Preface

Sun-Connect News publishes since 2012 practice-relevant articles from renowned international authors of the off-grid business. With 10,000 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 2017 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 2018
Dr. Harald Schützeichel
Editor of Sun-Connect News
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A long-standing rule of thumb among energy efficiency professionals is that a $1 investment in energy efficiency delivers $3 in savings back to the economy. As the African continent sprints towards its future, what could its businesses, governments, communities and households do with a three-to-one return on investment in energy efficiency?

Wide-scale deployment of highly efficient appliances and equipment can help Africa achieve universal energy access more quickly and cost-effectively. Energy efficiency is the cheapest and most abundant way to reduce capital investments in new power supply, increase grid and service reliability and expand access to electricity in Africa. However, to date, African policy and energy sector leaders haven’t even come close to fully exploiting energy efficiency’s extraordinary potential to meet the continent’s rising power demand and population growth. Ambitious and sustained energy efficiency efforts can, and should, be a keystone of Africa’s electrification plans.

**Developing a success story**

Where energy efficiency programmes have been prioritised in African countries, the results have been impressive. For example, to address rolling blackouts, Ghana’s government established Africa’s first appliance energy efficiency standards and labelling programme in 2000. The programme currently covers CFLs, household refrigerators and air conditioners, and Ghana’s Energy Commission plans to expand the programme to cover motors and televisions. Moreover, a ban on importing used refrigerators has prevented over 260,000 old appliances from entering the market.

According to research conducted by CLASP, consumers and businesses have benefited enormously from these policies; the room air conditioner standard alone saves $64 million dollars in reduced energy bills each year. Due in part to the more abundant, reliable, and affordable energy enabled by these energy efficiency policies, Ghana’s electrification rate, as recorded by the IEA’s World Economic Outlook 2014, stands at 72%, more than double the average in the region.

There is a profound opportunity to build on the successes of the Ghanaian experience across the continent. Preliminary analysis found that over 108 terawatt hours of electricity – nearly 18% of Africa’s total consumption in 2014 as indicated in the Enerdata Global Energy Statistics Yearbook – would be saved in 2030 if governments and markets across Africa transitioned to more efficient lighting, refrigerators, air conditioners and motors. Only four products, as identified by United for Efficiency, a SE4ALL Accelerator leading the implementation for energy efficient appliances and equipment.

In May 2016, ESI Africa reported that South Africa had adopted minimum energy performance standards (MEPS) and labelling for eight products based on European standards. At the official launch, which took place at the annual African Utility Week conference, Minister of Energy Tina Joemat-Pettersson stated that it was an “uncomfortable
truth that South Africa is among the least energy efficient countries in the world. When there is load shedding, South Africans look for more energy, rather than saving energy." Similarly, ECOWAS countries are in the process of developing MEPS for lighting, refrigerators and air conditioners. While promising energy efficiency efforts like these are underway, much more remains to be done if Africa is to be a leader, crafting a more reliable, more sustainable energy future.

Because they tend to be cutting edge technologies, energy efficient products can be more expensive and present a barrier to consumers – but this can be mitigated through economies of scale and innovation, as well as smart, targeted policy. For example, to address the higher up-front costs for more efficient refrigerators, UNDP and the Ghana Energy Commission launched a rebate scheme to incentivise consumers to trade in old, inefficient refrigerators for new ones. Many African countries subsidise electricity tariffs to make power more affordable and accessible, hiding the true cost of energy, discouraging uptake of energy-efficient products and equipment and incurring enormous cost to governments and taxpayers. In a report prepared by CLASP, The World Bank. EA+EE: Enhancing the World Bank’s Energy Access Investments through Energy Efficiency 2015, it is recommended that thoughtful investments and supportive policies that promote energy efficiency can reduce the need for these subsidies and supply-side costs, and these savings can be passed on to consumers in a variety of ways.

But the impacts of energy efficiency on the pace and costs of grid electrification are only the beginning. Super-efficient appliances designed for off-grid applications like solar home systems and minigrids present an extraordinary opportunity for African companies and consumers. Super-efficient off-grid appliances fundamentally transform the economics of decentralised energy, maximising the value of every available watt and putting life-changing modern energy services within reach of millions for the first time.

A 2015 analysis, presented in the paper Powering a Home with Just 25 Watts of Solar Power by Amol Phadke et al, found that super-efficient appliances can reduce the total cost of providing off-grid electricity services by as much as 50%. High quality, super-efficient off-grid appliances like the televisions, fans and refrigerators identified by the Clean Energy Ministerial’s Global LEAP Awards – an international competition that evaluates and identifies the best off-grid appliances – give off-grid consumers and businesses the modern energy services they demand and deserve, while radically reducing energy supply costs. And, these appliances create an exciting commercial opportunity for African entrepreneurs and energy service companies: a recent Global LEAP study estimated that this market could be worth nearly $5 billion per year by 2020.

By creating and sustaining demand for decentralised energy systems, putting modern energy services within financial reach of millions of underserved people, and providing growth opportunities for entrepreneurs, appropriate off-grid appliances are very much the future of Africa’s off-grid energy market. This market simply can’t, and won’t, reach its full potential without a complementary market of great, highly energy-efficient appliances.

Whether we’re talking about access to the grid, or access beyond the grid, energy efficiency is at the heart of a more affordable, more dynamic, more sustainable African states. Africa’s businesses and households want appliances, and Africa needs those appliances to be efficient.

Jenny Corry Smith and Matt Jordan are working for CLASP, a not-for-profit organization, focuses on market and policy solutions related to appliance energy efficiency.

First published: ESI Africa.
With around five percent of the region still without electricity, Latin America offers ample opportunities for solar solutions for off-grid households.

**Areas in need of off-grid energy solutions**

Some 1.3 billion people worldwide are still without electricity, and in Latin America the number is between 35 and 40 million, or 5% of the population, making it an attractive market for companies providing solar-powered off-grid solutions.

The region has three major areas that largely remain off-grid. Firstly there are significant parts of northern Central America – Guatemala, El Salvador, Honduras and Nicaragua, and some of southern Mexico that are without grid-connection. Then there’s the Andean region, comprising parts of Peru, Bolivia, Colombia and Ecuador. Lastly there’s the Caribbean. Haiti, in particular, is one of the most non-electrified countries in the world. Less than 50 percent of the population there is connected to the grid, according to Miguel Sagastume, solar Greenlight Planet’s business development manager for Latin America and the Caribbean.

Miguel’s company provides solar-powered lighting and phone chargers for off-grid households. “We see many opportunities in Latin America because even the markets that do have electricity are still very unstable, with energy shortages,” he tells Solarplaza.

**The business case**

The company works with commercial, social entrepreneur and advisory partners in the countries it operates in, he says, selling its products to its partners, which are in touch with the final consumer.

In some countries the company deals directly with villages, with its own sales force and on-the-ground personnel, but only in markets of greater density such as India.

“Having such a system in Latin America would be too expensive, and the company has yet to establish such a presence, having only been in the region for a year, and it is still in the networking process,” he says.

Off-grid areas in Latin America are now benefiting from projects launched in the last few years to bring electricity to remote communities.

