenguo says he pays 3,800 shillings (\$1.70) each week for the service, less than two-thirds of what he used to spend on kerosene.

Kizito Makoye is a freelance correspondent for the Thomson Reuters Foundation, based in Dar es Salaam, Tanzania.

Zadie Oleksiw

Solar business models for growth: The private sector needs to lead on India's rural electrification deficit

The Indian state of Uttar Pradesh is home to the country's largest population of un-electrified villages. According to data collected by the Council on Clean Energy, Environment, and Water (CEEW), more than seventy percent of Uttar Pradesh's two hundred and twenty million residents still depend on kerosene lamps and diesel generators for lighting and electricity.

Much of the problem is rooted in the lack of commercial viability: in the absence of subsidies, it's difficult for both utility distribution companies and for small-scale energy providers to earn returns in a market where the primary consumers fall near or below the poverty line.

CEEW also found that almost half of households without electricity were connected to the grid, showing that lack of infrastructure is only one layer of inadequate power delivery. Coupled with unclear regulatory policies and the high cost of capital, small-scale energy developers face a high barrier to entry in India's off-grid power market.

In February, Uttar Pradesh's state government launched the first minigrid policy in India aimed at easing some of those barriers for private developers, and the state's regulatory commission ratified it earlier this month with specific guidelines on implementation and compliance from the utility.

In addition to creating a thirty percent project subsidy, the policy removes restrictive service rules, such as arcane licensing requirements to operate as an energy provider, and outlines ways

that minigrids can coexist with the central grid if it reaches a village where a minigrid is already operating. For the first time in India, the policy also recognizes private minigrid developers as legitimate energy providers.

Mini, micro, and pico: size matters in the off-grid solar market

Omnigrid Power (OMC) is one of those solar developers, and they are pioneering the anchor load model, arguably one of the most promising mechanisms to deliver electricity to the masses.

The idea is that the minigrid powers an anchor tenant - a commercial entity such as mobile towers, ATMs, and gas stations - that requires reliable, around-the-clock power. Founded by former telecom executives, OMC currently focuses on powering mobile towers by building 35-50 kW sized solar projects - at least thirty percent more than mobile towers typically need.

With the remaining power, OMC services surrounding households and small businesses as a secondary market, usually offering two light bulbs and a mobile charging outlet for as little as one hundred rupees a month.

The cross-subsidy from anchor loads makes it feasible for OMC to absorb the costs associated with small household revenue, and soft costs associated with customer acquisition and service. These can be the biggest barriers for many small power companies that deal directly with house-

holds and rely heavily on local trust and relationships.

According to OMC, the market potential is huge: they estimate that there are about ten thousand mobile towers that have anchor load potential in the state of Uttar Pradesh.

OMC minigrids are large by off-grid solar standards, and incur significantly higher project costs than their smaller counterparts.

On the other end of the size spectrum, companies like Mera Gao Power specialize in solar microgrids, with modular projects as small as a single solar panel and a battery pack. Like OMC, Mera Gao Power installations also provide customers with two light bulbs and a mobile charging outlet.

Unlike OMC, households and small shops are Mera Gao Power's primary customer base. According to co-founder Brian Shaad, the company has over twenty-two thousand customers, which they largely attribute to the relationships they have nurtured at the village level.

The company's core business is in "hamlets" - remote areas with fewer than one hundred households and no commitment from the government that central grid power will ever arrive. Hamlets are also generally poorer than neighboring villages. According to Mera Gao Power's market research, incomes are seasonal and can be as little as forty dollars a month.

Mera Gao Power's advantage is that small systems can be installed in under a day, and that project costs are relatively cheap - nine hundred dollars - and can be recouped in as little as two years.

From micro to macro: reaching India's 300 million off-grid customers

OMC and Mera Gao Power share one principle: they both need to reach meaningful economies of scale to earn returns for investors and be profitable.

That bottom line, though, is probably the ticket to widespread electrification in rural India. Unlike

government or NGO-sponsored projects, both companies are obligated to generate returns for investors. Despite the best efforts of government and other development driven initiatives, rural electrification projects that don't prioritize private ownership have yet to demonstrate long-term viability, and graveyards of neglected, damaged, or abandoned projects litter rural India.

That's not to say that the roles of the government and NGOs in rural electrification aren't important. Rather, different sets of stakeholders play critical roles introducing financing, in advocacy and influencing lawmakers, and providing training and market research.

And the market potential is huge; nearly a quarter of India's rural population lacks access to electricity, and The Climate Group estimates the market size for distributed renewable energy providers in that space will be at least \$150 million by 2018.

Still, scaling across rural Uttar Pradesh and India is one of the most elusive challenges for any developer.

For OMC, the challenges are regulatory uncertainties and the high cost of capital. The new state minigrid policy won't be a panacea, but OMC is optimistic that by sanctioning the role of the private sector, the policy will draw investors by signaling the long-term viability of projects.

While companies like OMC welcome the policy, there are around forty enterprises in India offering off-grid solar services - most of which won't benefit from the policy due to the relatively small size of projects. For them, private sector innovation will continue to be the real catalyst to scaling across rural India.

Zadie Oleksiw is Fulbright researcher and clean energy advocate.

Solarplaza

The growing influence of telecom companies in off-grid markets

The growing use of mobile money solutions for electricity tariff payment is redefining the solar off-grid market in regions such as Africa. Here, mobile money services have seen a tremendous growth over the last decade.

As the adoption of solar off-grid power solutions grow within energy markets across the world, operators are increasingly finding mobile money solutions a viable enabler of consumer tariff payments. Companies promoting home-based solar solutions and appliances have found an equally tremendous capacity to scale up using the now popular Pay-as-you-go (PAYGO) model.

In this model, off-grid power subscribers only get access to electricity supplied by the home-based or centralized solar systems when payment is made, which happens through phone-based mobile money solutions that use customer's credit or dedicated vouchers via USSD (Unstructured Supplementary Service Data) codes. In all use cases, the power supply is blocked automatically when the fees are not provided.

Efficient tariff collection systems that would normally pose a hurdle for the fast-paced adoption of home-based solar solutions (especially in rural and poorly banked communities) have now been enabled by telecom companies using the PAYGO model.

They take advantage of the upward penetration of mobile phones in these markets and its ability to reach remote areas where alternative financial

institutions and offline payment solutions can barely function.

By mid-2013 there were 502 million active SIM connections in the African region (equivalent to a penetration rate of 61%). This figure has grown by 23% per annum over the last five years, according to GSMA, which represents the interests of mobile operators worldwide. By 2020, mobile penetration will have risen from 80 to 93%. In contrast, universal access to electricity in Africa is estimated to take until 2080 to be accomplished.

Nairobi, Kenya-based M-KOPA Solar is an off-grid company founded in 2012 which uses the now popular PAYGO model to provide solar appliances to Base of the Pyramid (BoP) populations. Between their inception in 2012 and 2016, they have connected over 300,000 homes in East Africa and have made about \$40 million in revenue within that same period. M-KOPA now has a presence in three African countries (Kenya, Tanzania and Uganda) as well as a franchisee in Ghana. Its story and that of other operators utilizing PAYGO model has led to many emerging questions about the role that traditional tariff collectors, such as banks, can still play in the market.

Could mobile money be the future of tariff collection for off-grid solar?

Areef Kassam, head of Mobile for Development (M4D) Utilities at GSMA says "Financial institutions have been involved in tariff collection for off-grid

companies in varying degrees in different markets and with varying success. However, mobile operators have a dramatic advantage in providing this service considering there are 37 global markets that have ten times the number of registered mobile money agents compared to bank branches and other 19 markets that have more mobile money accounts than bank accounts." According to GSMA, "Sub-Saharan Africa continues to account for the majority of live mobile money services (52%)," with West Africa seeing dramatic growth over 2015, with "year-on-year growth at 60.1%, twice the growth rate of any other region," GSMA says.

Do these advantages make telecom companies indispensable to the growth of off-grid solar solutions? Could they become an alternative to banks and other financial institutions?

Koen Peters, director of Global Off-Grid Lighting Association (GOGLA), explains that "Telecom companies and the mobile money solution which they offer are not absolutely critical to the growth of off-grid companies but they clearly have the capacity to be a game changer." According to Mr. Peters, "The strategic usefulness of telecom solutions in this sector will be optimized if they team up with banks and other counterpart financial institutions rather than compete, since each payment solution brings unique capabilities that are not readily available in the other. Therefore, off-grid companies, banks and telecoms could benefit more from collaboration rather than rivalry in the long term."

For example, PAYGO is essentially a rent-to-own model, which means that the solar appliances remain in the books of an off-grid company for many years in the form of loans. Financial institutions are in a better position to structure, bear and manage these forms of credit thereby enabling energy providers to focus on their core mandate of distributed energy provision. This becomes even

more critical when considering that off-grid companies are mostly funded using hard currency (USD or Euro) while loans and customer payments are denominated in local currency, an arrangement that predisposes off-grid firms to the risks of local currency devaluation if not properly structured through local banks.

Mr. Peters adds "Despite the growing number of deals between telecoms and off-grid companies, the telecom companies may not have shown the level of interest and participation expected within off-grid markets, especially in relevant conferences and other events."

It is however anticipated that telecom companies will become more aggressive in its outlook towards off-grid solar payment markets, since the proven ease of deployment and adoption for both sellers and buyers of solar solutions respectively is expected to continue to drive further collaboration.

According to Mr. Kassam of GSMA "Increasingly mobile operators see pay-as-you-go solar offerings as a key avenue to growing mobile money and customer loyalty, as customers become more active mobile money users through regular payments. This implies that other uses of mobile money could be intermittent, but regular payments (daily/weekly/monthly) required for power access in off-grid appliances could dramatically increase the rate of mobile money use.

SolarPlaza is a global solar energy business portal with worldwide news and information on photovoltaic products and services.

Kartikeya Singh

To scale or not to scale? Lessons from India's off-grid solar technology sector

Businesses working at the intersection of development and increasing shared value constantly find themselves navigating the question of whether or not they are having an impact. Impact, in this scenario, is defined by scale in number of customers (or beneficiaries) reached. Though the language may be fuzzy and the impact hard to measure, the question for any business working with those at the bottom of (or near the bottom of) the pyramid remains: to scale or not to scale? My own research on business innovations and the diffusion of off-grid solar technologies in India can help shed some light on the challenges and opportunities of scaling specific to that sector.

India is a country of 1.2 billion people, with over 400 million who lack access to reliable electrici-

ty. Government plans to provide power for all by 2019 include using distributed (off-grid) energy sources such as solar home lighting systems, solar lanterns and solar powered micro-grids. Buoyed by the UN's Sustainable Energy for All (SE4ALL) target to provide universal electricity access by 2030, entrepreneurs with novel business ideas have burst on to the scene. These entrepreneurs are taking advantage of both public and private capital to set up enterprises with a variety of innovations to capture this large market of consumers. In order to differentiate these enterprises from one another, we must create a typology based on their business models (see table below).

Typology of Off-Grid Solar Enterprise Business Models		
Type	Description	Examples
Formal	<ul style="list-style-type: none"> · Operate under formal regimes · Start-ups or established companies · Headquartered in cities 	SELCO, TATA Solar, Mera Gao Power
Informal	<ul style="list-style-type: none"> · Operate on the margins · Potentially high volume of sales · Highly embedded in local rural economy 	Independent sales agents
Retail	<ul style="list-style-type: none"> · Relies on company or independently owned network of franchise shops · Concession goes to the retailer of product 	Orb Energy, D.light Design
Direct Marketing	<ul style="list-style-type: none"> · Relies on independent sales agents (village level entrepreneurs) · Targets “last mile” customers · Sales commission paid by company to sales agent on each product sold 	Green Light Planet, Sakhi Retail
Sell	<ul style="list-style-type: none"> · Requires customer to travel to authorized maintenance and servicing center · Extreme case no after sales support or even warranty 	Akshay Urja Shops, informal sales agents
Sell & Service	<ul style="list-style-type: none"> · Quality after sales servicing support · Company technicians travel to customers’ homes for servicing 	SELCO, Orb Energy
Full Payment	<ul style="list-style-type: none"> · Off the shelf purchasing · Financing may or may not be available to assist customer · Customer owns product 	TATA Solar, Orb Energy, Green Light Planet
Rental	<ul style="list-style-type: none"> · Customer pays daily/weekly fee to an entrepreneur/company · No financing required because of small payments · Customer never owns the product 	TERI’s Light a Billion Lives
Pay-As-You-Go	<ul style="list-style-type: none"> · Uses mobile money transfers and smart metering technology · Payments are tailored to match customer’s energy consumption · Progressive purchase: a “pay-to-own” model 	SimpaNetworks, OMC Power
Community Managed	<ul style="list-style-type: none"> · Responsibility for management and ownership shared by community · Relies on communally agreed to governance structure, tariffs, and shared costs for maintenance 	Sunlit Futures and Gram Oorja micro-grids
Entrepreneur Based	<ul style="list-style-type: none"> · Responsibility of management and ownership falls on individual · Relies on social standing, capital and networks of entrepreneur in community 	Orb Energy, MNRE’s Akshay Urja Shops

But on scaling, my research shows that those businesses that achieve high unit sales in providing solar energy services to the poor are also doing so at the expense of providing greater technology choice options to their customers. When it comes to solar technologies, not all of them are the same. Whether or not you provide simply lighting or charging for mobile phones or energy for a higher productivity generating activity makes a difference. And ultimately the poor must be able to get up the energy ladder as their incomes and needs rise. For that there must be greater technology choice options.

In addition, the research reveals that the more products a firm provides, the more likely it is to also provide financing for its customers. While it is questionable whether end-user financing or subsidies are still needed to acquire solar energy services for everyone, certainly those at the very bottom of the pyramid need the help of financial innovations employed by businesses that make access to solar energy services easy and reliable. Companies employing pay-as-you-go (PAYG) solar home lighting systems and micro-grid operators

that allow for mobile payments are a good example. Investors and policymakers must consider the possible trade-offs between supporting firms likely to achieve scale and those likely to provide financing.

Finally, the value of scaling should be questioned in an industry that should be trying to move from providing technologies to quality energy services. Finding a balance between simply achieving scale in numbers and assuring that quality, defined by sufficient energy and an ecosystem of support structures for the technology post deployment, is essential if one is to genuinely provide access to energy for improving the livelihoods of those who need it most.

Kartikeya Singh is an IDRC Fellow at Center for Global Development.

Jon Sarpong

Challenges and opportunities for foreign solar energy firms in Africa

Many companies have identified Africa as a growth market but haven't identified the uniqueness of the region. A very big issue is that most companies really don't know the African market. Although it may seem like one homogeneous region of the globe, Africa is in fact a diverse collection of countries, cultures, sub-cultures and histories.

Understanding the specifics of your target market in terms of societal norms, language and religious practices is a crucial element required for business success. Many companies believe that they simply 'know better' than the indigenous population, and attempt to impose foreign thinking on the local populace.

"In Africa, all that matters is what you do on the ground"

Another huge issue is that many foreign companies have very weak in-country ground teams. In Africa, all that matters is what you do on the ground.

Solar companies that believe they can work remotely from their headquarters abroad, while making progress on a project in Africa, will soon find they have no project at all.

Another mistake is to place your project in the hands of incompetent and so called 'connected' individuals; I've seen companies cheated out of hundreds of thousands of dollars based on the promises of 'connected' locals.

In my opinion, an expert team with experience, as well as strong industry and political connections, is an absolute must for any successful project in Africa.

There are four words that strike fear in my heart concerning any project in Africa: "We've met the President." Politicising your solar business or project can have several adverse effects resulting from the highly charged nature of politics in many African countries.

The photo opp might seem great, but business may be hindered and suffer in the long run.

However, a big part of success for foreign PV companies in Africa comes out of the foundational work they undertake before actually initiating projects.

Taking the opportunity to have management and leadership exposed to cultural training is crucial because it exposes them to the normal business practices and cultural mores in specific Africa regions.

It's a big mistake to assume that what's acceptable in an American or European context will have similar appreciation in an African context.

"Local developers must be seen as partners, and not just a necessary evil"

Additionally, since most of Africa's PV industry is in a state of flux, companies must be flexible. The dynamic nature of life in Africa requires strong creative thinking and the boldness to adapt to

circumstances. Companies unwilling to embrace change soon find themselves a victim of this evolution.

As well, foreign companies should undertake due diligence on the country, project specifics and potential local partners. If possible, use a third party that knows the market to identify the 'talkers' (those that promise but don't deliver), 'walkers' (those who leave the project when challenges arise), and 'blockers' (those that will actually become a hindrance to the execution of your project).

Once connected with the right local support, PV companies interested in the African market, must have the mindset of mutual respect, and mutually beneficial relationships. Local developers must be seen as partners in the enterprise, and not just a necessary evil.

It is crucial for PV developers to fully understand the forecasted energy generation mix for their targeted African markets. A country may be welcoming PV developers today, but can't be sure what policy will look like in three years' time. They

must be aware of any hydroelectric resources due to come online and how this might affect tariffs.

"A patient man will eat ripe fruit"

Solar firms must have a long-term view of African markets. The transformation of many African nations may seem rapid; however, these nations are still built on ancient customs and traditions that infuse business practices.

A long-term vision will allow companies to navigate the ups and downs that will definitely arise. As the African proverb relates, 'a patient man will eat ripe fruit' – and this sentiment seems appropriate for those PV companies that aim to establish solar technology as an impactful energy source in Africa.