In Mexico, local firm Enlight launched a program in 2016 to bring electricity to rural communities by providing access to financing for solar arrays in collaboration with Iluméxico, a non-profit run by engineering students which launched a solar schools initiative in 2014 with the national solar power association (ANES), installing arrays in the country’s southeastern region.

The country’s first 100-percent solar-powered school opened in Chiapas state that year.

Sagastume says Greenlight Planet has yet to establish relationships with local authorities, and partners tend to be NGOs or private companies, but in some countries it is beginning to touch base with local and municipal governments.

“We are currently focused on Central America and the Andean region.”
The benefits that such systems bring are life-changing, enabling children’s study time to be increased by 75 percent, while bringing health benefits, particularly to women.

“It’s a very clear impact that you can create with one lamp. A person with no electricity in a rural community will spend $15 per month on candles, and most of these people have mobile phones, on which they will spend an additional $10 per month. The impact on their pocket is huge, so when we provide lamps the return on investment for these people is incredible, and the saving translates into food or schooling, or for investment in their agricultural projects,” Sagastume says.

Impact on safety and living conditions

“One of the biggest causes of death among women in rural communities is respiratory problems caused by kerosene candles, in addition to accidents and burns. Solar lamps therefore create a safer environment and avoids CO2 emissions.”

And the solar solutions are portable, which allows people such as migrant workers to take them with them.

“Off-grid electrification is still a relatively new sector, that has emerged over the last five years, and now has significant sales and investment,” according to Laura Sundblad, program adviser for facilitating access to finance at the Global Off-Grid Lighting Association (GOGLA). As the industry’s representative body, grouping together 85 members, GOGLA works to support companies in the off-grid sector on issues related to policy, technology and financing.

Financing: the next step

GOGLA also works with donors and investors to educate them about the sector and explain what kind of financing people need.

“The sector has attracted a significant amount of equity and debt investment, with the deal size and number of deals having increased, and attracting specialized investors in off-grid energy such as Sunfunder and Energy Access Ventures.”

“The next step is to go beyond the specialized fund managers to bring in mainstream financing, where it gets a little bit more challenging. Now we are engaging with local banks, such as in Kenya, and it is crucial that we get more local financial institutions involved, as we need to procure local currency financing,” she says.

“Our member companies are mostly small and medium-sized and are looking for financing for different parts of their value chain, either for their inventory or customers, so different types of financing are required.”

Sundblad says the two main markets GOGLA is focused on are East Africa and India, but Central and West Africa are also becoming more important. “In South East Asia there are still off-grid markets, and in Latin America there has not been such a traditional focus, but a lot of our manufacturing members already sell products to that market, and there are a number of companies now working there, with around 15 now present in Central America.”

“There are a variety of ways of reaching off-grid communities, either with a grid extension, a mini grid, or stand-alone, and it depends where those people are and what kind of infrastructure is in place, so there is no one-size-fits-all,” she says.

Off-grid solutions are a huge boon when the wait for a grid extension can take several years, which is a long time in a child’s life, and has a long-lasting impact on a child’s education and development. Such solutions can also be deployed in informal settlements around urban areas, and in humanitarian settings for disaster relief and in refugee camps, she says.

Innovation: the need and the risks

The growth of the sector is also encouraging innovation, given the need for companies to create and adapt systems for local conditions.

“There is a large human element to the sector, and customisation comes into play as we look at the next phase of solar home systems that can power different kinds of appliances. There have been several revolutions, such as the development of LED lighting, and the rapid gains in efficiency by different appliances, such as a TV that only requires an eight-watt panel to power it,” Sundblad says.

Customers’ electricity needs also vary widely depending on the region they live in. Families in South East Asia will want to power a fan, but that is not such a priority in East Africa, for example, where people are more likely to want a TV or a radio or a refrigerator, she explains.

“Innovation also comes in at the level of the
business model and the financing scheme, in addition to the technology, depending on the way that customers can pay for the service. That can depend on where people are, what kind of income they have, whether they are used to dealing with mobile money or use a bank or a savings group."

But innovating with all three things at once can be risky, she adds.

“And having strong local partners is key to bringing in the local market knowledge. The job creation part is important, as you need to make sure there are enough staff that are trained and able to serve the customers. For many of them this is the first time they are buying a solar product, and you need to have staff to explain how to service it and maintain a long-term relationship with the customer, or you risk losing the customer.”

Adam Critchley is a British freelance writer and translator based in Mexico since 1993.

First published: SolarPlaza.
The photovoltaic industry has been low margin for so many periods in its history that the concept of a margin healthy enough to profitably run an entire company is anathema to it. Focus on the benefits of multi gigawatt economies of scale on margins belies the lengths that PV manufacturers have undergone to salvage margin; lengths that include sourcing lower cost and thus lower quality backsheets, EVA, glass, junction boxes and polysilicon.

This acceptance of poor quality runs from one end of the photovoltaic value chain to the other as all participants from raw material manufacturers through to developers and end users seek to preserve margins by sourcing all components at the lowest available price.

Currently manufacturers from China are relocating manufacturing equipment to Vietnam, Thailand and other countries in South East Asia and are operating on the assumption that pilot scale production can be circumvented and commercial production more rapidly achieved. Pilot scale production is an essential step in the photovoltaic timeline. This timeline begins with research and development in the laboratory and ends with commercial production. The timeline from R&D through pilot scale production is ~20 years or more. PERC research and development began in the late 1980s. Moving from pilot scale production to commercial manufacturing can take five years. The point of pilot scale production is to repeat the process again and again and again until a reliable result is achieved. Even when equipment is relocated the pilot scale function should not be truncated.

A discussion of cost in the photovoltaic industry has to include the effect of incentives (tax and other), subsidies, grants, loans with favorable repayment rates, labor costs including benefits such as health care and unemployment, variable costs such as electricity, working conditions and frankly government goals concerning support. To ignore the rapid growth of manufacturing in low cost countries or to explain China’s lower manufacturing costs simply by virtue of money earned through the U.S. stock market ignores the significant differences country by country. All manufacturers have benefited at one time or another from significant government support for manufacturing. First Solar enjoyed support from the German government when it set up manufacturing in Germany in 2006/07 and no doubt irked more than one government official in that country when it exited in 2013.

Governments support domestic manufacturing for many reasons with the top three being a) tax revenues b) local jobs and c) GDP growth. The U.S. has inarguably the lowest level of support for its domestic manufacturing and China has some of the highest support. These two countries have completely different economic, political, cultural and social ideologies and systems.

It cannot be ignored that in terms of PV manufacturing costs China, with >50 percent of cell ma-

Paula Mints

Photovoltaic cost and price relationship
nufacturing capability in 2016, has an effect on the global manufacturing cost average. China’s manufacturing costs are extremely difficult to untangle and this untangling cannot be accomplished through public statements.

Components and raw materials used to produce solar cells and modules in China are half the cost and half the price of components sourced from other countries. The difference is a result of a completely different perspective about margins. For example, a low cost backsheet in the U.S. can be produced for $0.22 per square foot, while in China a low cost backsheet is sold for $0.22 per square foot. A higher performing formula such as fluorinated and Tedlar-based is produced in the $0.54 per square foot to $0.60 per square foot range in the U.S. and is sold in China for half of the U.S. production cost.

A normal manufacturing operation for a similar product to a PV module requires a >35 percent to run a healthy, thriving business that includes all the operations required to run a business including R&D. When the margin is truncated quality eventually suffers because all manufacturers will eventually seek methods of controlling costs and retaining a semblance of margin.

Cost behavior is a better measure of industry learning than price behavior. This is because price is most directly a market function and as the photovoltaic industry has little to no control of its markets the price function is measure of market reactions to government subsidies and not a measure of learning.

By any reasonable measure and despite its erratic and low margin pricing behavior, manufacturing cost learning in the photovoltaic industry has been outstanding as the following figures, 4.5 through 4.8, will illustrate.

Figures 4.5 through 4.8 observe costs (2016 constant and current) from 1976 through 2016. As a reminder:

- Current dollars do not adjust for inflation that is, current dollars are in the perspective of the year the goods were purchased.
- Constant dollars adjust for inflation and allows for direct price comparison from one year to another. Constant dollars are in the perspective of the year analyzed and in this case, 2016 dollars are presented. For example, $20.00 in 1976 would be $85.00 in 2016.

Paula Mints is Founder of SPV Market Research.
First published: Renewable Energy World.
Deficient governmental policies: the main obstacles for the off-grid industry

Harald Schützeichel

More than 15 years ago, when I started my work in the off-grid energy sector, I was convinced that the main obstacle to off-grid electrification was the rural population’s lack of purchasing power. In addition I expected, of course, obstacles on the part of the state bureaucracy and possible corruption as well as widespread legal uncertainty. As a consequence of these conditions, I presumed that there would be a lack of interest on the part of investors and, of course, insufficient financial resources.

I was surprised by the real facts because the actual pyramid of obstacles was upside down!

The purchasing power of the rural population is definitely not the limiting factor. Even poor people are not impecunious, and they can afford full energy access if the products are provided with a finance scheme.

But to provide end user finance options, lot of capital is needed. On the other hand: decisions of investors are relatively easy to predict. Basically they need three preconditions for their activity: stable policies and laws; investment friendly environment; profitable business plan. If these requirements are fulfilled investors will spend more than enough money to finance decentralised energy access.

The real problem for a growing energy access sector clearly lies at the governmental authorities and their policies. Of course, in brochures and speeches in conferences, one can read and hear with regularity how important solar energy for off-grid energy access is. Nevertheless, the reality in most of developing countries looks quite different: policies are either not clear or even made to obstacle a serious off-grid energy sector.

The consequences of the current policy situation are obvious. Some few samples:

- All developing countries allow the import of important products for the country with reduced or even no duty. Very often this applies for fossil energy, but also for entertainment and communication (mobile phones, TV). Unfortunately, in many developing countries there is no duty reduction for solar off-grid energy products.
- Very often legal regulations for doing business are not clear and quite complicated or bureaucratic. Consequently countries in developing countries usually range at the end of World Banks ranking for "Ease of doing business".
- Arbitrariness and bureaucracy at customs clearance is a challenge in all developing countries. Often products get stucked in customs due to lack...
of professional customs service. Sometimes it helps to pay an additional "service fee", which comes then to the next topic:

- **Corruption** is present in all steps of business activity; it starts at customs and continues all over the supply and distribution chain for an off-grid company.
- **Lack of finance through local banks** for off-grid energy access usually is due to high interest rate and request for hard collateral like land and buildings.
- Very often **crude regulations for doing business** limit the activity of companies and restrict the rights of foreign investors.
- Last not least many developing countries in Africa and Asia are affected by either insecure **political stability** or high **legal uncertainty**, which definitely is a No-Go for any investments.

The consequences of this situation are obvious: on countries where lots of people remain without energy access the national governments either are not able or not willing to ensure a sustainable business development.

In March 2017 Power for All published a report which states clearly the low policy performance in developing countries for Decentralised Renewable Energy (DRE):

![Bar graph showing policy performance](image)

Power for All, Decentralized Renewables: From Promise to Progress, March 2017, p. 3.

But what is a reality as well: as soon as governmental policies ensure a reliable economic business environment, the investors place capital to finance energy access business, companies are providing energy products even in very remote areas and the rural population is benefitting from this development. Well known samples are Bangladesh, India, Tanzania, or Kenya.

To honestly push sustainable energy access in Africa and Asia, national governments need to show the willingness to set and keep appropriate policies and fight against corruption and personal enrichment. We definitely don’t need more speeches in conferences or signed documents on political meetings. We expect actions from governmental authorities, not more words.

Harald Schützeichel is expert for off-grid energy in developing countries; Editor of Sun-Connect News.
First published: Sun-Connect News.
S tanzin Dolma is a woman who lives in the remote village of Shade, in the Zanskar valley of Indian Himalayas. Her village is located at a trek distance of 5 days from the nearest motorable road. Dolma has a house in this centuries old village and is living with her husband and 3 children. She tends to her farms during the daytime and comes back to her house in the evening. Once back, she lights up the kerosene lamps to provide illumination in the darkness of her house. Her family got a battery and two CFL lamps many years ago from the government which have stopped working, so kerosene lamps are their only hope for light.

According to the World Bank, over 1.1 billion people have no access to electricity, and a billion more only have intermittent access. These people rely on costly, outdated technologies that are harmful to their health, and hinder their opportunities for social and economic advancement. The people resort to kerosene lamps, candles, and smoky, inefficient cookstoves, which cause more health damage and environmental damage. The household pay most of the money as proportion of their household income for inadequate, dangerous, and unhealthy energy sources that kill many women and children prematurely.

How does one reach to Dolma in the first place, and once you reach her village, how do you provide them access to energy given the geographic constraints. There is a push for universal energy access by governments all over the world, however the barriers to reach universal access are socioeconomic, geographic and demographic. The challenge of reaching remote populations in rural areas makes capital-intensive electrification even more costly. Setting up of grid infrastructure involves huge investments during construction phase. These initial investments and the operating expense need to be recovered from the end users through a monthly tariff. Here is where things become difficult, since the high cost is being spread among rural population and the population is spread out, which results in a very high per household monthly tariff, more than what we end up paying in cities. The poor people end up paying more than the rich people for getting electricity. This is one of the major reasons that providing access to villages does not immediately result in the acceptance of electricity in each and every household.

So what do you do? How can one reach out to the several women like Dolma who don’t have access to electricity and improve their living conditions. Lack of electricity is a deterrent to income generating opportunities and blocks the outcomes on any investments done on education, health and women improvement. Households end up paying almost their entire month salary to buy kerosene for purpose of lighting up the household. To supply electricity to a villager, living in poverty and hardly
managing to eat 3 meals a day, the cost has to be optimized.

This can be answered in three parts, Energy Access, Energy Efficiency and Energy Economy.