Jon Sarpong is President of PV developer and consultancy Avior Global.

Kizito Makoye

Women solar entrepreneurs drive East African business surge

With solar power and access to loans, "we are more productive than ever before. On average we can get \$25 a day, even more," says one woman.

As the darkness falls on the plains around Bunambiyu, a remote village in Tanzania's northern Shinyanga region, Elizabeth Julius switches on her solar lantern to finish sewing clothes for her customers.

Not long ago, nightfall would have forced her to close her tailoring shop, or use a smoky kerosene lamp. But with the solar-powered lamp, Julius can now sew for as long as she wants.

"Solar energy has entirely changed my life. I use it at work and at home, yet it doesn't cost me anything," said the 29-year-old entrepreneur and mother of two.

"I often wake up at night to work because I need the money to support my family," she said.

Julius and her husband Zablon used to earn barely enough to meet the needs of their growing family, she said.

But three years ago, Julius secured a \$500 bank loan to buy solar lanterns, which she sold to customers.

With the additional income earned, she then sought another larger loan to expand her tailoring business to include a barber shop, mobile phone charging facility and a consumer goods shop, all powered with solar energy.

Now "we are more productive than ever befo-

re. On average we can get 50,000 shillings (\$25) a day, even more," she said.

Training for women

Julius' success is due in part to training from Energy 4 Impact, a London-based non-profit group that works in East and West Africa to improve access to energy. One focus of the group's work is lifting rural women from poverty through clean-energy entrepreneurship.

The group's new WIRE (Women Integration into Renewable Energy) value chain project aims to assist 400 women solar entrepreneurs by 2020 with training and finance, and help some of them provide 360,000 people in Kenya and Tanzania with access to clean cooking and solar lighting products.

The programme is part of the Partnership on Women's Entrepreneurship in Renewables (wPOWER) launched by the U.S. State Department in 2013.

Besides helping women grow their businesses, the effort aims to reduce climate changing emissions and deforestation for firewood, said Jerry Abuga, an Energy 4 Impact spokesman.

Godfrey Sanga, a programme manager for Energy 4 Impact, said helping women create clean energy businesses makes sense, as women are good at creating networks in rural areas and can spread the use of clean power.

Since 2013, 1,200 micro-businesses and 200

small and medium ones in East Africa have received help, and seen their sales rise an average of 32 percent a year, project officials said.

Julius said business management and technology training through the project was key to helping her scale up her business and her income.

"I have nothing to complain about. Virtually everybody in the village is happy with what we are doing and our services are exclusively solar," she said.

In Tanzania where only 21 percent of the population has access to grid electricity, according to Tanzania Ministry of Energy and Minerals, helping women become energy entrepreneurs is a useful way to improve lives of millions of people in rural areas, said Sanga, of Energy 4 Impact.

Almost 69 percent of the population in Kenya and 95 percent in Tanzania depend on firewood, charcoal and dung for cooking, the company said.

Smoky fires and kerosene lamps are a major source of household air pollution causing 14,300 deaths annually in Kenya and 18,900 in Tanzania, the company said.

Reliable equipment?

While the use of solar energy has been rapidly growing in Tanzania, getting quality equipment from reliable suppliers can still be a problem, Sanga said.

Growing interest in solar energy has attracted unscrupulous sellers, whose poor-quality

equipment can then hurt confidence in switching to solar, he said.

"Poor quality and substandard or fake products is one of the main factors that is discouraging people from using the clean energy technologies, due to frequent failures and general poor performance," Sanga said.

The Energy 4 Impact effort helps make sure high-quality, reliable equipment - and the knowledge to maintain it - is available, he said.

The effort also aims to bring solar power to rural areas of Tanzania where many people still remain unaware of the technology. To boost interest, the project hopes to assist solar entrepreneurs in putting on roadshows, forums with women and youth groups, and media campaigns, he said.

"By showcasing successful businesses and demonstrating the benefits using the clean technologies in increasing productivity, incomes and saving costs, it is expected that many people will be interested in adapting and using them in their lives for themselves and their families," Sanga said.

Kizito Makoye is a freelance correspondent for the Thomson Reuters Foundation, based in Dar es Salaam, Tanzania.

Finance

Abhijeet Bhandari

Fund raising challenges faced by start-ups

The first thing you need to remember is that every business is not attractive to a Venture Capitalist (VC) and hence raising capital becomes more complicated. Now, how do you realize that your business is not fit for a VC? Well, the easiest is to ask few VCs. The difficult part is to understand the inherent challenges of scale in your business that makes it less attractive to a VC. The simplest matrix to measure scalability is to assess increase in cost of operations (manpower and others) when servicing 10 clients vs 10,000 clients. If the costs increase proportionately, the company is NOT scalable. E.g. a typical manufacturing company's costs will increase as sales increase while in a technology enabled company, the costs will not increase proportionately.

I am not suggesting that you only build highly scalable VC oriented business but once you realize that your business is not for a VC, stop knocking their doors. You need to look for alternate platforms, Family Offices, customers, etc. as investors. A typical B2B services company would fall into this category where the company can operationally breakeven after some initial investments. As a corollary, you can also think of starting a company by getting a few corporate customers to get revenues, build relevant product and sustain before taking the next leap of growth.

Once you have achieved initial traction, the next challenge is to identify the "right" investor for your company. It depends on stage, sector and type of company. Stage will determine whether you will approach an angel investor, a VC or a Private Equity (PE) fund. The sector and type of com-

pany determines whether you should approach a VC or Family Office or others. We will restrict our discussion to Angel, Family Office and VC only.

Let's first understand angel investor. The biggest challenge here is to find angel investors who would be interested in your company. Unless you have a strong network, it is extremely difficult to reach these investors, get interest from them and also ensure that they have liquid money to invest at that time. Further, you need to convince at least 5-10 angel investors so that you get some sizable money from them. If you get only one angel investor he would like to get a lot of stake as his bargaining power goes up significantly. You should try to get at least get a few angel investors on your side. The same challenge remain with Family Offices as limited data about them is available so they are difficult to reach. There are platforms like grex.in and others who can help you here.

There is a different challenge with institutional investors. There are more than 400 institutional investors registered with SEBI but few are active. On top of it, institutional investors have their own sector and stage bias which dynamically keeps changing. I recently met a Vice President of one the largest and most active VC firms in India and he told me, "We used to do early stage a year ago but we are not doing it now." The other challenge is to find the right person in the VC who can understand your value proposition better. Although all VCs claim that they speak to everyone who sends them a mail, the fact remains that if the right person doesn't see your mail, it can just go to junk. And by their own admission, if a mail comes from a "trus-

ted" reference, the chances that it will be taken seriously and quickly is quite high. So, if you have a reference, use it and if you don't, find one.

Once you find the right investor, you need to spend time with them. Most entrepreneurs think that they will present to investors once and either they will agree or disagree to invest and the story is over. How I wish this could be true. Investment decisions are taken over a period of time and investors would like to assess tenacity, persuasiveness and relationship building with them. If they like you over a fairly long period, they will eventually invest in you. A typical fund raising exercise takes upwards of 6 months with an institutional investor and at least 3 months with angel investors. During the same time, you need to manage your business as well and it can be quite a task.

Being an entrepreneur, you should be prepared to hear "No" from both customers and investors. But there is no excuse for not doing your homework. If you go to a VC asking for half a million when their minimum ticket size is \$ 10 million, not only are you wasting his time but yours too. So, you must read a lot about the VC firm, the person you are meeting, ventures have they funded, their current focus, etc. Even if the VC says No, they generally help entrepreneurs as they also want to build relationship with great entrepreneurs even if they don't invest.

Further, you also need to be prepared to answer some tough questions. Most entrepreneurs get stumped when asked, "what will they do if they don't get funding now?" Not only should you have a plan to tell your investors but also for yourself. Investors test your perseverance and survival ability in adversities. You need to have alternate plan

(slow growth, internal accruals, family and friends, etc) so that you can sustain before you get your big break. Another typical question asked by VCs is, "How will they get exit?" This is extremely relevant question as VCs also want an exit for their investments. You need to research about potential buy-outs, other exit options for VCs.

Don't assume that getting investors is panacea for your problems. Instead, I would strongly recommend entrepreneurs to focus on their customers more than investors. If your customers are happy, you will stay in business and investors will come sooner or later. You need to keep building your product and get paying customers. Investors are bound to come if customers are coming. Focus on your customers and keep them happy.

Far too often entrepreneurs feel that if they solve 5 big problems, they should get funding easily. This is far from truth. You need to start from a core problem and solve it better than others. You only plan other additions once your core story is strong. Investors will also invest once there are customers buying your core story. In a limited resources (money and people both) environment, losing focus can be quite costly – both from customer and investor point of you. So, stay focused.

In the end, the success mantra is start small, fail fast, build value and customer loyalty and funding will surely follow you.

Abhijeet Bhandari is Co-founder & Head-Market Development, GREX.

Aimee Williamson

How industry leaders drive philanthropy forward in developing countries

Philanthropy in developing countries is increasingly being seen less in terms of old-fashioned charity and more in terms of social responsibility and positive business investment. While many successful industry leaders are still happy to donate to existing charities, agencies and NGOs are keen to make use of their considerable business acumen, as well as their wealth in order to drive change and encourage sustainable projects that will have a long-term measurable impact on the country in question.

Investment not handouts

A new breed of entrepreneurial philanthropists is emerging. They combine humanitarian aid with sound business decisions. They are often far more effective than the work of underfunded if well-meaning aid agencies.

The approaches vary, but generally the entrepreneurial philanthropists provide loans, grants or seed capital to promising SMEs in developing economies, sometimes alongside advice, mentorship and a range of helpful contacts. The businesses they invest in are carefully chosen for their potential not only to succeed, but also to transform their immediate environment for the better. Local job creation within their parent community should be only the beginning of this positive transformative impact.

Extremely selective

The US-based Acumen Fund acts as a conduit through which industry leaders can make financial donations secure in the knowledge that their money will be helping local businesses grow rather than just providing a financial Band-Aid. The fund targets high-potential entrepreneurs in developing countries in the health, housing, energy and water supply sectors, who are providing products or services for their country's poorer citizens- defined as those living on less than four dollars a day. Multinational firms such as Nike provide the funding, while relying on Acumen to identify those small businesses that are in the best position to affect widespread positive change.

Although they are necessarily extremely selective, Acumen claim their actions have already protected over 5 million people in Tanzania from malaria, re-housed 3,500 Pakistani squatters, and provided irrigation for over 150,000 Indian farmers.

Giving something back

Developing countries are also producing successful industry leaders who are determined to give something back to their society and help raise the overall standard of living once they are in a position to do so. Ehsan Bayat is an Afghan entrepreneur who was educated in the US but returned to found the Afghan Wireless Communications Company, providing comprehensive mobile tele-

communications coverage for his country following the fall of the Taliban. He also launched the Ariana radio and TV network and has won several awards for his work in the rebuilding of Afghanistan – see Ehsan Bayat’s blog for more details.

Bayat channels his philanthropic activities via the Bayat Foundation, which focuses on four main areas of urgent need in Afghanistan: education, maternity health, family services and clean water projects. In the latter area, the foundation has constructed several new wells around Kabul, Qala e Shahda, Herat City and Parwan. Poor sanitation and lack of access to clean water is considered a major social issue in Afghanistan, and is a primary contributor to the country’s health issues.

Other approaches

E+Co does invest directly in small businesses

across Africa, Asia and Latin America, sourcing capital from other investors as well as purely philanthropic donations. It specializes in aiding local energy suppliers, such as a hydroelectric company in Honduras or a rural solar power company in Mali. Other business leaders take it upon themselves to offer advice to the governments of developing countries on how they can improve their economies and make their export industries more competitive.

Increasingly, industry leaders are looking to go beyond financial donations towards a more proactive brand of philanthropy. They want to use their knowledge and connections as well as their wealth to bring about lasting positive change. While old-style giving still has its place, industry leaders realize that money is only one aspect of the help they can bring.

Dana Sanchez

Who gets a \$1B line of credit? Akon woos Middle East investors for solar lighting Africa business

Senegalese-American superstar rapper and businessman Akon visited the Middle East recently, trying to get financing for his business, Akon Lighting Africa.

Akon's goal is to bring solar lighting to rural Africa. He grew up in a Senegalese town that had no electricity.

He says he's brought lighting to 1 million Africans, and many of them got the lights for free as part of demonstration projects.

Charities don't really work in Africa, said Akon in an interview with *TheGuardian*.

"I think (charity) just holds the people down longer than it should," he said. "I think the only way to build Africa is to build for-profit businesses that create opportunities and jobs for the people locally."

Instead, Akon is trying to push a business model that he says addresses some of the past failures of others — one that can guarantee returns. High capital and maintenance costs have been some of the key barriers to scaling up solar power in Africa, where about 24 percent of the population lack access to electricity, according to a report in *Utilities.me*.

The focus so far for Akon Lighting Africa has been on demonstration projects of solar street lamps and home solar kits in several African countries, *Devex* reported.

The solar street lamp business, by way of government contracts and tenders, has been the

company's main business. Those installations and contracts are managed through the company *Solektra*, which was founded by Samba Bathily, and serves as the business arm of Akon Lighting Africa.

Over 200,000 solar household electric systems, 100,000 street-lamps and 1,000 solar micro-generators have been proposed and installed in targeted areas, creating direct and indirect jobs mainly for local youth, according to *Utilities.me*.

Now Akon, along with partners Bathily and Thione Niange, is promoting a self-sustaining model that can attract local and international investments.

"Until now, we have used \$240 million out of the \$1 billion that we have at our disposal. We are present in 14 countries and want to expand into an additional 30 countries very soon," Bathily said.

Attending the World Future Energy Summit 2016 in Abu Dhabi, Akon said he wants to install 15,000 microgrids in member countries of the Economic Community of West African States (ECOWAS). These include Benin, Burkina Faso, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo and Cape Verde.

To achieve that, he said he needs technical partners to help manufacture microgrids cheaply and financial partners to help de-risk the project.

"The more financial partners we can bring, the bigger the financing and the lower the risk for those investing in the project," Akon said. "We are

currently in discussions with major donors and financial institutions from whom we expect commitment.”

Fresh ideas and approaches are emerging from the Middle East that could help solve Africa’s energy crisis, Akon said. He described the Middle East as a “hub for pioneering sustainable energy thought leadership, innovation and investment.”

The know-how already exists to power Africa, Akon said. What’s still needed is greater technical innovation and more creative financial models.

“We believe that these resources are in the Middle East and that the positive growth in relationships between the Middle East and Africa will only create more business opportunities,” he said, according to Utilities.me.

Akon Lighting has set up a business model with governments based on prefinancing. African countries cannot always finance a \$100 million project in shot, Niang said.

“We divide this into four equal installments of \$25 million which most governments can easily include into their annual budgets.”

Solektra worked out a deal with Chinese suppliers for a \$1 billion line of credit, Devex reported. The company uses this as part of a financing package they offer to governments as they bid for contracts or tenders. The credit line enables governments to pay the cost in installments over several years.

Once the company starts operating the new microgrid project, it will launch solar kiosks—built on top of microgrids — that will serve as a one-stop-shop to manage payments and maintenance for energy services. The solar kiosks will also provide added services to communities such as ICT and refrigeration.

“We aim at is to provide these rural communities with an easy way to pre-pay for energy access through a pre-paid card system, which is gaining popularity across Africa,” says Akon.

How Akon’s business model works

Before launching a project, the company runs a pilot phase where solar lighting is presented and deployed in areas designated by the local authorities — most without access to electricity. The cost of this pilot phase is directly covered by Solektra.

The pilot phase is followed by a larger scale deployment, as part of an official tender process.

“At this stage we work with other financial partners. Today we have secured financing from suppliers, export agencies, international and local banks,” Akon said, according to Utilities.me.

Ecobank is the company’s main banking partner.

The company employs local people to install and maintain equipment, positioning itself as a social enterprise that wants a positive impact on populations to drive growth across Africa and give back to African communities.

Distributing free home solar lighting systems could be problematic in a market where businesses are trying to sell similar products, Devex reported.

Though some companies have been working on powering Africa for five or 10 years, Akon Lighting Africa has “probably accomplished more than every last one of them combined in less than two years,” Akon said.

There’s a string of failed projects where an outside company came to Africa, installed solar lighting, made money and left.

“Many people come in Africa with many projects and they cash out and there’s no sustainability,” Niang said. “We learned we need to ... make sure what we’re doing has continuity.”

Dana Sanchez is Editor of AFK Insider.

Josh Klemm

The World Bank's energy lending is stuck in the past

There's no question that solar and wind power are experiencing a remarkable rise. The latest energy studies show that investments and newly installed capacity for wind and solar are far outstripping other types of energy, including hydropower (which declined for the second year in a row). As leaders grapple with how to respond to climate change, the reduced cost of wind and solar technologies and the rapid clip of installation should be cause for celebration.

The World Bank's President Jim Kim has been vocal about the need for governments to increase solar and wind generation to help address climate change, but it turns out that the Bank's own lending is out of step with these trends. A review of the last five years of its lending practices shows that the bulk of the Bank's renewables lending still focuses on large hydro – at a time when the rest of the world is going in the opposite direction.