Energy Access:
One part of the answer lies in using decentralized power generation and mini grids to service the offgrid communities. Off-grid electrification, largely driven by local renewable resources has grown significantly over the past decade and is used to power new connections in rural areas. The traditional grid solution of utilities is now being complemented by off-grid solutions consisting of mini-grids and standalone home lighting systems. These innovative solutions are eliminating the need of a capital intensive infrastructure thereby allowing a low monthly tariff per household. There has been an immediate acceptance of mini grid and home lighting solutions in every community across the globe due to the low cost. Villagers have stopped buying kerosene and use only a part of the saved money to pay the monthly tariff. The International Finance Corporation (IFC) estimates there is an $18 billion market to serve these bottom-of-the-pyramid consumers that represents an untapped market opportunity for the private sector.

Energy Efficiency:
The second part of the answer lies in Energy Efficiency. If 1.1 billion people across the globe need to be provided access to electricity, it makes perfect sense to start these communities on energy efficient technologies and devices. New initiatives to integrate energy efficiency mechanisms with energy access are also now being promoted in the developing countries. Conventional electricity is AC (Alternating Current) in nature, however the electricity generated at source is DC (Direct Current) in nature. The conversion involves a 30% loss, which can be eliminated if the community is powered up using DC electricity. And this is possible for rural communities that stay together and are not spread out. DC Grids are now coming up as a practical answer to fulfill the energy needs of cities also. A growing number of devices in our homes run on DC- our mobiles, laptops, electric cars, LED Lights. Data centres increasingly use local DC micro grids for efficiency and cost savings. Using DC Grids offers the potential for home owners to power up their houses with Renewable energy and feedback energy to the grid.

Energy Economy:
Universal energy access is the most discussed theme at any national and international conference. There is a lot of funding put in by international organizations and corporate partners to accomplish the goal of energy access. However, the missing link is the development of a local Energy Economy.

Let us go back to Dolma to understand more what Energy Economy means. Getting funds from outside India in order to buy a solar panel and an LED Light from outside India is not really contributing to the economic growth of Dolma directly. She becomes an end user of a free technology donated to her. But what if you could train Dolma to assemble her own LED Lights? What if you could get Dolma to buy the LED Lights from a local store, LED Lights that are manufactured in her own region by women like her. Global Himalayan Expedition electrified a village in Himalayas this year, and gave villagers the provision to add television to the home grid on the condition that they buy the television. Out of 10 households, 9 bought the television, resulting in income generation for the local entrepreneurs.

Energy Access can be a big driver to promote Entrepreneurship and skill development in the rural areas by engaging the communities to manufacture goods locally using the funding. This will result in developing an economy working to fulfill the energy needs of the area.

Parallel economies that develop are handicrafts
due to the extra working hours that villagers get from the energy access and promotion of tourism to these rural communities giving tourists an experience of local culture and tradition with good facilities and charging points for their iphones. The Homestays as they are called in the villages, give tourists a chance to stay with the locals and experience their culture and tradition while allowing the villagers to earn income from the tourists. All this results in the creation of a livelihood where in the starting point was the access to energy.

It is imperative for us to work on the three areas of energy access, energy efficiency and energy economy to achieve universal energy access, and achieve it a faster pace than what it is today. Only when the three areas will be linked, will there by a successful transition of the world from energy poverty to energy sufficiency.

Jaideep Bansal is the Energy Access Leader for the Global Himalayan Expedition, and is also a global shaper from the World Economic Forum.

First published: Linkedin.
Is it the time to think big, again? Can only mega projects catch the country’s attention and lead Bangladesh to becoming a middle income country? On the road to 2021, the Government of Bangladesh has declared, among many other goals, to reach universal electrification (currently somewhere between 62-75 percent, and a matter of heated debates) and a 10 percent share of renewables in the energy mix (currently less than 3 percent).

So does this mean the days of ‘small is beautiful’ are over? It certainly should not be the case! It is important to note here that Bangladesh has been a global role model, showing how an energy transformation is brought about through household-based solar infrastructure initiated in its rural areas. Selling solar home systems through microcredit in the late 90s made Bangladesh an early adopter on a global scale, stepping into unfamiliar territory while electrifying its rural areas. But this first mover behaviour clearly paid off. Today, we count close to 4.2 million installed systems or solar systems in every fifth household in rural areas. At its peak, Bangladesh’s solar home system programme sold 2,500 solar systems per day.

However, these days are over. Two major interventions have turned the market inside out. First, the Rural Electrification Board (REB) has started to massively electrify rural areas through the national grid, powered by fossil fuels. Second, the TR Kabhika project was diversified to solar through which these systems are now being distributed for free. Both continue to have severe adverse effects on the sustainability of the globally recognised solar home system programme. Nonetheless, last month, the REB made headlines with its plan for two mega rural electrification projects in Bangladesh in order to cover the entire countryside at a cost of Tk. 143.55 billion. The plan was put in front of the Planning Commission which, in turn, raised concerns over the high cost of the two projects and REB’s implementation capacity.

But should this be the sole focus of our attention? Is it really the time to only think big? Interestingly enough, given the 10 percent or 2,000 MW energy capacity target from renewable sources, despite the rhetoric, approvals, and signed PPAs for mega solar parks, as of today the country only has 167MW in solar PV capacity, out of which 90 percent stems from these small solar home systems! Let us understand these systems better as laid out in the following points.

First, a recent study conducted in rural Bangladesh has in fact shown that that on average, these solar home systems perform significantly better than the national grid in these areas. The better performance is measured through the performance of the electricity service quality, measure along several attributes such as capacity, duration, quality, safety etc. It is time to recognise the role solar home systems have played and will play for
this country’s development and to stop undervaluing the level of energy access they bring. Recent implementations have shown that we can even interconnect those systems to form microgrids with a greater power supply, as a way to provide electricity both affordable and clean, while also supplying the villagers with an extra source of income. Those and other on-site solar options are the most expedient among the technical possibilities that fit the bill in meeting the universal access imperative.

Second, the International Energy Agency estimated that approximately 70 percent of the one billion people worldwide lacking access to electricity should have electricity through decentralised systems and only 30 percent through grid extension. Similarly, the Poor People’s Energy Outlook 2017, which was released this week at the Vienna Energy Forum 2017, performed a scenario analysis for Bangladesh. In its findings, the report states that only 34 percent of those households still un- or under-electrified should most economically be electrified using the national grid (2.4 million households). Grid expansion for the remaining 4.8 million would be uneconomical, and they would be best served with distributed solutions, almost all through stand-alone solutions (4.4 million) and only 5 percent through mini-grids. Current planning targets the complete opposite, going against economic acumen.

Finally, in my opinion the Planning Commission was right to return the REB offer; however, it should not only have done it on the grounds of costs and institutional capacity but also on the grounds of lack of more integrated planning. Attention should now be on how to avoid such external shocks to the solar home system sector, as well as on how we can target affordable and flexible electrification where people’s actual needs are at the centre of our focus. In detail, this requires re-evaluating the role that these allegedly “small” solar home systems can play as a sustainable complementary option to the national grid. This will enable us to use the existing resources in the best interest of the country and its Vision 2021. Imagine the combined power of more than four million individual solar PV systems put together!

Therefore, I urge the stakeholders to get together and re-evaluate what universal electrification actually means for us (and it is certainly not that everyone has access to a national grid) as well as the means by which to achieve universal electrification by 2021 for Bangladesh.

Sebastian Groh is Assistant Professor, School of Business and Economics, North South University, and Managing Director of ME SOLshare Ltd.
First published: The Daily Star.
4 ways blockchain will disrupt the energy sector

Yongping Zhai

In the last five years or so, so-called “disruptive” technologies—such as distributed renewable energy, smart grids, energy storage, and fuel cells—have clearly impacted the energy world. While energy professionals are still adjusting to the new reality, let’s take a look at blockchain, an emerging yet potentially even more disruptive technology discussed during a seminar on advanced clean technology solutions for development at ADB’s recent Annual Meeting in Yokohama, Japan.

Blockchain is a game-changer, according to Don Tapscott, a TED Talk speaker and one of the world’s leading thinkers on the economic and social impact of technology.

“The technology likely to have the greatest impact on the next few decades has arrived. It’s not social media. It’s not Big Data. It’s not robotics. It’s not even artificial intelligence. It’s called blockchain.” said Tapscott.

So, what does the somewhat obscure term “blockchain” mean exactly? How might it affect the future of energy systems? And how will this technology impact ADB’s lending and technical assistance operations in developing Asia?

With blockchain, intermediaries become obsolete

Let’s first try to briefly explain the concept. In a traditional environment, regulated third parties, such as public utilities or banks, act as intermediaries for financial, energy, or any other transactions. The service that these intermediaries provide add cost to every transaction.

Blockchain, on the other hand, allows people to trust each other and transact directly peer-to-peer through a tamper-proof database that can be accessed by any member of the network. A simple example is buying a used car using a secure electronic ledger that can debit the buyer and credit the seller, instead of a bank-issued check, to make the payment and cut out the middleman.

This means that intermediaries become obsolete. Its most noteworthy feature is that blockchain isn’t dependent on a central authority for storing data, so there is no single point of failure.

Blockchain comes at right moment to transform energy sector

To grasp blockchain’s impact, you might want to use the 5 Ds as a memory aid. It is technology that is digitalized, deregulated, decentralized, distributed, and democratized.

Interestingly, the world’s energy systems are also following the 5Ds of blockchain as a greater share of renewable energy is being integrated into electricity grids thanks to smart grid technology, the proliferation of rooftop solar systems, and better battery storage.

This technology comes at the right moment to support the transformation of the energy sector.

Developing Asia can leapfrog on energy sector through blockchain

Blockchain technology can help developing countries in the Asia-Pacific to leapfrog in the development of their energy sectors. There are four
areas where development institutions can help them do this.

1. **Capacity building and institutional strengthening.** Support can be given to help energy regulators and power utilities use blockchain to improve their financial management. The technology can then help the companies register and record the ownership and current state of assets, digitize contracts, and verify and execute metering and billing transactions.

2. **Modernizing grids.** While blockchain may seem at first too disruptive for power utilities, it can actually help them keep up with rising power demand in smaller, lower-value blocks.

Blockchain can also make existing energy industry processes more efficient by serving as the backbone for the smart grid systems that automatically diagnose and respond to network emergencies and problems.

This way, for instance, if a natural disaster destroys transmission towers or transformer substations, the grid can quickly and automatically reroute power to prevent a massive blackout.

3. **Renewable energy mini and microgrids.** Blockchain empowers individual consumers and producers. When each household that can generate and store electricity can enter into automated, peer-to-peer transactions with other households or sell power back into the grid at the market price, the households (consumers) become “prosumers”.

The technology can help organize, coordinate and secure resilient peer-to-peer power systems.

4. **Green finance and carbon trading systems.** Blockchain can be deployed to both schemes, which are crucial to support the implementation of developing member countries’ Nationally Determined Contributions under the 2015 Paris Agreement against climate change.

The technology can help provide guarantees of origin, emission allowances, and renewable energy certificates.

ADB’s annual lending in the energy sector is around $5 billion per year, half of which goes to clean energy (renewable energy and energy efficiency). The other half goes to transmission and distribution systems. By including blockchain and other advanced technologies, ADB’s energy sector operations can have even greater development impacts.

It can also push developing countries in Asia and the Pacific toward the all-important 6th D – de-carbonization of the economy.

Yongping Zhai is Technical Advisor (Energy), Sustainable Development and Climate Change Department, ADB.

First published: ADB.
When the Narendra Modi government came to power, nearly 18,500 villages languished in darkness, untouched by electricity 134 years after Thomas Alva Edison started his first electricity distribution vendor and 67 years after India’s independence. The absence of this most ubiquitous resource, which city-dwellers take for granted, has over the years exacerbated the problems of illiteracy, disease, personal safety, and sheer destitution amongst the millions of inhabitants of the neglected villages.

Equitable access to resources has been a common theme for the various governmental initiatives over the last three years. With power, it started with the Prime Minister pledging from the ramparts of the Lal Qila in his 2015 Independence Day address that all of the remaining 18,452 villages would be electrified within 1,000 days. As of March 2017, ahead of the schedule, over three-fourths of this target has been met, and the complete electrification of all villages is on track to meet the 1,000-day deadline.

One of the key methods for electrification for some of these villages is off-grid solar. This involves providing small solar units for a village to light up common areas and households which are interested. Some of these villages are situated in extremely remote and hilly regions, and electrification by the grid isn’t logistically or economically feasible.

Most of these villages are located in the Northeastern states, deserts of Rajasthan, or in the Left wing extremism-hit districts in eastern India. Over 2,700 villages in the country are being electrified using this method.

Recently, a study titled *Does basic energy access generate socioeconomic benefits? A field experiment with off-grid solar power* in India was published in a journal Science Advances, authored by academics from universities in the United States of America and United Kingdom.

The paper details result of a year-long study conducted in villages of Barabanki district, Uttar Pradesh. The study was conducted between February 2014 and July 2015 to explore the impact of off-grid solar power on 1,281 rural households dividing them between groups using and not using off-grid solar power.

This project was supported by a rural solar power provider, Mera Gao Power (MGP). The study focused on 81 randomly chosen un-electrified habitats, dividing them between treatment (with the microgrids) and control (no microgrids) habitats.

Of the treatment group of 50 habitats, 21 adopted the microgrids. 117 households adopted the MGP service at some point in time during the study. MGP charged a nominal fee of Rs 100 per month for the facility, providing two light-emitting diodes (LEDs) and one mobile charging point against the microgrid. The power was provided to houses within 100 metres of a central pucca house in these villages. MGP provides electricity after 7 pm, the peak energy demand time - when families are together.
Based on these statistics, it is quite clear that the study had the following characteristics:

- Localised to a couple of blocks in Barabanki
- Dependent on MGP rules, business model, and efficiency
- Focused on participating households, not necessarily the most backwards or needy ones
- Limited by physical location of households
- Covering a short duration of power availability at the hours which are usually dinner hours for families.