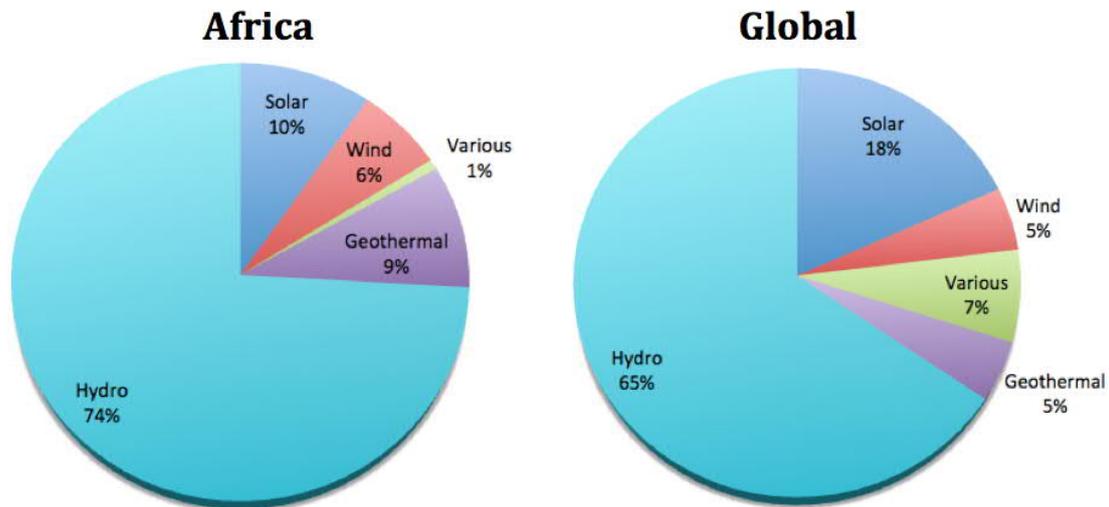
Large hydropower is an outdated, expensive technology that suffers cost and time overruns, a

long deployment period and vulnerability to climate change. Hydropower reservoirs are also major emitters of methane, an especially potent greenhouse gas.

Rather than lead by example, the World Bank has fallen behind governments and markets, which have readily adopted solar and wind as the future of renewable energy generation. A review of World Bank lending since 2010 shows 65% of its lending for renewable energy supported conventional hydro over new renewables. (The World Bank considers hydropower as renewable.)

In Africa, where energy access rates are the lowest, the World Bank is even farther behind the curve – nearly three quarters of World Bank renewables lending is going towards hydropower, versus just 10% and 6% for solar and wind respectively.

World Bank Renewable Energy Lending, 2010 to 2016



This despite the findings of the International Energy Agency (IEA), which estimates that to deliver energy access to the 1.3 billion globally who lack it – about half of whom are in Africa – two-thirds will have to come from renewable sources such as solar, wind, biomass and micro-hydro. Large hydro, however, requires a centralized grid. So who's getting the energy? It's not those suffering from systemic energy poverty.

In the 1970s, building a dam may have looked like the best option. But in the intervening decades, the cost of solar power has dropped dramatically. Given that Niger is located on edge of Sahara Desert, an area with some of the highest solar potential in the world, solar is the best option. In addition, studies show that solar can be harnessed for both on- and off-grid-based generation widely in Africa.

The World Bank's current lending strategies are doing impoverished countries a disservice, particularly in Africa. They are foisting outdated and expensive hydropower projects on the continent most vulnerable to climate change-induced drought and floods. And they're doing it at a time

when wind and solar have never been easier, faster or cheaper to deploy. Nowhere is this truth more stark than in Niger, where the World Bank is currently supporting a \$1 billion "prestige" project cooked up in 1970s: the Kandadji Dam. Kandadji would deliver, at most, 130 MW to the power-starved country during the rainy season, and considerably less the rest of the year. Even more troubling, the project will have a massive social footprint – over 60,000 people will have to be relocated to make way for the dam's reservoir.

The World Bank likes to present itself as a lender at the cutting edge of new developments. In reality, it would help if they could at least catch up with the rest of the world. The future of millions depends on it.

Josh Klemm is Policy Director at International Rivers.

News Ghana

Low investment hinders access to energy

The “Decentralized Energy: the Fast-Track to Universal Energy Access” launched on the side-lines of the African Development Bank (AfDB) 2016 annual general meetings in Lusaka, the Zambian capital said the opportunity costs of delaying access to energy could be remedied if multilateral development banks and infrastructure development agencies incorporated into their plans the full spectrum of energy options, including decentralized renewable energy systems.

The report, produced by Power for All, has pointed out that the need to achieve universal energy access could be addressed by emphasizing in investing in decentralized renewable energy systems such as solar home systems and mini-grids which offer the best path.

“The out-dated emphasis on large-scale infrastructure initiatives is misguided considering 85 percent of the energy-poor live in rural areas where decentralize renewable energy can deliver on energy access goals, and climate, gender, education, health and rural development goals quicker, more cost-effectively and more reliably than the centralized grid can,” the report said.

It added that despite its clear prioritization as a global goal, little progress has been made in achieving universal access to date, noting that despite multilateral development banks’ mission of poverty alleviation decentralized renewable energy spend still only accounts for a tiny fraction of their total investment in energy access.

As of 2014, the African Development Bank invested just one percent of its energy access portfo-

lio to decentralized renewable energy, with the remaining 99 per cent going towards large energy infrastructure projects, the report added.

The report has since outlined a new framework for achieving universal access before 2030 which also outline what multilateral development banks could and should take to expedite delivery of electricity to the 1.1 billion people living without access to modern energy services.

The report has identified three specific course of action for multilateral development banks which include utilize energy access opportunity costs assessments in funding solutions, catalysing dedicated energy access super funds to accelerate the decentralized renewable energy sector and mobilizing national decentralized renewable energy accelerators in countries suffering from energy poverty.

“Energy access is central to nearly every major development challenge the world faces today, and with decentralized renewables, it doesn’t have to wait,” said Power for All’s Kristina Skierka, director of the global campaign.

“With a reprioritization of funding, shifting of internal incentives, and adaptation of successful, fast-track funding schemes for decentralized renewables, the multilateral development banks can become the great accelerators of energy access and leaders in achieving power for all,” he added.

While the global Sustainable Development Goal (SDG) for universal energy access is 2030, the AfDB’s “New Deal on Energy for Africa” is commit-

ted to achieving universal energy access across the continent by 2025.

The AfDB has announced major commitments on energy access, but its focus appears to remain on large infrastructure.

News Ghana is Ghana's leading online news publication for business executives in West Africa.

Jigar Shah

How solar investment can light up India

Two days after assuming office, Indian Prime Minister Narendra Modi declared his intention to harness solar power to get every home in India access to at least basic lighting by 2019. This is a bold plan, and just one of many from Modi when it comes to climate and clean energy. But for his plan to attract foreign dollars, he needs to take it one step further - he needs to detail exactly how the Indian government is going to make this goal less risky so private capital can invest. Last week's announcement of \$60 million to back innovative solar financing is a start, but more needs to be done.

Bringing reliable electricity to the nearly 300 million Indians without it is definitely a daunting task, but it's something that can be done with a plan and a change of approach. The reason? India already has the technology and the capital. What is needed is a true government commitment not only through words but also with policy. Anything short of that will not attract the private capital necessary to accomplish the Prime Minister's 2019 goal.

Many have pushed universal grid connections through a centralized grid as the only means to power the poor. The problem is that the grid is slow and cumbersome to bring to far-flung communities, and even where it exists its dysfunction still leaves many in the dark. That's why investing in nimble, cheap, direct clean energy services can be life changing — a few light bulbs so children can study, a TV for some entertainment, a ceiling fan to weather the heat, and of course a place to charge their mobile phone at home.

The 21st century solution to meeting basic electricity needs is putting the most advanced clean energy technologies in the hands of the world's poorest communities. That stands in stark contrast to the failed 19th century solution of making communities wait potentially decades if not more for heavily polluting and expensive technologies. That is the 2019 standard that Prime Minister Modi hopes to hold India to.

In recent years, technologies such as solar lanterns, home solar power systems and micro-grids have transformed thousands of lives in India. What people don't realize is these devices provide benefits far beyond energy services. They drive financial inclusion by allowing people to open up bank accounts and serve as credit history to unlock future opportunities for citizens to borrow money for things like businesses, homes, and cars—a key goal of the Modi government.

To get India's millions access to basic electricity will require over \$10 billion of investment over the next three years. The truth is the money is available in both the public sector - the United States Agency for International Development (USAID), the World Bank, and the Asian Development Bank have all committed to funding Indian off-grid renewables - as well as from private investors. But to unlock that money we need smart, targeted investments that make this space less risky and get money flowing.

Additional early-stage assistance from the Indian government preparing projects and government-backed loan guarantees give comfort to

foreign capital that they can make money serving these populations.

What is required now is a clear policy directive by the Modi government and support from international public financiers. First loss guarantees, more early-stage project grants, and other forms of targeted financial assistance can finally bring hundreds of millions of people into the 21st century. Every country that has fully electrified its population did so with full government financial ba-

cking. It's time for the Indian government to do the same. Private capital is waiting.

Jigar Shah is President & Co-Founder of Generate Capital; also Founder of SunEdison.

Harald Schützeichel

A tribute to the inventor of Pay-as-you-go: Jürgen Gehr

For several years now, the sale of solar home systems in developing countries has been booming through pay-as-you-go technology (PAYG). This supports lending by the possibility to turn off the power when the installment is not paid. More and more providers with different techniques are emerging. PAYG technology is particularly popular in East Africa today.

Who invented pay-as-you-go?

The PAYG technology was invented in Morocco. The company Afrisol, founded by the German Jürgen Gehr, has been striving, since its inception, especially for those households which were not connected to the electricity network.

Jürgen Gehr soon realized that the high initial costs hindered the spread of off-grid solar energy. On the other hand, the households had monthly smaller amounts to pay their current energy needs. His solution: in the year 2000, he developed a solar home system, whose charger was automatically switched off when the customer did not pay. In addition, the charge controller had a data logger, which allowed to monitor and control the user behavior.

The solar home system from Afrisol, the so-called "SunBox" supplied 4 energy saving lamps (LEDs were not yet operational) and a TV with electricity.

With his idea, however, Jürgen Gehr encountered a lot of skepticism: the provision of small loans to rural households by an installation company seemed to be too unusual. Especially for

investors who could have helped the idea to breakthrough.

The further spread

In 2004, the Stiftung Solarenergie - Solar Energy Foundation implemented the SunBox from Afrisol with integrated PAYG technology for the first time in East Africa: in Ethiopia. In cooperation with its own installation company (SunTransfer), a network of 15 rural solar centers was set up in the following years, each with trained technicians for maintenance and service. On behalf of the Stiftung Solarenergie - Solar Energy Foundation, the solar technicians sold solar home systems by means of loans to Ethiopian households. By 2012, more than 10,000 solar home systems were thus sold and the PAYG technology was constantly being further developed.

It was the beginning of the PAYG boom in East Africa. Later, SunTransfer transferred the successful model to Kenya. Shortly afterwards, today's leading PAYG companies emerged: Mobisol, Bboxx or M-Kopa. Their merit is to have made the sale by means of consumer loans also interesting for investors in Europe and the USA on a larger scale.

Jürgen Gehr did not live to see the global boom of his PAYG idea: he died on August, 22 2007 at the age of only 54 years.

Harald Schützeichel is Editor of Sun-Connect News.

Technology

Kathryn M. O'Neill

Going off grid: Tata researchers tackle rural electrification

More than 300 million people in India have no access to grid electricity, and the problem is especially acute in rural communities, which can be difficult and expensive to reach with grid power.

At MIT's Tata Center for Technology and Design, researchers are exploring ways to extend electricity access to such communities using microgrids—-independent electricity generation and distribution systems that service one village or even just a few houses. In addition to being flexible in size, microgrids can run on whatever power sources are available, including wind, hydropower, and the source accessible at all sites: solar power.

"A large number of people, particularly in rural India, won't be electrified for decades, and the situation is similar in other parts of southern Asia and [in] sub-Saharan Africa. The statistics say that 1.5 billion people worldwide lack access to electricity, but many more don't have reliable access," says Robert Stoner, deputy director for science and technology at the MIT Energy Initiative (MITEI) and director of the Tata Center. "We're looking for ways to make electricity available to everyone without necessarily having to go through the costly and time-consuming process of extending the [national] electric grid. With policy support in the form of regulation and financing...it's conceivable that microgrids could proliferate very quickly. They might not supply a level of access equivalent to that offered by a well-managed grid but would provide an affordable and significant step forward in quality of life."

Microgrids can be powered by diesel genera-

tors or by renewable technologies, among them solar power, which is becoming more attractive as the cost of solar technology falls. "If you use solar, [the fuel is] essentially free," says Rajeev Ram, MIT professor of electrical engineering and a Tata Center researcher. In addition, he says, "microgrids are attractive because they let you pool resources."

Nevertheless, the widespread adoption of microgrids has been stymied by several challenges, including the high cost of setting up private generation and distribution systems and the business risk of investing in a system that's susceptible to being undercut by an extension of the electric grid.

At the Tata Center, researchers are addressing such concerns from multiple angles—from mapping out national electrification networks, to providing planning assistance to rural entrepreneurs, to developing technology that can make it easier to build microgrids organically, from the grassroots up. Indeed, the researchers say that properly designed microgrids can be grid-compatible, reducing the risk to investors and providing an intermediate stage to grid connection where this is technically and economically viable.

"Everyone agrees we have to scale microgrids" to address the rural electrification gap, says Brian Spatocco, a Tata Fellow who worked on microgrids as a PhD candidate in materials science and engineering at MIT. The problem, he says, is that "not one size fits all."

Reference Electrification Model

To address the microgrid challenge at the macro level, Tata researchers led by Stoner and

Ignacio Pérez-Arriaga, a visiting professor at the MIT Sloan School of Management from IIT-Comillas University in Madrid, Spain, have been developing and implementing a sophisticated computer program that can help government planners determine the best way to provide electricity to all potential consumers.

The Reference Electrification Model (REM) pulls information from a range of data sets—which in India include satellite imagery, the Census of India, and India’s National Sample Survey, which gathers statistics for planning purposes. REM then uses the data to determine where extending the grid will be most cost-effective and where other solutions, such as a microgrid or even an isolated home solar system, would be more practical.

“We are approaching the problem of rural electrification from the perspective of planners and regulators,” Stoner says.

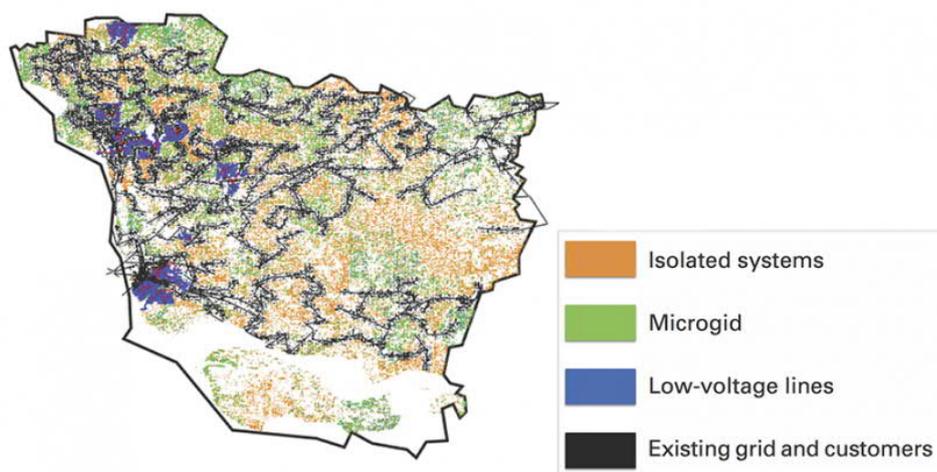
Satellite imagery is used to map the buildings in a given location, and demand is estimated based on the types and profiles of the buildings. REM then uses pricing and technical data on such equipment as solar panels, batteries, and wiring to estimate the costs of electrification on or off the grid and to make preliminary engineering designs for the recommended systems. The model essentially produces a snapshot of a lowest-cost electrification plan as if one could be built up overnight.

“This is a technology tool that [officials] can use

to inform policy decisions,” says Claudio Vergara, a MITEI postdoctoral associate working on the REM project. “We’re not trying to tell them what the plan should be, but we’re helping them compare different options. After a decision has been made and detailed information about the sites is gathered, REM can be used to produce more detailed designs to support the implementation of each of the three electrification modes.”

Currently, Tata researchers are using REM to model an electrification plan for Vaishali, a district of 3.5 million people in the state of Bihar in India. “We’re designing the system down to every house,” Stoner says.

In the project, results from REM were used to identify the best locations in Vaishali for microgrids (see diagram below). In July 2015, the team visited two candidate sites, each with between 70 and 250 houses, and REM will now be used to produce a detailed technical design showing all the equipment and wiring needed to electrify them. Then, Vergara says, a local Tata partner will put REM to the test by actually building the microgrids. “The pilot will help us improve the model,” Vergara says. “We’re making many modeling assumptions now, so we need real-world validation.” Once the software has been perfected, Stoner says, the researchers plan to make it openly available.



This map shows the results of using the Reference Electrification Model (REM)—a computer program designed at MIT with collaboration from IIT-Comillas University—to determine a minimum-cost electrification solution for each one of the approximately 400,000 buildings estimated to be non-electrified in the Vaishali district of Bihar, India. The program assigns each building to either a stand-alone system, a microgrid, or a grid extension (indicated by the low-voltage lines).