The study has brought out several conclusions. The notable positive conclusion was increased availability of power and savings from the amount spent on kerosene. The study also found no positive impact of off-grid solar power on socio-economic upliftment. Information on socio-economic variables such as savings, household expenditures, household business creation, time spent in productive work by women, use of lighting for study, etc., was collected before and during the period of the study.

Even though the paper cites several other similar studies - most importantly one conducted in Rwanda - that establish an inseparable causal link between off-grid solar electrification and socio-economic upliftment, it notes no improvement in socio-economic indicators in this case in Barabanki. The authors do note that "our findings do not imply that larger systems for generating off-grid solar power cannot produce broader socio-economic benefits."

Agency and media reports in Indian outlets, however, extrapolated this study limited in time, access, capacity, and spread to infer that off-grid solar was irrelevant in its entirety.

The comments on no socio-economic upliftment have been differentially played up without accounting for the limiting study parameters. In fact, some of the conclusions were unexceptionable - if there is extra power for the dinner time, that’s not likely to increase female participation in employment.

Or if the extra power is available at the time when families are in their homes, there isn’t likely to be any extra sense of physical safety for women.

In contrast, the off-grid solar power access being provided by the government under the various rural electrification initiatives is far greater than what has been provided by the private company involved in this study.

For instance, the government’s off-grid solar kit will, in addition to LEDs and mobile charging points, provide households with fans and charging points for other appliances. Moreover, the government programs are targeting 24/7 constant and affordable supply of power, not conveniently chosen 1-hour evening power availability.

Even with the minimal access which the study is based on, the benefits are clear. There is an improvement in lighting as well as the reduction in usage of kerosene, which will improve the health of people and reduce subsidy burden.

Even for this limited positive impact, it would take more than a year to see perceptible improvements in lives of people - for instance, better health leading to reduced medical expenses over time.

With much greater access to off-grid solar power that is being guaranteed by the government, irreversible socio-economic benefits will accrue to the remotest regions of India.

Electrification is, of course, a necessary condition for such benefits, but the local governments have to ensure a lot more - access to physical infrastructures like roads, jobs, and financial access to tie in all the pieces together.

India’s size and the terrain is a big challenge for any infrastructure provision, and 100 per cent electrification is no exception. However, precisely because of these geographical complexities, India should take a source-agnostic view when it comes to filling gaps in electrification, as long as the cost is not a constraining factor.

Solar micro-grids are and should remain, an essential intermediate step in the provision of power supplies to remote villages.

India should take substantial, incremental steps forward, rather than waiting for ad infinitum on the sidelines to take that one big leap. Solar micro-grids are good for the immediate purpose, and let great not be the enemy of good.

Aashish Chandorkar is a Management Consultant based in Pune and working in Mumbai.

First published: Swarajya.
Pieces are falling into place for an important collaboration between India and Africa to end energy poverty. The stakes are high, as sub-Saharan Africa and India account for over 80 percent of the world’s 1.1 billion unelectrified.

On the heels of the first annual meeting of the African Development Bank (AfDB) ever held in India last month, this cross-continental partnership is evolving quickly, both in the public and private sectors.

Of note, it is taking place at a time when India’s long-time rival China is investing tens of billions of dollars in African infrastructure to secure resources for its future development, adding an element of geopolitics that will be worth following despite India’s position that it is not engaging in Africa with “strategic intent” but to end poverty and promote social justice.

India already pledged in 2015 a concessional credit line of $10 billion to Africa over five years, earmarking at least 15-20 percent (or up to $2 billion) for solar energy projects, largely off-grid, to be implemented through the India-hosted International Solar Alliance (ISA).

The area most ripe for immediate collaboration is solar irrigation, which is already scaling rapidly in India and will be a major help to the AfDB in its goals of achieving universal electricity access and ending hunger and malnutrition by 2025. India too has major ambitions, including 100 percent household electrification by 2019.

The intent to ramp up collaboration was clear at the AfDB meeting, where India’s government said it had received interest from Indian companies to install 664,000 solar pumps, install 56 megawatts of mini-grids and train 5,400 solar mechanics in Africa.

“We would love to share our experiences, to work together with the African continent and all the countries of Africa to take the benefits of modern technology, to take the benefits of low-cost deployment of these technologies on a larger scale to the remotest corners of Africa, to the poorest of poor of Africa,” said Piyush Goyal, India’s minister of state for Power, Coal, New & Renewable Energy and Mines, during the AfDB meeting.

“We should look at scaling up this engagement, being it skill development, being it expanding your micro-grids, or even utility-scale renewable energy programs, be it introducing the most modern technologies in Africa, being it helping you assemble in the initial stage and finally manufacturing solar and wind generating equipment,” he added in comments during the AfDB meeting.

Goyal said the ISA would launch a new program to scale up deployment of mini-grids in Africa, which would focus on design, adoption of common standards, aggregating demand, helping establish global credit enhancement and de-risking mechanisms, assessing demand and costs requirements, identifying and developing attractive payment models for consumers, and persuading member
ISA countries with overseas assistance budgets to earmark a portion of their soft loan money.

Astrid Manroth, director of Energy Transformative Partnerships at the AfDB, added: “There’s so much experience here [in India]... and I think we’re very well equipped to take this back to Africa and also see how we can partner on a longer-term horizon.”

Aside from mini-grids, the opportunity for solar irrigation is immense. Sub-Saharan Africa has 60 percent of the world’s uncultivated land and the lowest yield of any region globally. Less than 6% of farmland in sub-Saharan Africa is under irrigation, compared to 20 percent in the rest of the world.

Solar-powered irrigation enables farmers to switch from expensive, heavy and polluting diesel-powered water pumps to sustainable, renewable power.

This provides a consistent supply of water to support productivity throughout dry seasons, with knock-on benefits to nutrition and household income. Not only does decentralized renewable energy deliver electricity for improving rural, farming communities, it makes those communities more resilient to climate change and saves governments money (versus grid extension).

According to Indian private sector companies, the ISA line of credit is initially targeting deployment of 100,000 solar irrigation pumps in Africa. Because the credit has a local content requirement, they expect it to lead to increased business partnerships between Indian and African companies.

Commercial Bridges

Already, a growing number of Indian and African companies and social enterprises are building commercial bridges between the two regions.

Husk Power Systems was one of the first Indian companies to be actively involved in developing the energy access market in Africa, focused on Tanzania, Uganda and Nigeria. It develops biomass and solar mini-grids (and hybrids of the two), and is currently converting 5 mini-grids in Tanzania into solar/biomass hybrids, which can provide 24/7 power to homes and businesses. Husk is also committed to doing 5 mini-grids in Nigeria.

Husk has prioritized skill training to go hand-in-hand with technology transfer in order to scale deployment, and established a cross-cultural skill development program that has trained Tanzanians and Ugandans on mini-grid operations. In addition, Husk has worked extensively with regulators of multiple countries, and in 2015 hosted the Uganda Ministry of Energy and Mineral Development for two weeks for a training program on mini-grid technology and development.

Another leading Indian mini-grid developer OMC Power is also developing its strategy to enter the Africa market, starting in Kenya. Both OMC Power and Husk are part of the Rockefeller Foundation’s $75 million Smart Power India program, which has been working to commercially scale mini-grids over the past two years with a goal of eventually electrifying 1,000 villages in India, and which is now looking to expand its experience and learning into Africa.