GridForm

Another project under way at the Tata Center addresses the barriers to entry for potential microgrid entrepreneurs. Such businesses face several hurdles, including the high cost of determining the most cost-effective sites for their projects. India's government and public utilities often provide no information about where the electric grid is likely to be extended next, and calculating the likely demand for electricity in a village typically requires costly, on-the-ground research—all of

which makes it tough for any potential microgrid entrepreneur to make the case for profitability and to secure financing.

Three MIT graduate students and a postdoc are working to develop GridForm, a planning framework that rapidly identifies, digitizes, and models rural development sites, with the goal of automating some of the work required to design a microgrid for a small village.



This GridForm model of a village in Bihar, India, shows the optimal layout of hardware for the load profiles of the community. Each building, color-coded by the cost (in Indian rupees) of supplying electricity to that structure, is wired to a central generation/storage node (solid lines), and the nodes are connected to each other (dotted lines).

“Doing a custom system for every village creates so much work for companies—in time and in the human resources burden—that it can’t scale,” Spatocco says. “We’re trying to expedite the planning piece so [entrepreneurs] can serve more people and reduce costs.”

Like REM, GridForm begins with satellite data, but GridForm goes on to use advanced machine learning to model individual villages with a high level of detail. “We’ll say this is a house and this is a house, hit run, and the machine learns the properties of a house, such as size and shape,”

Spatocco says. The goal is to produce a hardware and cost model of a target village that is 90% accurate before anyone even visits the site.

GridForm also develops load estimates, based on factors such as demographics and the proximity of buildings, and provides entrepreneurs with potential microgrid designs and even lists of necessary equipment. The program incorporates data sets on solar radiance and uses an algorithm to determine the best configuration of solar panels, battery packs, and distribution wires to power the greatest number of houses at the lowest cost.

“We’re providing everything from siting to planning to implementation—the whole process,” says Kendall Nowocin, a PhD student in electrical engineering and computer science working on GridForm. The other two researchers working on the project are George Chen PhD ’15, an MITx postdoctoral teaching fellow, and Ling Xu, a PhD student in health sciences and technology.

The main difference from REM, the researchers say, is that GridForm envisions electrification being built from the ground up rather than from the top down. “We think rural entrepreneurs will electrify themselves,” Spatocco says. “We want to create insights that are immediately useful to practitioners on the ground—what to buy, what it will cost, where to put it.”

Already GridForm has been used to develop detailed microgrid plans for four villages in the state of Bihar, and the team is working with Indian social enterprise SELCO Solar to do the installations, providing service to 2,000 to 3,000 people.

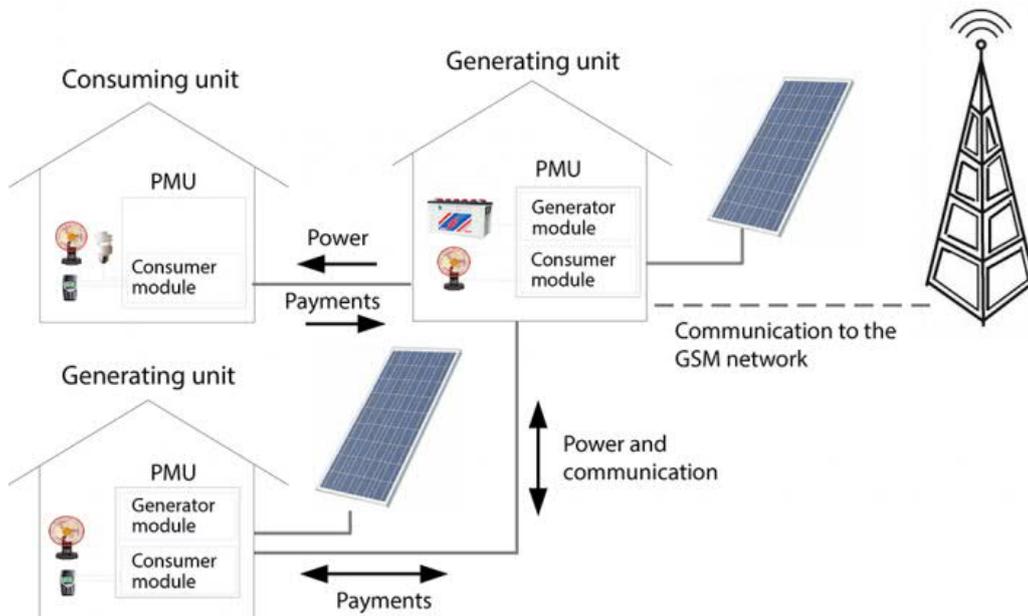
uLink

A third Tata Center project focuses on fostering

the organic growth of microgrids by enabling residents to share extra power-generating capacity with their neighbors via an inexpensive piece of hardware, the uLink power management unit (PMU).

A “demand response” system that meters and controls the flow of electricity, uLink can adjust the demands it serves based on the supply of electricity that’s available. The system reflects an innovative approach to electrification, Ram says—one that acknowledges that the standards for electrification common in the developed world are unrealistically high for poor, remote areas. Building in the system redundancies necessary to ensure 99.9% availability is simply too expensive—and particularly unrealistic in India, where even the areas served by the grid are plagued by power outages.

“Here we can guarantee a basic level of service, but we don’t guarantee 99.9%,” Ram says. “This is a very powerful way to manage the cost of electricity infrastructure. Demand response allows you to size the system for average demand, versus peak demand.”



uLink’s power management units (PMUs) are shown connecting generating sources, batteries, and loads to form an ad hoc microgrid. Sophisticated computing power within the units enables power and information to be transferred automatically throughout the microgrid, which could one day employ the mobile phone system (aka the GSM network) for payments and system monitoring.

What that means is that when the sun is shining and batteries are fully charged, microgrid customers can run all of their appliances, but when it's been cloudy for a few days and the system is low on power, uLink can signal users to shut off loads; as a last resort, it can even shut off loads automatically. Automating this function eases the social difficulty of sharing electricity, the researchers say. Once users have pooled their resources, there's no need to argue over who can use which appliances; uLink allots electricity based on which loads have been predetermined as "critical" and therefore not subject to shutoff when system demand peaks. Everything else can be shut off by uLink as needs arise.

Users themselves determine which few loads are "critical," providing an element of choice not typically seen in home solar systems, which hardwire their loads. uLink features several outlets, enabling users to plug in a variety of appliances. At maximum capacity, the initial prototype low-voltage, DC system provides about 25 watts per household, enough to run a fan, a cellphone charger, and a couple of lights.

"The hardest part is making a box with all these functions at a cost people can afford," Ram says, noting that the uLink consumer unit is designed to cost about as much as a cellphone, making it affordable for most Indian villagers.

uLink was field-tested in June 2015—five houses were wired together for two weeks—and the

delivery, metering, and networking systems worked well. The next milestone for the developers is to test the algorithm designed to estimate how much electricity is available from the system's batteries and solar panels and optimally shed loads. "This is definitely a work in progress," Ram says.

Indeed, all three Tata Center projects are still being refined, but together they offer a rich portfolio of potential solutions to the problem of rural electrification, the effects of which many of the researchers have seen firsthand.

"Electricity is not just empowering. It's an enabling force. Electricity goes right into livelihood activities," Spatocco says, noting that just a few lights make it possible for residents to work in the evenings, for example, or to improve their efficiency with simple machinery, such as sewing machines. "People can double or triple their economic output."

There are also benefits few in the West might imagine, as Ram discovered by interviewing residents of one non-electrified Indian village: "They conveyed how frightening it can be to have a snake in the village if no one has a light."

Kathryn M. O'Neill is MITEI correspondent.

Debajit Palit

Sustainable electricity for all: Experiences with mini-grids in Senegal

Maka Saar is a small remote village in Senegal, about two hours' drive from the nearest city Thies and another one and half hours' drive from Dakar, the capital of Senegal. Until two years back, it had around 700 residents who depended on paraffin candles and small torches for their lighting needs. There were some diesel generators to meet the few productive loads in the village. In 2015, a company called 'Enersa' established a 10 kWp solar power plant with a 1.5 km underground distribution network to provide electricity to the households and small businesses. The aim was to generate clean electricity from a village-scale solar power supply system for the 60 households and small shops. Similar to Enersa, there are many other small power companies that have set up solar-diesel hybrid mini-grids in Senegal, primarily with support from different donor agencies. For example, the German development agency, GIZ, has reportedly supported setting up of 300 mini-grids in the country. Further, around 400 mini-grids are being implemented by ASER (Agence Sénégalaise d'Électrification Rurale) with support from multilateral and development finance institutions.

Status of rural electrification in Senegal

As per World Energy Outlook 2015 report, close to 45 percent of the population, that is, approximately 6 million people, in Senegal lack access to electricity, as compared to 68 percent unelectrified population in sub-Saharan Africa. Globally, 1.2

billion people do not have electricity access with a majority of them, approximately 634 million, in sub-Saharan Africa. Senegal relatively has a much better electricity access rate than many other sub-Saharan countries, particularly its neighboring countries, where rural access rate ranges between 2 and 20 percent. This energy poverty – lack of access to modern energy services—manifest itself as dependence on costly and harmful fuel for lighting and associated household pollution resulting in adverse effect on health.

Senegal's national utility, Senelec, maintains an electricity grid that reaches most of the country's urban centers and large rural habitations. As part of the reforms in the late 1990s, the government created the ASER to increase the electrification rate in the rural areas. ASER currently is managing two major programs: (1) the rural electrification priority program, under which it has allocated six concessionaires to extend rural electrification through the private sector, and (2) locally initiated rural electrification projects.

Experiences with mini-grids in Senegal

As a part of the multi-partners research project called 'Solar xChange', I visited Senegal with a team of co-researchers from Norway and Kenya, during March 2016, to understand the energy access situation and learn from the solar hybrid mini-grids that have been installed by private developers. The Solar xChange project is led by the University of Oslo, and our institution, TERI (The

Energy and Resources Institute), is one of the research partners. Our team visited five villages near Thies city, which are served by hybrid mini-grids. All these mini-grids are run commercially with users paying metered tariffs based on a novel concept called “electricity blocks,” developed by a German company, Inensus. These mini-grids were implemented during the last two to four years and they all are functioning well, except one, where one of the charge controllers was found non-functional. The villagers who have taken connections from the mini-grids are using the electricity to meet their basic lighting needs and for charging their cell phones. There are also some small commercial enterprises using electricity from the mini-grids in these villages.

In Maka Saar, there are two shops selling grocery products and each has a freezer to store cold drinks, ice cubes, beer bottle, etc. These shops are paying around 16,800 XOF (1 US\$ = 584 XOF) per month towards electricity charges for the freezers. They shared that they are earning approx. 15,000 XOF per month after meeting all their expenses, including the expenses on electricity. In case of households in this village and other villages in the cluster, they are paying a tariff of 925 XOF per week per electricity block. One typical block is equal to maximum 50 W of load running for four hours a day, that is, around 1.4 kWh per week. The company also collected a one-time connection fee of around 20,000 XOF per electricity block. Typically, the households in the villages, where our team visited, were found to have subscribed to one to two blocks to meet their basic household need. However, we also found some larger households that have subscribed three to four blocks and are running TV and fan in addition to the LED lights.

While tariff might appear to be on a higher side as compared to the grid electricity provided by Senelec, in the absence of grid electricity in most of the villages in the country, decentralized electricity is currently the only reliable option in these villages and many other similar villages in the country. The Village Power Committee, set up by Enersa in all the villages where they have mini-grids, said that they plan to have a few more small productive enterprises that can run on electricity from the mini-grids. Enersa also shared that depending upon increase in demand for electricity, they may think of increasing the power plant capa-

city in future by coupling small wind generating systems with the existing solar plants.

We visited another village, Ndombil, where we found a maize grinding shop, being run on electricity from the mini-grids, in addition to around 64 household connections. The shop was found to have two grinding machines (2.2 kW and 1.5 kW), installed recently, with one machine converting the raw maize into the coarse grain and the second machine grinding it to fine powdery grain. Currently, the demand for grinding is not high, and the machines run only for an hour per day; however, the entrepreneur was optimistic that in a month's time, there will be more customers and both systems will run for longer hours. Though the purchase price of the grinding machines and the payment being made towards electricity charges vis-à-vis the entrepreneur's current earning from maize grinding do not justify the business viability, the fact that solar mini-grids can support productive enterprise such as a grain mill, justifies the efficacy of decentralized projects in meeting both household and small business' energy demand.

We also found some unconnected households or de-electrified households in these villages, which have not taken the connection or are not buying electricity blocks every month due to monetary constraints. On discussion, it was found that they are actually spending more on torch batteries than the price of an electricity block. However, as they can buy batteries for their torches at different times during the month, it is easier for them to spread the spending than paying Enersa at one time. We also visited three other villages, Sine Moussa Abdou, Leona, and Wakhal Diam, all at traveling time of around one to two hours from Thies, and found similar usages of electricity in these villages.

Challenges in scaling up: Some solutions

This may be little early to predict whether the mini-grid models can continue to provide sustainable electricity in the villages of Senegal and sub-Saharan Africa. Most of the projects face a number of challenges—technical, policy, and regulatory. Discussions with the regulatory commission and ministry officials indicate that Senegal is planning to double its electrification rate in the next few years, primarily by extending the central grid. They are also planning to harmonize the tariff for

the grid and the mini-grid systems for reasons of equity. However, grid tariff is much lower as compared to the tariff charged by the private operators of the mini-grids (approximately 117 XOF per kWh for central grid versus more than 500 XOF per kWh for mini-grids). Enersa has thus slowed down on their initial plan for setting up 30 mini-grids because of the lack of clarity on the future treatment of mini-grids by the electricity sector regulator in Senegal. The regulator is reportedly also not providing the license or approving the tariff for mini-grids and, thus, the mini-grids are being operated without approvals and with uncertainty. This is a common issue across sub-Saharan Africa and South Asian countries, where mini-grids have been successfully piloted by many private sector players but are slow in scaling-up. While there is definitely a need for private finance to scale-up electricity access in energy-starved countries, unless clarity is provided through better policy formulation by the respective governments, the sector may not see scaling-up in the short to medium term beyond the grant-supported pilots. Further, an objective and scientific approach need to be adopted to set tariff for grid-connected and remote mini-grid-connected consumers and/or ensure cross-subsidy from a universal energy access obligation fund; otherwise, the mini-grids would be at an obvious disadvantageous position. The mini-grids should also be designed such that the infrastructure is grid compatible and can be interconnected with the main grid system, to draw and feed energy, as and when the main grid reaches such remote villages.

Another key issue worth highlighting is building the technical support system to provide the required post-installation maintenance services to the mini-grids. As mentioned in the previous section, one of the charge controllers in Leone village was not working and reportedly became defective due to a lightning strike. Due to this, the power plant is not working at full capacity and there are frequent power cuts, resulting in strong dissatisfaction among the users. We were told by the Enersa technical person that the equipment needs to be sent to a different country for rectification as there is no authorized service center of the original equipment manufacturer in Senegal. This calls for building technical support systems in the sub-Saharan countries where mini-grids are being set up. As business is currently not adequate, the

companies may find it difficult to invest in building supporting infrastructure, but without the maintenance infrastructure, scale-up is not possible. Programmatic grant support can play a big role in addressing the issue and in creating the necessary post-installation maintenance infrastructure covering different regions of Africa.

Last but not the least, access to finance at the right terms and conditions is critical for scaling-up. While partial grant support from various donors is available, generation of the remaining capital at lower cost and/or without any collateral is difficult for many private players because of the high perceived risks of investments in mini-grids. The problem gets compounded by the smaller capacity of these projects. Donor agencies need to work with local governments to create a revolving fund that can be used to provide soft and collateral free finance. However, a strong performance monitoring system will also be required to ensure that the fund is utilized properly to achieve the project outcome.

Is grid extension the remedy?

While there is an ongoing debate between the efficacy of grid extension and off-grid models for electrification of remote rural communities, a recent paper titled "Rural electricity access in South Asia: Is grid extension the remedy? A critical review", published in the Renewable and Sustainable Energy Reviews has dealt with the issue comprehensively by juxtaposing grid and off-grid modes in terms of their merits and demerits. The paper based on extensive literature reviews, infers that instead of considering each of the modes of electrification in a stand-alone manner and perceiving them as mutually exclusive or competing with one another, as usually perceived in the policy sphere, off-grid electrification can actually be considered as a complementary mode and should ideally be integrated with grid expansion to serve the bigger cause of ensuring universal rural electrification.

Debajit Palit is Associate Director and Senior Fellow at TERI.

Godfrey Ogbemudia

When the grid becomes the back-up energy source for business enterprise - The Nigerian story

As blood is to human beings, so is energy to business enterprise. The difference between the developed countries and under-developed countries of the world is energy access. For example, an IEA report in 2010 stated that the residential electricity consumption in Sub-Saharan Africa, excluding South Africa, is roughly equivalent to consumption in New York.

It was widely reported in several national dailies in the country on the 31st of March 2016, when all generating plants in Nigeria for about three (3) hours produced zero (0) Megawatts of electricity. The most interesting thing about it was; nobody noticed it and it did not affect economic activities in any way due to the fact that Nigerians and business enterprises operating in the country have now made their generators the grid and the grid as their back-up energy supply.

It is no more news that a lot of industries have been forced to close down their manufacturing activities here in Nigeria and have relocated to other countries due to the epileptic power supply in the country. Other business places that are still in the country are finding it very difficult to break even due to the increasing cost of production occasioned by lack or in most cases poor electricity supply. Business enterprises run almost entirely on generators powered by diesel or petrol.

The World Bank has earlier ranked Nigeria 187 out of 189 countries with regards to the ease of getting electricity. In March 2016, the National

President of the Manufacturers Association of Nigeria (MAN), Dr. Frank Udemba Jacobs, speaking at the sideline during a courtesy visit to the Minister of Science and Technology, Dr. Ogbonnaya Onu, in his office in Abuja put the daily cost incurred by its members in generating electricity to power their industries at over N9 billion.

Current Challenges with the Grid

Since 2001 when the National Electric Power Policy was adopted up till May 2015 with the unbundling of Transmission Company of Nigeria (TCN) into an Independent System Operator (public) and a Transmission Service Provider (private), the federal government has shown real commitment to privatization drive of electricity sector here in Nigeria. In spite of all these, technically the grid is still far from the capacity of being able to deliver at least 40,000MW of electricity daily to meet the demand of the population put at about 180 million as at April 2016, for Nigeria to achieve her vision 20:20:20 goal.

Currently, Nigeria can't even boast of 5,000MW daily generation. If you combine the 23 generating companies (GENCOs) together in terms of installed capacity for both the gas and hydro power plants, it's about 12,067MW but you never get this from them. According to the National Energy Regulatory Commission (NERC), the installed available capacity is about 6,840MW. But right now since 2015, the actual generating capacity is 3,941 MW which is

usually occasioned by shortage of gas supply and reduction of water level at the dams.

According to (REEEP), Nigeria's per capita power capacity is 29 watts per person compared with Brazil's 480 watts per person and America's 2,900 watts per person. Nigerians connected to the national grid experience 80% demand/supply gap and most businesses self-generate their power. Additionally, the transmission network is overloaded, with poor voltage profile in most parts of the network. There are frequent system collapses and exceedingly high transmission losses, often in the region of 30-35%.

Solving Business Enterprises Energy Challenges in Nigeria

With the uncertainty surrounding the petroleum industries as a result of global decision to move away from fossil fuel completely and the current challenges in the national grid, solar energy is the sustainable solution to the issue of stable power supply for business enterprises in Nigeria.

Nigeria possesses huge potential of solar energy sources. She lies within the sunshine belt and the solar radiation varies from about 3.5kWh/m²/day in the southern part to 7kWh/m²/day in the northern region of the country with an average daily sun hour of about 6-8 hours per day. Most business run actively within 8hours (8am-4pm) in Nigeria.

Captive generation using petrol and diesel is very expensive and will continue to add to cost of production. In 2009, in a document authored by the Assistant General Manager, Project Monitoring

Office, Ify Ikeonu, The Nigerian Electricity Regulatory Commission (NERC) revealed that Nigerians spend about N796.4 billion (approximately \$5 billion) yearly on fuelling their generators. A breakdown shows that N540.9 billion was spent on diesel and N255.5 billion goes into the purchase of petrol annually for power generating sets.

Doing captive generation with solar PV is far cheaper. Although the initial upfront cost may be expensive depending on your energy demand (if batteries will be involved), it pays for its own self. For example, the headquarters of the organization I currently work with, the Community Research and Development Centre (CREDC) in Edo state southern, Nigeria runs completely on solar pv system which was installed September 2014. In nine months, the system has paid for its self and we have never had a down time in terms of power supply till date.

Solar system components are becoming cheaper and globally, renewable energy is attracting huge investment yearly. The report titled "Global Trends in Renewable Energy Investment 2016" just released by UNEP and Bloomberg started that Global investment in renewable power capacity, at \$265.8 billion, was more than double dollar allocations to new coal and gas generation, which was an estimated \$130 billion in 2015.

Godfrey Ogbemudia is a renewable energy expert.

Nidhi Bali

It's not off-grid; it is just the smaller grid!

The biggest deterrent that prevents off-grid energy access enterprises from scaling up is the word off-grid! This and more was discussed during the recently held workshop on Enhancing Capacity to Accelerate off Grid Energy access along the side lines of the Sankalp Global Summit 2016. With the presence of financial institutions such as banks, Non-Banking Financial Companies (NBFCs), impact investors, energy enterprises and industry associations the event witnessed exciting discussions on ways to accelerate energy access for the un-electrified and under electrified millions in India.

"Off-grid", a word for decentralized energy that is different than a grid-extended facility is the first barrier to be scaled to ensure rural poor perceive this as "real" energy and a solution that is sustainable and cost effective. Instead of addressing a decentralized solution as "off-grid", an understanding of the solution as a little or a smaller grid that meets demands better and complements the 'free but unreliable grid power' is the need of the hour.

Although well begun is half done. The other half in case of energy access enterprises requires equally innovative outlook. As per the participants, this half comprises aspects related to four major areas –

People: It is very hard to recruit and retain highly skilled people at all stages of business. Be it senior management or field staff, talent is expensive and not readily available for this sector. The problem notwithstanding, the challenge of founder

legacy persists where co-founders find it hard to delegate tasks and find that they are unable to focus on strategic business areas.

Policy: Ambiguity in policies regarding universal electrification and political grandstanding keeps investors interested in "off-grid" ma

Partnerships: Partnerships are an important element for enterprises that lack credible market information and last mile reach.

Pioneer support: A lack of ecosystem for pioneers to try new innovations in the sector does not help. With very few incubators or accelerators focusing on access to energy sector in India, enterprises fear experimentation and in absence of new technologies or innovations energy access

To complicate the problem with the perception of "off-grid", these enterprises continue to be assessed by lenders using the traditional approaches like the credibility of historical track record and availability of collaterals. Both these areas pose significant challenges since energy access enterprises are relatively new with few collaterals and little or no credit history. Moving away from traditional collateral based models to cash-flow centric models can go a long way paving way for non-banking finance companies and innovative financial solution providers to take center stage. Suitable enablers like guarantee based mechanisms can also help channelize the initial capital required to nurture and grow these enterprises. Traditional banks and microfinance institutions may find consumer financing easier to start with to enable growth of this critical industry. Appropriate

business models that deliver energy 'off the grid' as a solution and not as a product need to be encouraged as well. Captive mini grids with a commercial client like telecom tower or a fuel station as the base anchor load was discussed as an attractive proposition for investors and lenders.

The core need however remains transforming the perception of 'off-grid' into an understanding of a 'smaller grid' and this industry may turn out to be the potential disruption that is required, much like what mobile phones did to telephony a decade ago. Amen!

This article is an outcome from a workshop held at the Sankalp Global Summit 2016 supported by Shakti Sustainable Energy Foundation.

Nidhi Bali is Engagement Manager at Intellectap (India).

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Are batteries guilty as charged?

Worldwide, the use of energy storage from renewable sources is rising, as more countries commit to renewable energy targets and attempt to reduce costs. As an example, Australia has experienced remarkable growth in installations of solar photovoltaic (PV) panels in recent years. Energy storage technologies are the next logical step; once they are sufficiently available at the right price point, they are likely to have a similar market penetration to solar PV.

The present lag in scientific understanding of battery energy storage systems at the domestic and small commercial level is contributing to a clear gap in policy development for battery storage best practices. The difference in pace between the development of standards versus the technology is likely to be a significant policy issue on a global scale.

Our research aims to use Australia as an example of a country that already has residential and commercial uptake of battery storage technology, and thus an opportunity to set a global norm for capability and standards in the industry. Here, we discuss the potential social implications relating to domestic and small-scale energy storage safety, and highlight areas requiring future research.

As battery technologies advance and decrease in unit cost, the installation of sufficient battery storage for domestic requirements is becoming more affordable. Thus, energy storage is an increasingly attractive prospect for many homeowners. Energy storage technologies are appealing because they are more environmentally sustainable and

allow consumers to reduce electricity use from non-renewable sources. They are also customisable and can be designed to suit individual household requirements and applications, offering homeowners more independence and flexibility.

Rapid growth

Australia has already experienced remarkable growth in installations of solar photovoltaic panels in recent years. Energy storage technologies are the next logical step to help match renewable generation to electricity demand. Once the technology is sufficiently available, it is predicted to have a similar market penetration to solar PV. Energy storage has the potential to stabilise and improve the efficiency of Australia's electricity grid, especially with the increasing popularity of renewable solar and wind generation. It can store renewable energy for later use, and help to manage household peak demand, provide backup power and adapt customer usage in response to feed-in tariffs. Domestic energy storage can be connected to the centralised electrical grid to supply or receive electricity from the network; or it can form a stand-alone system for household use.

Some companies have already begun marketing campaigns based on future energy storage production and the industry is likely to experience significant growth as multiple companies compete for market share. However, the speed of this new technology development and market diffusion has the potential to outpace scientific understanding of the limitations and risks, and the development of

industry best practice, safety guidelines and procedures, before these systems are installed.

However, the Australian public has a low awareness of battery storage technologies and the industry faces the potential risk of a serious incident occurring. We recommend that further research urgently addresses the global and national need for standards relating to domestic energy applications. The standards should consider whole-of-life practices, including disposal and recycling, particularly for emerging technologies such as lithium-ion battery storage systems. Greater consensus is also required on safety recommendations for different technologies.

At the front line

Interviews were held with 24 electricians who had installed battery units and with private battery suppliers. Participants were asked about their experiences with batteries through all stages of battery life, from transport and handling to design, installation, storage, maintenance and recycling. Three focus group workshops were held to complement and extend interview data. One focus group comprised solar PV installers with varied experience in battery storage installations. The second group comprised consumers of solar PV and/or battery storage, while the third comprised members of the general public who did not have solar PV or battery storage.

Four clear themes emerged from our research: lack of accreditation and training; lack of available and accessible information and low general knowledge about battery technologies; lack of commonly accepted safety procedures, including how to extinguish a lithium fire, and; unclear standards for some aspects of installation, maintenance, recycling and disposal.

Lack of accreditation and training

The literature review indicated solar PV installers experienced inconsistency in solar-specific accreditation and training as a limitation of their industry, given the expanding range of new businesses aiming to fill the market demand for rapid growth in solar PV installations to capture limited-time government incentives. This suggests that many installers rely on general knowledge, past experiences and learning on the job. Focus group participants noted that because of the lack of ag-

reed best practices, the rules “changed regularly” and were not enforced, checked or audited. Installers therefore have variable standards for installations, resulting in “some installations [being] below standard”. Similarly, respondents from the interviews and focus groups indicated the significant lack of accreditation and training opportunities regarding battery storage installations at the domestic level, especially for lithium-ion battery technologies.

Focus group participants indicated that consumers had no way to tell who was a reputable installer and as a result; “customers now don’t trust industry” because of experiences with some door-to-door salespeople “pushing” uptake and lower-quality installations.

Accreditation is an important signal to consumers that the technology is ready to be taken up and that sufficient systems are in place for safe installation and monitoring over time. As one consumer noted: “Do I need to know about batteries? I just need [someone] to come and install it.”

However, if there is no way of finding an accredited installer, consumers are forced to do more research and have more understanding of the system themselves. This key barrier to energy storage uptake results in a range of different systems, some of which have been put together by a motivated, yet untrained, do-it-yourself consumer. As one installer pointed out, there were “plenty of DIY installations out there”.

Consumers are confused about how to find an appropriate installer, and installers experience tension and rivalry over who is sufficiently skilled to service this market and which procedures are considered best practice. Most importantly, inadequate training and accreditation results in the potential for unsafe installations.

Lack of information

Research identified the unavailability of specific information about energy storage, particularly regarding choosing the right product, and basic knowledge of correct installation, maintenance, disposal and recycling of the product. Lack of information was noted as a barrier by consumers in focus groups: How long will it last? How much does it cost? How big is it? How safe is it? How much maintenance does it need? As a result of so many

questions, they came to the conclusion that “it’s too difficult”.

Furthermore, very little information is available about environmental effects after disposal. This has affected both installers and customers, because despite “huge interest in battery storage”, consumers were left thinking the industry was not yet advanced enough to make a purchase. Otherwise, for motivated consumers who persisted with looking into making a purchase, the only information available was highly technical, confusing and had large gaps. Some thought you would “need a university degree” to understand it.

The social implications of inadequate information include potentially significant safety incidents and injuries. As one installer noted, it was just luck that the industry “hasn’t had idiots kill others yet”.

Another area of confusion was the lack of consensus on how to extinguish a lithium-ion battery storage fire. Australian residential energy storage installations presently do not require passive or active fire suppressions systems as part of their installation (excluding in the ACT). This is mainly due to a lack of understanding or knowledge of the best way to extinguish such a fire. Current literature suggests using sand, liquid nitrogen, water mist, lithium chloride, foam, or wait it out – all of which have advantages and disadvantages. As one installer explained: “I blew up \$25,000 of lithium batteries to check the failure ratings.” As the required scientific information did not exist, he decided he needed to make his own assessment.

Lack of safety procedures

In addition to the lack of information, other safety risks identified in our research included unsafe battery storage installations by untrained or inexperienced installers or homeowners, and uncertainty about the safety procedures required by installers, homeowners or the emergency services. This was especially concerning to installers, given that different battery storage systems have different fire responses, but that homeowners and emergency services were unlikely to be able to differentiate between them. This problem is compounded by the lack of best practices or standards on warning labels for the batteries and storage system enclosures.

Examples of risky procedures cited in interviews included installations that were exposed to

high and variable temperatures, or used for multiple purposes, such as a shelf or table, or storage of garden tools. Some installers had already experienced safety incidents – luckily, without injury – such as smoking lithium-ion battery units.

During one focus group, an installer gave an example specific to solar PV systems without storage, which involve the risks of roof fires from roof-top electrical isolators, and of being unable to turn off systems from the ground. With the addition of battery storage, the consequences of a fire due to failure could be even more catastrophic. Electrical isolators are designed to meet minimum safety and electrical standards at the time of installation. However, the present standards do not address the degradation of the isolator hardware due to Australian environmental exposure over the commissioned life of the installation. As part of overall system safety procedures, cabling and devices such as roof-top isolators that feed into battery storage systems also need to be prevented from physically degrading over the life of the installation.

The safe disposal and recycling of batteries faces significant challenges in battery chemistries still under research and development, such as phosphate or manganese-based lithium battery chemistries, which have little or no valuable metals such as cobalt or nickel. These technologies have a net negative value for recycling; the effort to recycle them only for their lithium content will be very high, and recycling in the long term will likely be mainly for ecological benefits and adherence to environmental laws. This is unlikely to provide sufficient incentive to drive the development of safe disposal and recycling requirements.

Another issue identified in our research was the absence of reporting – for example, very few residential and light commercial stationary energy storage installations or incidents have been recorded. There are no records or mandatory reporting process requirements to capture this information in the Australian industry. As one installer noted, he had heard of 167 fires in six months as a result of faulty roof-top isolators, but this was not captured in reports and so was unable to be substantiated. However, it demonstrates the lack of reporting or data repositories for current installations.

Unclear standards

Some standards are available for mature or es-

established energy storage technologies and for the connection of inverters to the electricity network: for example, lead-acid batteries (AS 4029), nickel-cadmium batteries (AS 3731) and their applications as secondary batteries for use with stand-alone power systems (AS 4086 and AS/NZS 4509). However, several of these standards are out of date (up to 22 years old) and only consider specific cases, such as off-grid and stand-alone, while modern use of these technologies has expanded to broader applications.

The standards are currently being revised, with a focus on residential (up to 10-kVA single phase) and commercial (up to 30-kVA three phase) applications. The timeframe for the development of these standards is unclear. Meanwhile, the industry is proceeding with installations.

Other existing standards cover a variety of grid and off-grid connections, vehicle-to-grid connections and demand response. New standards will need to include demand response capabilities, electromagnetic compatibility, smart communication, training and maintenance, transportation, safety and emergency guidelines, and environmental/recycling requirements.

As noted in the previous section, standards are unclear regarding the labelling of battery storage systems, with no differentiation required when labelling different battery types. This issue is also apparent in the disposal and recycling of batteries. For instance, lead-acid batteries have strong and established standards, while there are significant gaps for lithium-ion and other chemistries, which are mostly sent overseas for processing.

General knowledge

The interviews and focus groups noted that general public understanding and awareness about energy storage technologies is low, especially regarding safety. Participants emphasised that it was important to avoid panic or undue sensationalism of the dangers of energy storage. However, they thought it was just as important to avoid a serious incident through having a basic understanding of the risks and proper procedures for handling batteries.

Consumer perceptions

The main perceptions about energy storage from consumers were positive. The majority find it

attractive as “free energy” and “clean energy”, which enabled one to “have the lifestyle you want and not worry about the cost”, and feel good to “leave something for our grandchildren in terms of the environment.” Many consumers also noted the attractiveness of being completely independent and saw it as very appealing to “go completely off-grid”.

However, the technology was seen to be too new to implement now: there were still “teething problems” and it was still perceived to be “too expensive”. Perceptions about the size or number of batteries required and their placement were also considered a barrier by some consumers: as one participant noted, “I don’t want another shed.”

Some misperceptions about batteries were also noted. One consumer said that “they wouldn’t be giving us batteries that can’t be recycled”, while another stated that “it’s not going to be a lead-acid battery, it’s going to be much more sophisticated than that.” A commonly held misperception was: “I thought there was just one battery in different sizes.”