On the solar irrigation front FuturePump - a solar irrigation company based in Kenya with manufacturing facilities in India, has installed 2,000 systems in Africa, and is now turning its sights toward India. Claro Energy, a leading Indian solar irrigation company which has 6,500 solar pumping systems in about 15 Indian states, is exploring how to enter the Africa market.

The Energy and Resources Institute (TERI), a non-profit research institute in India, through its Lighting a Billion Lives program, has reached 20,000 homes in Sierra Leone, Ethiopia, Kenya, Uganda, Mozambique, Rep. of Congo and Nigeria. Several educational institutions, including TERI University and Gujarat Energy Research & Management Institute, have also started programs to educate African officials, utility executives and entrepreneurs.

Interesting initiatives are also under way that originated in Africa and are finding their way into India. For example, Greenlight Planet is piloting its pay-as-you-go solar service in India based on its innovative business model in Africa that has reached over 5 million homes. D.light, another company that has established a strong foothold in Africa, is also looking at bringing the “paygo” model to India.

Civil society is engaging more deeply as well. Barefoot College, an India-based NGO, has trained solar entrepreneurs, with vocational training centers in Senegal, Burkino Faso, Liberia, South Sudan and Zanzibar that serve the Sub-Saharan region.
The SELCO Foundation is also looking to establish its off-grid ecosystem model in Tanzania to help build the enabling environment needed to scale the sector.

William Brent is a director of the Power for All campaign and a long-time evangalist of renewable energy.

First published: Thomson Reuters Foundation.
It is widely agreed that energy subsidies impede the efficient functioning of markets. The resulting distortions in prices work at odds with policies to improve energy efficiency and reduce the cost of energy services and associated externalities such as health and environmental damages.

The analysis developed in this article finds that kerosene is used in 173 countries, at a cost to consumers of $43.4B/y, $60.3B/y including direct economic subsidies, and $77.2B/y including certain externalities. Despite low world oil prices, direct economic subsidies for kerosene were $18.4B in 2013, and $34.7B including environmental externalities. These values correspond to 72% and 56% of total kerosene costs being passed through to consumers, respectively.

When excluding advanced economies, the pass-through values fall to 40% and 35%. Approximately 52% of the global kerosene supply receives direct subsidy, or 63% when externality costs are considered. The cooking end use receives $2.0B/y in direct kerosene subsidies, lighting $7.1B/y, and heating and other residual uses $9.3B/y, or $76 per over all households each year.

Defining subsidies at this level of granularity is useful for pinpointing policy issues and opportunities. Promoting a transition to energy efficient off-grid energy services is one of the most cost-effective ways of reducing dependency on subsidies.

However, the very presence of subsidies undercuts this process by diluting market price signals and rendering energy efficiency investments less cost-effective, while competing with other social and development-focused budgetary needs.

Kerosene subsidies are additionally counter-productive because the emerging technologies they impede (e.g., improved lighting and cook stoves) also improve productivity, safety, and quality of life. Forty-five countries - many in the developing world - have priced kerosene such that there are no direct subsidies, and twenty-two have done so even when accounting for environmental externalities, suggesting the practice is economically and politically feasible.
stand-alone solutions still have the image of being only a “first aid” not only for off-grid customers: also governments, investors, power companies, banks see the stand-alone technique more as a temporary solution. The large capital flows go to network-based technologies. At most, the micro-grid is still accepted as "little brother".

New technology developments in Europe and Australia

A change in this attitude that the grid or micro-grid provides the only solution for a modern power supply will come ultimately again from the technically developed countries: in Europe and Australia solutions are increasingly being implemented to make households and businesses independent from the public power grid.

Triggered by the dissemination of LiFePO4 batteries, more and more companies arise focusing on the offer of “solar plus storage” - and therefore advertising that households and companies can make themselves completely independent from the grid.

- In Australia the Solar-Plus-Storage market is growing significantly. For households it became a sign of modernity to go off-grid and just rely on a personal in-house-solution for power. Studies forecast that by 2018 half of the local households will have said goodbye to the power grid and will have gone off-grid.
- In Europe so called "solar-rooftop-systems" provide reliable and affordable power for compa-
Sarah Alexander

Energy solutions shouldn’t just tick boxes, they should transform communities

A recent research article concluded there was little evidence to suggest positive changes in socioeconomic development by introducing off-grid solar power in the form of a basic solar lighting plus mobile charging systems in un-electrified areas. At SELCO we concur with the findings but believe that some aspects of the related study’s methodology and analysis fall short of adequately providing linkages that affect socioeconomic improvements. For example:

1. **Was the system designed to meet end user needs or to meet an electrification target?** It is important to ascertain how the solution was matched to the need. In other words, who made the decision to "give" or "have" electricity? "We would like to provide electricity to the people" is very different from "I want to have four to five hours of lighting because in my house we lack XYZ." Understanding the demand for the solution is critical. Providing a lighting solution merely because the site was previously un-electrified and assuming that any solution would be an improvement, would have overlooked the specific functions the light could have served for the household. The typical solution among mini-grid models or electrification schemes is to provide a connection to lighting vs. designing systems that meet specific requirements of the household. The latter would have led to different system designs and placement of lights that were more suited to the requirements.

2. **Quality of lighting.** Further, it is unclear whether the basic energy unit – a “two light” plus mobile charging – was suitably designed to meet the needs of each household or to simply slightly improve upon the existing kerosene lamp in terms of lumens and fumes. We suspect it is the latter, in which case the quality of lighting improvement is marginal so the household will see only a slight benefit even in terms of security, safety, satisfaction and general well-being – which are important byproducts of lighting.

3. **When do capital subsidies make sense, particularly in the mini-grid model?** The study suggests that in order to observe socioeconomic changes some form of subsidy is required, primarily in the form of capital subsidies to allow for larger loads by the service provider. We agree. However, we would take this further to suggest that in a mini-grid model there needs to be a bifurcation between the generation and distribution side. In current models, the same service provider takes on both parts. A capital squeeze is felt because collection periods and amounts do not always match the principal and interest on the loan for the entire model. Thus, both parts require different capital structures. The distribution side has to be financed in a way that enables charges for service plus distribution without a full recovery of the asset cost – like telecom companies (Airtel). The generation side, however, may need more long-term financing in which the capital subsidies...
make sense. In the study, ill-designed capital subsidies on the overall model might lead to increased affordability for the end user but in the long term it will lead to an unsustainable business model for the service provider.

4. **Who works where and how long?** The study asked women, "How many hours do you spend working per day?" The rationale was that men are engaged in agriculture while women have home-based livelihoods. We are unclear if this was an assumption; if it was, it’s a pretty large assumption to make. We think a better approach would have been to first understand if women (or men) are engaged in home-based livelihoods, and then measure the changes in hours spent working before and after the intervention.

**Electrification without an ecosystem is not transformative**

We would further extrapolate the findings to any form of basic lighting – grid or off-grid. For those four hours post-daylight to facilitate higher social and economic value, there has to be a more mature ecosystem present that opens opportunities for education, livelihoods, health and so on. In many cases, including this context, that mature ecosystem is absent.