Such comments demonstrate that battery energy storage technology is an area of complex social perceptions, misperceptions, lack of information, assumptions and beliefs that are rarely researched.

Where to from here?

Our results highlight that current levels of energy storage installations in domestic settings are outpacing consumer – and in some cases, installer – information and understanding. Focus group participants felt that this posed a real risk of a serious, industry-damaging incident occurring. This demonstrates an urgent need for further research into developing scientific consensus on safety recommendations and best practices for installing domestic energy storage technologies. Participants also identified a need to develop clear, consistent standards and best practices for using energy storage in the home, particularly regarding newer technologies such as lithium-ion. Better education, specific training and accreditation is also required to ensure that essential information reaches those who are using these technologies.

The lag in scientific understanding of battery storage at the domestic level contributes to a clear

gap in policy development for battery storage technologies. The difference in pace between the development of standards and technology is also likely to be a significant policy issue on a global scale. The wide range of applications for energy storage technologies; including grid-connection, vehicle-to-grid, plug-and-play systems, distributed energy and smart grid integration; all need to be considered to avoid similar gaps between markets and sufficient scientific and standard status.

To close this gap, new standards must be developed that incorporate demand response capabilities, electromagnetic compatibility, smart communication, training and maintenance, transportation, safety and emergency guidelines, and environmentally friendly disposal and recycling requirements.

Science and government must work with in-

dustry in this process to urgently address this gap and avoid serious and preventable safety incidents.

This white paper was authored by Aysha Fleming, Aditi Mankad, Kate Cavanagh, Chris Price, Sam Behrens, Nigel Haigh and Owen Lim of the Commonwealth Scientific and Industrial Research Organisation.

CSIRO, the Commonwealth Scientific and Industrial Research Organisation, is Australia's national science agency.

Laurie Guevara-Stone

Changing lives with solar microgrids

Haiti is the poorest country in the western hemisphere. Only 25 percent of the 10.3 million people in the country have access to electricity. One nonprofit organization is testing a solution that could not only change the lives of the unelectrified in Haiti, but could be a model of how to bring electricity to the 1.2 billion people in the world still living in the dark.

EarthSpark International has built a 93 kW solar-powered microgrid in the small town of Les Anglais (pop. 3,000 in the “downtown” area), which currently supplies clean reliable power to approximately 2,000 people.

Why a microgrid?

Haiti has more than 30 existing municipal microgrids, but most of them don’t work. And even when they do function, they run on diesel and operate just a few hours a day, a few days a week. So EarthSpark’s goal was to provide people with 24-hour clean affordable electricity.

EarthSpark began working in Haiti providing people with small solar home systems and solar lanterns, products that are life-changing tools for people without access to grid electricity. But the organization soon realized that those aren’t the solutions to which everyone aspires. “To truly unlock economic opportunity, people need access to higher levels of electricity than what a solar home system can provide,” Allison Archambault, president of EarthSpark International, told RMI.

“With the right conditions minigrids can provide energy services in a low-cost sweet spot

between small levels of energy consumption that can be effectively served by small stand-alone solar systems and traditional grid extension,” according to Eric Wanless, a principal in RMI’s international practice leading the Sustainable Energy for Economic Development initiative. EarthSpark isn’t the only group focusing on microgrids. Husk Power has brought electricity to 200,000 people in the highly unelectrified state of Bihar in India, using rice husks to fuel microgrids; Powerhive, Devergy, and PowerGen are bringing power to East Africa with solar microgrids; and Gham Power is building solar microgrids in rural Nepal.

A microgrid can give residences and businesses enough power to run motors, process agricultural products, and power freezers. Plus, much of the electricity used by rural industry is seasonal, such as an agricultural mill, which is used during harvest season and on market days. “Building an energy system just for that mill would mean an asset that is under-utilized much of the time,” adds Archambault. “But with a microgrid, you can use that capacity for other uses, and everyone buys down the cost for everyone else. We like to say our system is powerful enough to energize industry, and progressive enough to serve every single customer.”

Tackling technical challenges

Many technical challenges arise when building a microgrid that you don’t necessarily encounter with individual systems. The EarthSpark team looked all over the world to find a low-cost, high-

functionality meter that would allow their small utility to customize tariffs, manage demand, and offer pay-as-you-use services. They couldn't find anything, so they designed their own. The SparkMeter technology is now installed in nine different countries serving microgrid and central grid operators.

The SparkMeter metering and billing system is a critical component in the Les Anglais microgrid as it allows people to prepay and buy as much electricity as they need, in the same way Haitians buy phone credits, and in the same way they are used to spending money on kerosene or diesel. Tariffs are different for different customer classes, and there is also time-of-use pricing. For example, in the middle of the day the solar array generates more power than is needed to charge the 400 kWh of batteries in the system, so the surplus electricity is sold at a cheaper rate.

Overcoming logistical challenges

Working in developing countries like Haiti brings a lot of logistical challenges as well. There is often not a clear process for implementing innovative projects. When Earthspark hired a firm from the Dominican Republic to build the distribution system, the firm brought a crane to help install the poles and wires. Unfortunately, the crane got stuck on the border for five weeks as the officials weren't sure how to deal with a vehicle that was not a truck or a car. All of the linemen and staff, not to mention the community members, were extremely frustrated as the installation was put on hold for over a month. Finally the head of the largest telecommunications company in Haiti lent the project a crane.

Archambault calls the process "derisking by doing." The actual construction process revealed where the hiccups might be. "A lot of unknowns and a lot of risks remain," she says. "We're doing the research and development on the business model, focusing on Haiti, but solutions we're coming up with are relevant to a lot of places around the world that need energy access."

Confronting legal and regulatory challenges

One of the biggest challenges comes in the legal and regulatory framework in Haiti, or lack thereof. In the absence of a clear legal and regulatory framework it will be difficult to get investors.

While family foundations, National Geographic, the United Nations, and USAID funded the first microgrid, Earthspark wants to get to an investable model, which means a proven track record.

All of these challenges are not specific to Haiti, as can be seen in RMI's current work to help the Rwandan government raise the country's electrification rate from 24 percent to 70 percent by 2018. RMI recently delivered a diagnostic with actionable recommendations to the government on how to supply around 50 percent of the population with power from the grid, and over 20 percent of the population with power from off-grid systems. The diagnostic included a set of recommendations that need to be implemented quickly in order to create the conditions necessary for future success. The RMI team remains in Rwanda to help government and the private sector fit those recommendations into the nation's evolving energy system.

"A big part of the work we're doing in Rwanda and elsewhere in sub-Saharan Africa is all about helping investors and companies like EarthSpark clearly articulate the minigrid value proposition in the context of a host of electrification options to ensure that the capital that is put against the problem delivers the most impact," says Wanless.

Promoting economic development

Residents of Les Anglais not only have access to reliable power 24 hours a day, but are also saving money on their energy expenses. Before the microgrid, they were spending about \$10 to \$12 each month for kerosene and spending \$3 to \$4 each month to charge phones (at nearly \$0.25 per charge). Now residential microgrid customers are saving 80 percent of their household energy budget, paying about \$2 to \$3 per month for much better quality power. And EarthSpark's larger business customers are saving 50 percent over what they were spending on diesel.

EarthSpark's goal is to build 80 microgrids in the next five years, bringing power to over 200,000 people, a small dent in the 7 million Haitians still living without access to electricity. But for those 200,000 people, it's a game changer. "We have small enterprises using electricity for the first time, people starting new businesses. The carpenter now has power tools. The hotel and the mill have been able to drastically reduce their power bills, by switching off their big diesel generators. And people

come up to me and tell me their children no longer have the smoke of kerosene burn their eyes when they're studying," says Archambault. EarthSpark's project in Haiti and RMI's work in Sub-Saharan Africa are delivering clean reliable electricity to people and unlocking huge opportunities for rural communities around the world.

Laurie Guevara-Stone is the Writer/Editor for Rocky Mountain Institute (RMI).

Declan Murray

Designing (for) solar waste from Nairobi

Solar waste is not as present in Nairobi as in the rural regions of Kenya yet it is here and it is here in the capital, that distributors, financiers, government and manufacturers make the decisions that have real consequences for the end user at the end-of-life. If there is one thing to take away from this post it is that waste is everywhere, even in smart office-blocks.

When I am describing my research to people they, or I, sometimes use the term 'end-of-life'. It is common, not just in my focus area of the off-grid solar industry, to think of waste as being something that occurs at the end, when we throw away a used product; when our phone no longer makes calls or our kettle no longer boils water. In this post I want to show that when dealing with waste we shouldn't just be looking at the end, at the person who disposes it but at the people who financed it, designed it, sold it, even distributed it, as they are the ones defining and designing that waste in addition to generating it themselves.

This post then, a summary of my latest field-work stint: the last three months in Nairobi, looks at how financiers, manufacturers and regulators generate waste and determine that which is generated by the end users.

The aim of the stint was to capture what I call the 'high-level' perspective. That is that when I've been visiting users at home, retailers in their shops or mafundi in their workshops I have been conscious that all of those groups' actions and understandings have been shaped by decisions made earlier, or higher up, the chain. For instance a user

might not take a broken product to a fundi because they were told not to by the sales agent, or a retailer selling multiple brands might not remember what the warranty process is for each particular one or further still a fundi might not be able to fix a broken product because of the way it has been assembled.

The rest of this post is structured around the three groups I have been speaking to: manufacturers and distributors, banks and micro-finance institutions and government/regulatory organisations.

The makers and shifters



This is a d.light warranty card. I found it in a box of returned products sent to the Greenlight Planet offices. To me it symbolises a second key idea of this post: that just because a system is in place it does not mean it is followed. This customer got

further than most as they have filled out their warranty card, but unfortunately it has ended up at the wrong company – will Greenlight, in one Nairobi neighbourhood, now deliver this card to d.light up the road? I was told not. As for what became of Teresa’s product: Is it still with her? Is it sitting (with some sister solar waste) unidentified in a box at d.light without its warranty card? Maybe we will never know.

Most of the manufacturers and distributors I spoke to do offer a warranty on their products. That warranty varies. It can vary in length between 1 and 2 years or in what it covers; some offer a separate warranty on the battery from the rest of the product or system. Further variance is found in how that warranty is activated; be it pen and paper as shown here, an SMS/USSD system or scanning a barcode upon purchase. When it came to actual use of these warranties though, the manufacturers and distributors I spoke to showed more consistency.

“You can’t always guarantee that the customer will activate the warranty which is actually why we’ve tied the, we’ve now tied a monetary incentive to activate the warranty, which is a new promotion that we’re running, with the idea that we can increase warranty activations through you get 20 shillings if you register your [product].”

These words of one Country Director echoed that of those I spoke to at other companies. Warranties are there then, but whether they are working is another question.

The ones with the dosh



This sign is in the lobby of the building where I found Teresa’s warranty card. Somewhat ironically the warranty card (above) was in a box that had

been sent from One Acre Fund (4th Floor) who finance both d.light and Greenlight Planet products. I haven’t interviewed One Acre Fund as they are not currently operating in my main field site of Bomet. Juhudi Kilimo however (2nd Floor), are, and they, like Family and Equity Banks, explicitly mentioned after-sales as a component of their ‘due diligence’ process when deciding which manufacturers to partner with.

“We have selected these companies based on their warranty programmes and after-sales support, after-sales support...It was an, it was an elaborate 13 page document that allows us to see this is a company that, you know, is able to, you know, offer support, especially in terms of honouring warranties”

In general, finance actors see the after-sales suite of business activities as the responsibility of the companies. However, they are playing an active role in those activities especially given the range and changing nature of sales models adopted by the manufacturers themselves; these range from those who have their own branded shops or service centres in the village, through to roaming agents, freelance agents, or even having NO in-country representative. Very often, where there is no permanent presence, the bank or MFI is better known and more accessible to the customer than the solar company. An example of this would be Mogogosiek in Bomet County where a two year partnership between the Kenya Tea Development Agency (KTDA) and Barefoot Power saw a shop set up in town as a sales and service centre. Since the project wound up in 2015 (and the shop closed) many of its beneficiaries have been approaching KTDA (the finance partner) for technical assistance with their waste products. Although financiers might regard their job as done when the payment is completed (a moment which usually coincides with the warranty period) their age, profile and presence means they are involved in these end-of-life issues too.

Departments, institutes and associations



This is KIRDI, the Kenya Industrial Research and Development Institute. The Institute is based in the south of Nairobi on the edge of the city's main industrial district. I wanted to upload this picture here as I was struck whilst cycling around Nairobi conducting these interviews by two questions: one of geography and another of atmosphere.

On the geographic question I noted that all the solar companies were situated in a couple of wealthier, largely expatriate-populated areas in the west of the city, while the more peripheral regulatory groups are based in the south with the finance organisations found closer to the city centre. Of course, this urban geography is nothing unique to Nairobi or the solar sector but what it did do was get me thinking about positioning. Although the likes of KIRDI, or the Ministry of Energy and Petroleum or the Kenya Renewable Energy Association (KEREAA) are national bodies, the way and frequency with which they referred to international actors like the Global Off-Grid Lighting Association (GOGLA) or the World Bank and International Finance Corporation (IFC) made them feel more like the Kenyan branches of a broader multinational.

This then manifests itself in terms of atmosphere at these 'national' bodies. It felt like their job is to enact an agenda imposed from above; creating an enabling environment, removing barriers and opening the market. One employee at the Energy Regulatory Commission (ERC) spoke as follows:

"also there are a number of financiers, for example World Bank, financiers, who want to venture in to that space by providing financing for the different investors, but now they, they can't do that because they fear there are no regulations in that in that area, in fact we just had a meeting last week, where where they really wanted to know, what's our role, in regards to the smaller smaller

systems, because it's like they are looking at providing solutions in the off-grid counties, there are 12 counties...that they have already identified, but now without regulation, them giving finances now becomes a challenge."

Where's the waste you ask? Well several interviewees in this group had demonstration or marketing stock sat in their office given to them by the same international (foreign) companies and organisations apparently governing the sector.

Three months, three messages

1. Waste is everywhere
2. Systems do not equate to action
3. The Kenyan solar industry is not all that Kenyan

It appears that the 'high level' in Nairobi runs even higher than I might have first thought. Across all three groups, the interviews and what was discussed felt much closer linked to each other and to the international context than the local setting where the rest of my fieldwork has been conducted. After-sales seems so far to be limited to warranty. The focus instead, is on growing this market, selling more and impacting more lives. Not bad things, I just wonder if in prioritising product quality (brightness and capacity) over service quality the sector is running the age old risk of putting technology ahead of the people it is supposed to serve.

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Countries

Sutapa Deb

India matters: Solar revolution in Uttar Pradesh

In Hardoi district of Uttar Pradesh, private diesel generators power the rural economy. Noisy, polluting and expensive. The state electricity grid has reached some areas, but there is a chronic shortage of power. Those with connections get only a few hours of supply in a day and almost never during peak hours. Businessman Pradeep Kumar Shukla had to produce his own electricity when he set up a petrol pump near Pipargaon village. The village is 110 km from Lucknow. "When we started the petrol pump, there were so many power cuts that we had to totally depend on generator sets. These filling machines are computerised and cannot be operated manually. It cost Rs. 1.25 lakh to install the generator and we spent an additional Rs. 18,000 a month to run it," Mr Shukla said.

Most of the 60 odd branches of Grameen Bank of Aryavrat in the district depend on diesel power. As do telecom towers, hospitals, colleges, small shops and other businesses.

But now that is changing. Companies based on renewable energy are bringing in a clean and reliable solution to these remote villages. One of these companies is Omnigrad Micropower Company or OMC. Founded by three former Ericson employees, OMC set up its first solar power plant in Jangaon village in Hardoi district three years ago. They received an overwhelming response and today they have 70 plants in Uttar Pradesh. Each plant has a capacity between 50 and 100 kw and each has a grid about one to 5 km long.

At the Pipargaon plant, we meet Rohit Chandra, Managing Director, OMC. He says the plant was

commissioned eight months ago. "This place was taken on lease. The size of the plot will be about 900 sq m on an average and the technology has advanced so much that you can package a lot of solar power in a panel these days, which means you'll require a smaller footprint. So, a size like this is good enough to take you to about 100 kilo watts. We have a large storage bank here where we store power. And every of the plant has about 300 amp hour of storage. So when the sun goes away in the evening, the batteries are charged and able to give energy after sunset. From here the energy goes into inverters and rectifiers and is pumped on a 24X7 basis. The inverters are used for converting DC to AC to 130 volts," Mr Chandra said.

When this plant's distribution network increases, it will cover nearly 2,000 households and small businesses. Mr Shukla's petrol pump has an OMC solar power connection. Instead of the Rs. 18,000 a month he previously spent on diesel, he now spends only Rs. 4,000. "My electricity problem is fully solved. The company has stuck to its commitment of providing 24/7 power supply," he said.

Shri Jagdev Singh Mahavidyalaya, a rural college, draws power from the plant at Attrauli. Students can now use the computer lab. A shopping complex is coming up near the Attrauli plant. Centred around the promise of uninterrupted solar power supply are ambitious plans to open a cyber cafe and tractor agency. The Jangaon branch of the Gramin Bank of Aryavrat is also an OMC customer. "We now spend around Rs. 3,000 a month. Earlier we would have to spend nearly Rs. 15,000 on the generator. The advantage is there is no noise pollu-

tion and air pollution," Gramin Bank branch manager Ram Narayan Prajapati said

It all started with what was for OMC a clear business opportunity. There are nearly 5 lakh telecom towers in the country. 50 per cent of them in rural areas. Most of them relied 20 hours a day on diesel generators. Telecom towers are one of the largest consumers of diesel in the country, consuming around 2 billion litres of diesel every year.

OMC entered into an agreement with telecom companies, setting up their plants near the telecom towers to provide them solar power. Telecom towers no longer have to maintain generators or hire people to run them.

The company calls it an ABC business model that is sustainable and scalable. A stands for the anchor load which are the telecom towers, B denotes the small and medium enterprises and C is the community, a majority of whom are below the poverty line. The A and B segments help in giving affordable services to C. Product packages have been designed for each segment in the village. Smart metering allows OMC to prefix loads and timings. The community pays for the subscription in advance. Rs. 110 a month gives them one 7 watt LED light from 5 pm to 11 pm and a mobile charging socket.

From 24 hour metered supply to the richest individual in the village to bite sized packages for the poorest consumers, there are packages that are relevant to each one.

At the busy Atrauli crossing, nearly 40 shops selling a variety of fruits, medicines, snacks and sweets have lights powered by the OMC grid. They said they would use battery operated lights till they got the LED lights from OMC that were brighter. Charging the batteries was a challenge.

Near the crossing, we come across three shacks lit by LED lights. In one of them 18-year-old Manisha is busy at work on her home science assignment. She says she would like to train as a teacher and the lights are helping her to study whenever she wants. "It's been 3 months since this light was installed. It is now easy to cook food, as well as to study. We no longer face any problems," the young student said.

However, there is another contradictory reality of families who live at subsistence level and cannot pay 100 odd rupees a month. At Jangaon village, we meet Nirmala as she cooks the evening meal

using a kerosene lamp. She says they are unable to install OMC because there was never any money to spare. They ate only when they earned.

"I have small kids and my husband works as labour. We have to buy everything from the market since we don't own any land," Nirmala said.

In the next six months, OMC is planning to double its capacity from 2.5 megawatt to 5 megawatt, making it one of the largest solar mini grid operators in the state. Their grid is reaching high density areas, where there is economic activity. However, the activity is mainly non-agricultural. It is expensive to extend the grid to agricultural fields that are usually at a distance from the village and presently pumps used for irrigation are not being powered by OMC. Where the grid does reach, customers can get continuous power supply. The plants use diesel generators as a backup for those days when there is low solar power generation due to rains or fog.

According to the Ministry of New and Renewable Energy (MNRE), the ideal solution is to produce locally and distribute locally. It is extending support to private rural energy service providers like OMC. According to G Prasad, Director, MNRE, the government is extending a fixed capital subsidy which is approximately 25 per cent to 30 per cent of the total amount. "The remaining equity they have to bring on their own, maybe at the commercial rate of interest. Since they have to take bank loans, they have to maintain this as a commercial venture. Otherwise they can't survive. After five years they have to replace the battery, they have to maintain the plant, pay salaries. They have to make profit as a company. This is the model we envisage."

OMC is a for profit company with a significant social impact. What is interesting is that it is attracting funds from the commercial space as well as the social impact space.

For instance, Smart Power India, a new non-profit entity set up by the Rockefeller Foundation. With the help of a \$75 million grant, it is helping companies such as OMC and others to set up mini grids to serve 1,000 villages in the next three years. "The philanthropic capital acts as a catalyst to allow this industry to emerge and sustain itself and yet at the same time allow for it to be a completely competitive source of power to go to the communities. It is a capacity enablement entity to provide

the requisite support to market proponents. It is a kind of trying to create a platform in which a wide variety of mini grids can operate," cKinetics Managing Director Upendra Bhatt said.

Private players have shown an increasing interest in solar mini grids in the last 4 years. There are multiple models operating in the state.

Some offer small solutions like pico grids which are of less than 1 kilowatt capacity and are usually DC systems. Others deploy micro grids which have a capacity between 1 kilowatt and 10 kilowatts. The Boond energy company deploys micro grids with less than 2 kilowatt capacity. "A 2 kilowatt microgrid system will electrify 40 to 45 houses and each house will get 2 to 3 LED lights and 2 plug points, one for a mobile and one for any other appliance. They would get a peak load of 40 watts. Some of our microgrids are owned by another person. We facilitate a bank loan for buying hardware as well as software and the person pays the EMI to the bank. So the goal is what he collects from 40 houses. Let us say he collects Rs. 100 from 40 houses that Rs. 4,000 should pay off his EMI and a profit for him. We believe that this is a model to grow and it is extremely scalable and it gives income to someone from the community." Boond Engineering and Development CEO Rustam Sengupta said.

Another company, Ren-en-gen, has joined hands with an NGO to launch a 10 kw micro grid in Sitapur district. It offers 3 LED lights and a mobile charging point for Rs. 150 a month. According to Ren-en-gen, villagers were earlier using kerosene that cost them Rs. 250 a month. They also had to walk miles to charge their mobiles, for which they paid Rs. 10 an hour.

"Ren-en-gen made their own investments, along with the NGO, Sankalp Samarpan Samiti, and another investor, SCT. From the business point of view, the break-even may come somewhere around the 7th, 8th or 9th year, but what was important was the social impact and how it would lead to the growth of the rural economy. Right from the design innovation up to the operation, the plant is maintained by Ren-en-gen. At the same time what we did was train 3 local guys to handle the maintenance and daily collection from villagers," Ren-en-gen Solutions Chairman Santosh K Lalwani said. In Kannauj district, the state government has set up a 250 kw solar mini grid to power

villages. It is able to run flour mills and agricultural pumps. However, a key challenge for government owned projects is long term operation and maintenance by the contractor. The tariffs charged are low and unviable and the contractor does not sustain interest in the project.

For private rural energy service providers, who want to run a professional operation, the absence of a national or state level policy on mini grids leads to uncertainty. A 50 kw solar plant with a distribution grid can cost up to Rs. 1 crore. Since mini grids are not viewed as infrastructure, long tenure financing is a big challenge. If and when banks extend loans, they do so at high commercial lending rates. There is no tariff parity between mini grids and central grids. Central grid consumers get a host of hidden subsidies that make tariffs lower for them. The sector needs a great deal of investment and for investors to come in the state government needs to come out with a clear cut policy on mini grids. For one, there is no clear direction regarding the government's electrification programme.

According to Debajit Palit, Associate Director, TERI, "So you set up mini grids in rural areas, and tomorrow the central grid extends to those areas. How do you interconnect your mini grid to the main grid and feed power to the main grid at a power purchase agreement? Or take power from the main grid in case there is a deficit from your mini grid system? There is still lack of clarity on how to do that in terms of both the technical consideration and also in terms of a proper exit mechanism for the mini grid developer. I think these are some of the challenges which are not allowing the scaling up of mini grids in India even though India has a huge potential for mini grids."

To promote greater private investment in this sector, the Uttar Pradesh government is coming out with a comprehensive mini grid policy. It will be the first state to do so. According to Parth Sarthi Sen Sharma, Secretary, Non-Conventional Energy and Secretary to the Chief Minister, Uttar Pradesh, "One of the challenges is to balance the interest of the consumers and the interest of the investor. One challenge would be if the grid comes with sufficient number of hours of electricity and the villagers are no longer wanting this investor's micro grid, then what kind of comfort can be given to the investor? How do we select the investors? There

may be some villages in which it is just not commercially viable. In that case, how is the viability gap to be met by the Government? And if we are meeting the viability gap, we need to have a transparent system in place to select the investors.

Mr Sen Sharma also struck a note of caution, saying, "Whenever we are talking about increasing the share of alternative energy, and this is a worldwide discussion, the two major points in my mind is still the difference between the price of conventional and non-conventional energy and the grid stability. Alternative power typically requires some hours of production and some hours of non-production. Therefore, we can go up to a particular limit, but we cannot wish away conventional power. That will remain the mainstay in my opinion."

Mini grid proponents believe this could be the view in the rearview mirror. But for those looking ahead, the picture is different. A renewable energy ecosystem is emerging even as Prime Minister Narendra Modi has announced the installation of 100 gigawatts of solar power by 2022. Innovative business models will lead to increase in scale and with the development of technology, solar energy is likely to become cheaper. The technology is robust and allows it to be integrated to the central grid based on conventional energy. With the support of an enabling policy, mini grids may be the best way to reach the over 300 million people in the country who are waiting for power.

Sutapa Deb is an Indian television journalist.

Business Call to Action

Bangladesh: Access to clean water and job creation for disadvantaged youth through solar power

Watersprint, the Sweden-based environmental technology company, has joined the Business Call to Action (BCtA) with a commitment to provide 50,000 people in Bangladesh with access to safe and clean drinking water by 2020.

To support this effort, the company will provide training and employment to 500 disadvantaged Bangladeshi youth.

While lack of access to clean, safe drinking water is a global problem, Bangladesh is particularly hard hit. According to the World Health Organization, high levels of arsenic in the country's groundwater – principally due to the arsenic-rich rocks through which the water is filtered – have affected nearly 35 million people in Bangladesh and contribute to 1 out of 5 deaths – the largest mass poisoning in history. Treating the country's groundwater would require a massive investment in infrastructure.

At the same time, surface water sources such as lakes, rivers and ponds are rife with bacteria and viruses, contributing to illness and deaths. Diarrheal disease is Bangladesh's biggest killer, contributing to 62 out of every 1,000 deaths in children under five each year. Tackling surface impurities, however, does not require the same level of infrastructure investment.

Watersprint's unique UV-LED technology is able to remove bacteria and viruses from water with very low energy consumption: the unit can run on

just 12 volts from a solar panel or battery. This technology was already on the market in Sweden for use in showers for water disinfection and legionella, when it caught the attention of Nobel Laureate Muhammad Yunus. At his urging, the company developed the Watersprint product to clean bacteria and viruses from surface water, and is working with the Yunus Center in Bangladesh to train and employ young people as distributors. Ten of Watersprint's portable Micro Production Centers (MPCs) were installed in and around Dhaka in 2015.

"With this new technology, we will take another important step towards sustainable access to safe drinking water in developing countries", said Anders Ruland, Watersprint's Chief Executive Officer.

"For the first time, a water solution can be set up and operated without a great deal of complexity or high cost. Empowering youth through income-earning opportunities is a key component of our inclusive business model and we are pleased to be acknowledged by BCtA for our work."

Watersprint believes its inclusive business model, which combines access to affordable, safe drinking water with training for youth as distributors, is highly scalable. The company plans to expand the same inclusive business model to three additional countries by 2030.

"Watersprint's inclusive business model is an excellent example of the private sector's unique

ability address a market need – in this case safe, affordable water – while meeting long-term development needs such as youth employment and environmental sustainability,” said Sahba Sobhani, BCtA’s Acting Project Manager. “We are pleased to welcome Watersprint as a BCTA member and look forward to the company’s continued growth.”

“Business Call to Action” aims to accelerate progress towards the Sustainable Development Goals by challenging companies to develop inclusive business models that engage people at the base of the economic pyramid.

Kristin Lau

Light for life: Nepal solar farming

Energy is at the forefront of most economic, environmental and developmental issues the world faces today. In Nepal, roughly 80% of the population lives in rural mountainous regions that lack access to reliable electricity. Solar integration for agricultural purposes has been implemented throughout various parts of rural Nepal to aid in irrigation and agricultural needs all year round.

The remaining population of Nepal is grid-connected, but face a 500 MW energy deficit, with 16+ hours of daily blackouts on average during load shedding hours. Many businesses run privately owned diesel generators for backup, but still suffer from increasing fuel costs, frequent shortages, and pollution from fumes and noise. In the current situation, local businesses have been forced to shut down and are actively seeking out clean, reliable and alternative energy solutions. Solar energy has become a very feasible and viable answer to power Nepal and provide a path towards energy independence.

Farmer Dilli Ram Regmi, 65 years old, lives in the farming village of Jharlyangdi in Walling, Syangja District. He's been a farmer since the age of 16 and grew up working in agriculture. There are 12 members in his family and they depend on agriculture to make a living. Dilli Ram saw a lack of water in his community and shared his concern with the Syangja Agricultural Committee. With the help of local and international charitable organizations, iDE Nepal, Renewable World and SunFarmer, a Solar water MUS (Multiple Use System) was implemented in December 2012 and completed

within two months. His community uses a solar powered water pump that lifts water from the valley below to a tank above the community on a hill. Access to 16 water distribution taps stand outside the 32 households in the community and provides water for drinking and irrigation giving Dilli Ram and his family back time they would otherwise use for collecting water.

Renewable World and iDE Nepal, describes a Solar MUS (Multi Use Water System) as an improved approach to water resource management for small communities to meet both domestic and agricultural needs. The Solar MUS system provides the farmers in Syangja with a 15,000 Litre storage tank. During the dry season, there is a scarcity of water and with a second storage tank, the farmers would have the opportunity to irrigate an additional area of 520 sq. meters of land. The land in Sirubari is ideal for vegetable farming, but currently there is only enough water for drinking and livestock. Traditionally, the land was able to grow millet, corn, rice, and vegetables including tomatoes, cauliflower, cabbage and radish.

Nepal continues to rebuild with reliable energy technology that is clean, efficient and affordable. Access to reliable energy is fundamental to a modern quality of life for its citizens and the country's global prosperity.

Kristin Lau is a Toronto-based photojournalist from Queens, New York.

Lauren Braniff

Building a digital finance ecosystem in Zimbabwe

There's a familiar story rolling out across Africa (and around the world): mobile money services launch, millions register for the service, but few become active users.

Of those who are active, close to 90 percent of those transactions are airtime top-ups or person-to-person transfers, falling short of true financial inclusion.

Coupled with declining voice revenues, mobile operators are increasingly looking toward a next generation of financial and non-financial services that leverage mobile money.

In many countries, mobile operators have focused their diversification efforts on a relatively predictable progression of products: airtime topups and P2P, bill payments, payroll and bulk payments, linking to banks, merchant payments, and perhaps international remittances. In Zimbabwe, the leading mobile operator, Econet, has followed a similar pattern, but what sets them apart is their parallel efforts to drive mobile money usage in other sectors, including energy, education, agriculture, and health.

Another unique factor is that innovation until recently has largely been driven from within the company rather than through outside players. The EcoCash motto "Live life the EcoCash way" provides a hint at the company's ambitions to touch on almost every aspect of their customers' lives, with EcoCash as the payment mechanism at the core. Econet has taken on the role of building out an entire ecosystem of services that are meant to both improve the lives of their customers while

also generating transaction volume for their mobile money service.

Sample Products

Econet Solar: With only 40% of the population having access to on-grid electricity, there is significant latent demand for household power in Zimbabwe. Econet Solar offers solar lanterns and a home power station, available with short-term financing from Econet, with payments made via EcoCash.

EcoSchool: EcoSchool offers zero-rated access to digital content for tertiary students in Zimbabwe. Students access digital books, e-courses, mobile courses and job alerts via a web-based platform at a fraction of the cost.

EcoFarmer: EcoFarmer provides a range of services to the large number of agricultural households in Zimbabwe. What began as an information service has evolved into a program offering insurance, savings products, loans and other valuable services to 700,000 subscribers in the farming community.

Ruzivo: Ruzivo is a digital learning platform for primary and secondary school students. The service was developed to compliment the government's efforts to improve the national pass rates in Zimbabwe. By making content accessible at an affordable rate of US\$ 2 per month, Ruzivo aims to reach all of Zimbabwe's 3.6 million primary and secondary school learners.

While many mobile operators around the world

are feeling the pressure to expand mobile money use, few, if any, have directly entered into other sectors in the manner that Econet has. Why has Econet taken this direct intervention approach?

First, their market dominance provided them with the brand recognition and resources to test and roll out products more quickly than other players. Under pressure to increase the volume of EcoCash transactions, the fastest path was to do it themselves.

Second, the startup community in Zimbabwe is just getting its legs. A number of incubators and hubs now exist and are fostering a new era of technological innovation in Zimbabwe. But just a few years ago this wasn't the case and innovation was driven from within Econet and other large corporations. Today, Econet is a supporter of one such incubator and involved in holding hackathons and contests to find their next big ideas. Opening their doors to this community of innovators will likely generate many more innovate products and mobile money use cases than would be possible in-house.

Third, and related to the second, is the issue of Application Programming Interfaces (APIs). APIs facilitate communication between two software programs, and are an important ingredient in the growth of products and services that use mobile money. Econet has opened their API to a group of partners and aggregators, enabling connections to several online merchants, e-commerce sites, utility companies, and remittances partners. In a similar fashion, Safaricom recently began opening access

to their APIs in Kenya. Start-ups are calling for even more openness from mobile money operators, so perhaps this is the beginning of a trend toward more open systems which will support further innovation.

Econet's focus on the development of EcoCash seem to be paying off. Econet Services, a division of Econet established to manage EcoCash and the other overlay services, contributed 11% to overall revenue in the first half of 2015, up from 7% in the same period the previous year. Despite this success, however, not all of their new business lines have taken off at scale. Difficult economic conditions have crippled Econet's ability to offer products on longer-term credit, a critical ingredient for the success of similar products in other markets.

But there's reason to remain optimistic. Emerging solutions, such as a solar power unit or clean water solution that one can pay off in small amounts over time or an education savings product that balances discipline and flexibility, are the type of real-life applications customers want. Continued innovation, openness to partnerships, and access to APIs will drive the future of mobile money and transition it from an airtime top-up service to an enabler of products and services that transform lives for the better.

Lauren Braniff is a consultant working with CGAP.

Sally Bolton

Going off-grid in Timor Leste

Flashback to early 2011: the Arab Spring was spreading across the Middle East and northern Africa, the hunt was still on for Osama bin Laden, and a massive earthquake and tsunami devastated Japan. At the time, I was only vaguely aware of these events, because I was living in remote Timor-Leste, with almost no access to news media. Pop culture had, however, reached us, albeit a little behind the rest of the world, and I was being woken each morning by Justin Bieber's Baby. Not by choice, but because my neighbours' kids delighted in belting it out at every opportunity.

Even now, any time I hear Baby, it takes me straight back to my time in Timor-Leste as a Kopernik Fellow. My mission: to help Kopernik's local partners to distribute solar lights, water purifiers, clean cookstoves and rolling water drums—and to evaluate the impact these simple technologies were making on people's lives. Over six months we contended with raging rivers, crumbling roads, a broken ferry, and a fuel shortage, as we worked to reach coastal and mountain villages in one of the poorest regions of southeast Asia.

This past February I returned to Timor-Leste and visited Atauro, a small island 25km north of Dili, where Kopernik has worked with local partners since 2011 to distribute a range of technologies. Three coastal villages on the eastern side of Atauro have access to electricity for 12 hours each night. Unless the ferry breaks down and is unable to bring fuel for the island's generator—in which case the hours of electricity are reduced as fuel is

rationed, as had happened in the three weeks prior to my visit.

Electricity is yet to reach the other villages on the island, but fortunately, solar lights have, through Kopernik's Light Up Atauro, Switch on Atauro and Lights for a Brighter Future projects. Everyone I spoke to on the island was very enthusiastic about the lights. "You see them everywhere, up in the mountains," said Mario, who runs a simple eco-lodge in Adara, on the more remote, western side of the island. "People love the d.lights, because they're just so easy," Mario told me. "Great!" I responded, "let's go find them!". To which Mario laughed nervously, as he explained that the only vehicle on the island able to get up into the mountains had just been rented by another group for the next three days.

"No worries, we can hike up to Makadade!" I said enthusiastically. Mario dubiously eyed the gathering storm clouds and suggested hiking up the steep slopes—which rise to almost 1,000 metres at the island's highest point—during a torrential downpour might not be the best idea. I had forgotten how much life is ruled by the weather during the wet season in Timor-Leste.

As a Kopernik Fellow, blessed with the luxury of time, I would have waited out the rain until a clear day dawned and it was safe to venture up into the mountains. Constrained by time, I instead met with Mana Neka from Move Forward, our local partner in Bikeli village. Working with Move Forward (and another partner, Roman Luan), we distributed two 'generations' of d.light solar lanterns on Atauro:

the older generations (S10 & S250 models) have a battery life of around two years, while the newer generation (S20 & S300) have improved batteries expected to last more than five years.

Mana Neka said that the batteries have started to fail on some of the older lights, but the newer lights are in good working order. There have been problems with rats chewing through the solar panel cord, in which case neighbours have been sharing one panel between two solar lights—charging one light for six hours in the morning and the other light for six hours in the afternoon. Sharing is caring, and in another example of this, families in Bikeli village—which is connected to the island’s electricity grid—have been lending their solar lights to relatives who live in villages without access to electricity. However, when there is no electricity in Bikeli, people reclaim their solar lights!

I also talked with Obadias, Mana Neka’s husband, who has become a Mr Fix-It for solar lights in Bikeli, helping people troubleshoot problems and find solutions. For example, if a fisherman drops his solar lantern in the sea, the salt water will corrode the inner circuitry, causing the light to stop working within a week. However, Obadias has figured out that if you immediately pull the solar lantern apart and rub cooking oil over the components, you can stop the salt water from damaging the light, and it will continue to work. Obadias also helps people identify problems with non-functioning lanterns, for example switching out the battery to check if the problem lies with the battery or with another component of the lantern. He said that when he visits other villages, he always reminds people to clean their solar panels, to ensure they charge effectively. To quote Daniel, Kopernik’s current Engineering Fellow, Obadias is a genius for figuring this all out for himself, without any formal training in how solar lights work.

Solar technology is not entirely new on Atauro—there are in fact solar panels dating back to the 1990s which are still being used on the island. This is a little unusual, as in other parts of Timor-Leste so much was destroyed in the aftermath of the 1999 referendum for independence. Isolated from mainland Timor, Atauro escaped this destruction, and offered a safe haven for families fleeing the violence in Dili. Larger solar panels are being used by businesses and institutions on Atauro

which need electricity during the day, to power tools and laptops for example, or who need a reliable nighttime source of electricity. Barry, who runs an eco-lodge in Beloi village, said the cost of solar panels has come down dramatically since he first came to Timor-Leste more than a decade ago—dropping from around US\$600 for an 80W panel, to now around US\$1/W. But the challenge is finding reliable batteries to use with the panels—Barry said that the batteries available in Dili are pretty poor quality, and need to be replaced frequently.

And this is where the advantage lies in simple solar lanterns like d.lights to meet basic lighting needs—they are just so easy to use and maintain, very reliable, and backed by a warranty if faults do arise. There is no doubt in my mind that these solar lanterns are making life easier for people living without access to electricity on Atauro. The challenge continues to be how to establish a sustainable supply chain to allow people to replace their solar lanterns when the batteries reach the end of their lifespan, or to buy additional lanterns, or upgrade to a solar home system, or to allow new customers to buy their first solar lantern and take their first step up the much vaunted ‘solar ladder’. Capacity and willingness to pay for the solar lanterns were big challenges in the implementation of our solar projects on Atauro.

Mana Neka said that a man recently visited Move Forward from a village where they introduced the solar lanterns several years ago, but were not able to convert interest into sales. He came in ready to buy six solar lanterns for his village, with the cash to pay for them outright, but unfortunately Move Forward no longer had any d.lights available.

It seems like an extremely long purchase funnel—the customer journey through awareness, interest, desire, and action—but the solar lanterns are a significant outlay for families with very low cash income. Perhaps that’s just how long some people need to trust the technology, understand that it is a wise investment, and save the money to be able to make the purchase. But it’s a timeframe that is unlikely to attract commercial interest in solar light distribution on Atauro—especially as market opportunities can change dramatically when the government commits to expanding electricity access. There is talk of connecting the

island to the country's electricity grid via an underwater cable. The political will to develop Atauro does not seem to be there yet, but who knows what will happen as a result of next year's national elections.

One big development since my last visit is the introduction of competition to the telecommunications market in Timor-Leste. Breaking Timor Telecom's monopoly, telcom companies from Indonesia and Vietnam have helped to drive down the price of phone calls, SMS and mobile data significantly, and coverage seems to have improved considerably too. This must be making life easier in so many ways, allowing families to stay in touch and making work easier too. If I was still in remote Timor-Leste, I would have no excuse for not being

up-to-date on important world events—or at least on the latest Justin Bieber album.

It turns out a lot can change in five years, but a lot can stay the same too. Across Timor-Leste, a lot more people now have access to electricity, which is certainly a promising development. Yet, on Atauro Island, solar technology continues to serve a crucial need for safe, clean, bright light at night.

Sally Bolton leads the communications team at NGO Kopernik.

Tonderayi Mukeredzi

What's holding back off-grid renewable energy in Zimbabwe?

Zimbabwe has enormous potential to adopt renewable energy technologies, its government and experts say. Solar is particularly promising, and could supply 10,000 gigawatt hours of electricity per year - more than the country's current total power production - if the funding were available to fully exploit it.

But as a discussion heard in Harare last month, the renewable energy market is littered with structural pitfalls. These may hamper the development of off-grid power, increasingly styled as the quickest and cheapest way to get clean energy to millions of poor people without electricity.

Here are some of the potential problems identified at the energy discussion involving government officials, businesses and sustainable energy groups:

Policy gaps

The government has committed to provide an adequate and sustainable energy supply through formulating an effective regulatory framework and policies, and promoting greater use of new energy sources. But the environment is not yet conducive to a renewable energy revolution.

While the National Electricity Act of 2002 opened up the energy sector to independent players, and an Energy Policy was enacted in 2012, the country lacks a specific policy for renewable energy.

Sosten Ziuku, director of renewable energy in the Ministry of Energy and Power Development,

said the government is still developing many of the critical policies that will catalyse renewable energy use. A Renewable Energy Policy is expected by year-end.

Other key policies on biofuels and feed-in tariffs, a renewables "readiness assessment", a rural energy master plan and an energy systems development plan are all at various stages of drafting.

But even with the energy policy that is in place, implementation is lagging, Ziuku said.

"We have also observed that there are no specific long-term targets, clear action plans, timelines, and implementation strategies for renewable energy," he told the discussion. "More importantly, we don't have reporting, monitoring, and evaluation frameworks to guide progress."

Finance

Access to finance is another major impediment, with a lack of adequate financing models to promote the uptake of renewable energy technologies.

Much can be learned from affordable pay-as-you-go systems championed by the private sector and non-governmental organisations. But energy access experts say other financing channels for solar systems - such as mobile payment systems and micro-loans for clean energy investments - are limited.

On top of this, Fungai Matura, an energy expert with SNV Zimbabwe, said skepticism is high among

local financiers towards backing solar projects.

William Ponnella, chief executive of solar products firm Zonful Energy, identified the lack of finance as a major bottleneck for consumers and distributors, with many manufacturers demanding cash up-front and companies selling products for high prices.

While solar products are duty-free, the country does not have fiscal incentives in place for investors, such as feed-in tariffs, tax rebates and renewable energy certificates, which have proven to be key drivers of renewables in European markets.

And in general, Zimbabwe has a high political risk profile, which makes it an unattractive destination for foreign energy funding.

Ziuku said that without clear tariff structures for grid-connected green projects, conflict was likely between private players and the Zimbabwe Energy Supply Authority (ZESA), which owns the grid and is also a competitor.

Power Purchase Agreements between ZESA and independent power producers need to be clear, he added.

At least 23 independent producers have been licensed, but most of their projects have yet to start owing to financial difficulties.

Quality control

Without standards and guarantees for most imported solar technologies, the energy market is largely unregulated, resulting in the importation of substandard products.

The high failure rate of imported technology has choked off the solar market but trust in the technology is rebuilding, Ponnella said.

The market lacks skilled installers, with the majority of electricians claiming to be solar installers without proper training, he added. Meanwhile, after-sale service for solar is virtually non-existent.

The Standards Association of Zimbabwe and the Zimbabwe Energy Regulatory Authority (ZERA) are still drafting many of the required solar standards, including regulations for solar water heaters,

lighting products, the solar PV industry and energy management.

ZERA's director of renewable energy, Tobias Mudzingwa, said the authority is building a dedicated solar PV equipment testing laboratory which would check components such as solar modules, batteries, charge controllers and inverters. It is also funding the establishment of a test centre for solar thermal systems.

Strategies for off-grid power

Organisations working to boost access to energy say that for off-grid systems to work effectively, forthcoming policies must include targets, milestones, and monitoring and evaluation protocols for all types of renewable energy.

They are also calling for mandatory standards for solar components and installations, as well as enforcement mechanisms for warranties and guarantees to safeguard consumers.

Also critical are the promotion of viable business models, fiscal incentives, ease of doing of business, and help for suppliers to offer the right technologies to the market, they say.

Chiedza Mazaiwana, Power for All Campaign spokesperson in Zimbabwe, said the campaign is building government capacity to develop policy and regulatory frameworks that can promote accelerated growth of the off-grid renewables market.

It is also supporting business and civil society to adopt affordable business models to speed up the deployment of decentralised renewables, and working with the media to increase public awareness of their efficacy.

Tonderayi Mukeredzi is a freelance contributor to the Thomson Reuters Foundation, based in Zimbabwe.

Maarten Kleijn and Edouard Fagnon

Bright lights for Benin: Market introduction of Pay-as-you-go solar

In Benin most people in rural areas are not connected to the electricity grid and depend on lanterns which run on dirty and costly kerosene or short-lasting battery powered lanterns for lighting. They also spend a significant amount of money on charging their phones at local kiosks (FCFA 550 – or around USD 1 – per week, according to our research). Solar lanterns with phone charging capabilities could be an ideal replacement for these energy needs. We discovered this from speaking with many rural households in Benin during a previous solar project and finding that demand for such products is high. Greenlight Planet's Sun King products were especially popular, but potential customers did not have the cash available to pay for these products up front and said they would prefer paying in instalments.

Introducing Pay-as-you-go solar products

Through the Bright Lights for Benin project, we are introducing Pay-as-you-go (PAYG) solar lanterns to the Beninese market for the first time. PAYG allows customers to buy the lantern for a small down-payment and pay it off in regular instalments. If the customer does not pay, the system is automatically switched off by the manufacturer. For this project, we brought together one of the leading producers of solar lighting products, Greenlight Planet, and a Beninese solar import-supplier, ARESS, to introduce these products to the market. Greenlight Planet's Sun King Pro is equip-

ped with Easy Buy, a payment platform tool developed by Angaza, a firm that specialises in developing PAYG capabilities. Through Easy Buy, customers could pay off the system in weekly cash payments to a sales agent.

The next step was to integrate this payment platform with the mobile network operator – MTN Benin, so customers could pay installments with their mobile phones. This took time, but is now in place and will allow customers to pay for the lanterns using mobile money, without having to physically visit the agent after the initial purchase. Once all payments are made over a 24 week period, the lantern is unlocked indefinitely. So far, customers are enthusiastic about the PAYG mechanism, because it helps them to pay progressively for their solar lanterns. One customer remarked: 'I pay for my solar lantern as I buy credit for my mobile phone.'

Using an existing distribution channel

SNV is in partnership with MTN for the project implementation, following a previous successful joint collaboration in the solar sector in Benin. MTN already has a well-established distribution network of agents, to sell phone credit and banking services, that penetrates deep into the rural areas. We provided selection, sensitisation and training of the MTN agents for the sale of solar and the use of the pay-as-you-go mechanism, with the contribution of ARESS.



In the infographic, the distribution model is visualised schematically. Solar manufacturer – Greenlight Planet – ships the solar products to solar import-supplier – ARESS – in Benin and ARESS distributes the products to local MTN agents. The MTN agents then sell the solar products to local customers enabling them to spread out their payment over a 24-week period.

MTN agents receive FCFA 2,500 (USD 4.30) in commission from ARESS for each lantern sold. One of the agents said: ‘ARESS does not have to worry about the collection of payments; with pay-as-you-go and mobile money payment, the payment channel is secure.’ MTN and ARESS also implement marketing campaigns to make customers aware of the benefits of these products; a formal launch with a press release will occur later in the year.

Pilot phase

For the pilot phase of the project which ran from April to June this year, 16 MTN agents were selected in two off-grid municipalities in the south of Benin. To date, 170 lanterns have been sold by these agents. The slow start to the pilot taught us an important lesson, namely that the cost of the solar lantern is a key factor for customer engagement in the PAYG mechanism. At first, the price difference between a cash and PAYG purchase was too high and the repayment period too short. During the evaluation meeting it was decided to double the repayment time (to 24 weeks) and reduce the total cost of the PAYG payments. Customers now pay FCFA 900 per week (USD 1.50), similar to average weekly household spending on kerosene and phone charging. A new shipment of 2,280 brand new lanterns to Benin is currently underway. More than 200 MTN agents have already been selected for the next part of the project and they are eager to start selling once the solar lanterns arrive.

A unique and solid partnership matrix has been created – in which mobile technology plays a central role – that will provide many rural Beninese with clean and affordable energy, continuing after the project is over.

Maarten Kleijn and Edouard Fagnon are Energy Advisors at SNV.

Appendix

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News Ghana	Ghana's leading online news publication for business executives in West Africa.
Ngalame, Elias Ntungwe	Thomson Reuters Foundation.
Nixon, Tim	Managing Editor of Sustainability at Thomson Reuters.
Njagi, Kagondou	Freelance contributor for the Thomson Reuters Foundation, based in Nairobi and writing on climate change issues.
Novogratz, Jacqueline	Founder and CEO of Acumen.
O'Neill, Kathryn M.	MITEI correspondent.
Ogbemudia, Godfrey	Renewable energy expert.
Oleksiw, Zadi	Fulbright researcher and clean energy advocate.
Palit, Debajit	Associate Director and Senior Fellow at TERI.

Penar, Peter	Researcher and PhD candidate in the Department of Political Science, Michigan State University.
Sanchez, Dana	Editor of AFK Insider.
Sarpong, Jon	President of PV developer and consultancy Avior Global.
Schützeichel, Harald (PhD)	Editor of Sun-Connect News.
SciDev.Net	A source of news, views and analysis on information about science and technology for global development.
Sevea	Supports entrepreneurs and organisations to build and scale sustainable solutions leading to social, environmental and economic impacts.
Shah, Jigar	President & Co-Founder of Generate Capital; also Founder of SunEdison.
Singh, Kartikeya	IDRC Fellow at Center for Global Development.
Slater, Victoria	Copywriter at QLCredit.
SolarPlaza	Global solar energy business portal with worldwide news and information on photovoltaic products and services.
Tomlinson, Daniel	Entrepreneur, author, researcher and expert in energy access.
Tozun, Ned	Co-founder and CEO of d.light (US).
Vesper, Inga	Global news and features editor at SciDev.Net.
Wisembaker-Scheel, Courtni	Author for Home Improvement Leads.
Zollmann, Julie	Independent consultant.

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