SELCO’s experience from the early ’90s reinforces repeatedly that without plugging in suitable linkages there is a tendency to speak of electrification targets measured by number of households. Simple electrification around the world, without the existence of a suitable ecosystem, has not led to transformation. That ecosystem needs to be created and strengthened by a host of local stakeholders to complement efforts of last-mile energy enterprises to transform the lives of the poor.

Taking the study to the next level, SELCO would like to propose further insights that will build on this scenario to enhance the social impact or value of lighting solutions:

1. **Is a system affordable because it is cheaper or due to cash flow-based end user financing?** A subsequent article in *The Economist* proposes that cheap batteries and capital subsidies for larger systems will allow for larger system designs that can more adequately meet the needs of the end users to bring about significant socioeconomic change. It is important to bring down the storage costs to make the system more affordable, but even then it is unlikely that these end users will be able to pay for it upfront. They will still need some form of financing. A larger, higher-quality system (even in the absence of cheap batteries) can be designed with financial products from local financial institutions that are matched to the cash flows of the poor to reduce affordability barriers. However, making something affordable depends on who “demanded” the system; in our experience, financing emerges as an option when end users express specific needs that go beyond upfront cash affordability.

2. **How is socioeconomic development defined within the context of energy access?** The community in the study appeared to be very poor with no prior home-based livelihoods or small businesses. Simply placing a light in a household will not magically bring about any meaningful social change. That requires supporting activities such as skills training and subsequent market linkages. Even if higher loads were possible, the technology needs to be suited to local use and be efficient to bring down the costs of the solar powering it. Further, any energy solution is sustainable for the poor only if it includes three key elements: technical, social and financial. The absence of even one of these elements will destabilize the longevity of the solution.

3. **Partnerships to build the ecosystem.** Any energy solution is only as good as what it is used for. Without resource support and an active effort to unlock the potential for other socioeconomic benefits – such as newer and more efficient appliances, end-user financing and relevant delivery models – the impact is likely to be limited. Last-mile energy enterprises need support from community partners, financial providers, inclusive investors, local manufacturers, policymakers and others to plug in at different points of the solution.

At SELCO, we’ve completed solar-based interventions in nearly 400,000 individual underserved homes over the past two decades. We believe that current trends of standardized off-grid lighting solutions, in the absence of critical linkages and rapid scale-up of electrification schemes, will serve only to meet an electrification target rather than bring about meaningful socioeconomic change. We need to move away from metrics that capture the number of connections and toward the reliability and quality of those connections. Electrification is a
prerequisite for development but does not guarantee that development will follow. For economic benefits to flow, electrification needs to be integrated into a broader development plan. The study provokes important questions that are not simply related to the impact of the solution, but also the conditions under which this impact can truly take place. We propose a follow-up to the study that plugs in this perspective and thereby provides meaningful insights into how and when energy solutions can bring about transformative socioeconomic change.

Sarah Alexander is a senior adviser at SELCO Foundation. Huda Jaffer, lead designer at SELCO Foundation, and Mohan Hegde, COO SELCO India, contributed to this post.

First published: Nextbillion.
Solar products, beyond lanterns, are currently out of reach of the extreme poor

Kat Harrison

In the global effort to make off-grid energy, and solar in particular, affordable to the 1.2 billion people currently without energy, there have been a number of encouraging breakthroughs in the past decade. For example, the production cost of solar has fallen rapidly — down 80 percent since 2010 — and is likely to fall even further. Across many parts of Africa, a pay-as-you-go revolution — often built around the spread of mobile-banking — has transformed the purchase of solar energy. Unlike in the past, where consumers had to pay high upfront costs, today they are able to make incremental payments via smaller mobile money instalments.

When it comes to increasing solar's affordability and bringing off-grid energy within reach of the poor, these trends are undoubtedly encouraging. However, the growth we've seen in the sector is still a drop in the ocean when compared to the 600 million Africans who continue to live beyond the grid.

Why, then, if solar has become so affordable, have key innovations such as solar home systems not scaled beyond the 600,000 or so systems sold across Africa to date?

Motivated by this very question, the CDC Group, the UK's Development Finance Institution committed to catalysing greater inward investment in developing countries, asked Acumen to investigate just how affordable solar is to those who need it most. We undertook a review of current literature on everything that's known about the ability of consumers in Africa to purchase off-grid energy, with a particular focus on solar.

Here's what we learned:

Solar products, beyond lanterns, are currently out of reach of the extreme poor. Limited available data makes it difficult to draw firm conclusions. However, research on solar lantern customers across East Africa by SolarAid suggests that more than 80 percent of customers live in extreme poverty (below $1.90 per person per day). By contrast, data collected from customers across five solar home system and mini-grid companies across East Africa by Acumen using our Lean Data(SM) approach shows that a third of customers live below the relative poverty line of $3.10 per day. We believe that even this lower level of penetration of home solar systems into the base of the economic pyramid is impressive. But it also shows we still have a way to go before more powerful systems are made universally available to the very poorest.

Financing helps drive sales, but those accessing solar through credit don't always understand what they've signed up for. Financing for solar offers huge promise in terms of making energy access more affordable. However, it is not without its challenges. A significant number of customers
say that they find contracts and credit approval processes confusing, and feel uncertain about just what it is they’ve committed themselves to. Equipping sales agents to adequately explain these processes may be a way to cross the financial literacy divide and ensure customers do not overstretch their finances.

**Access is about more than just affordability.** Whilst affordability is undoubtedly a key factor in unlocking greater energy uptake for the poorest, as important are three further drivers of adoption: Awareness, Advantage, and Access. Lack of awareness and a lack of trust in the quality of solar products remain a major challenge when it comes to large-scale adoption of off-grid solar products and services. This is especially true where markets have been flooded with low-quality knock-offs. And while the sector might be growing, solar companies are currently concentrated in a few countries, mainly in East Africa, meaning consumers across the rest of the continent struggle to access products even where there is a willingness to buy.

We still have a lot to learn. While a picture of why and how poor customers gain access to off-grid energy is emerging, our review shows that it still remains relatively sketchy. There is more to discover about how to encourage greater affordability of solar products. Questions on our mind include: whether low-income customers are taking on too much financing to access solar products and therefore putting themselves at financial risk and, if so, how does that impact their ability to access and purchase off-grid power? What is the relative importance of affordability when compared to Awareness, Advantage and Access? And, do women purchase and value energy differently from men?

These findings have reinforced, rather than revolutionized, our understanding of the opportunities and constraints poor customers face when purchasing off-grid energy. That said, they remind us that when it comes to reaching poor, off-grid consumers, sweeping generalizations should be avoided and understanding nuance is key. While the majority of attention has been paid to falling costs of producing solar energy, this alone will not ensure the universal spread of off-grid energy. Many other factors are at play. For example significant consumer education is still required to explain the benefits of solar, particularly beyond East Africa, consumers may need greater protection especially where they take out loans, and, in order to reach the very poorest, prices for more powerful systems still need to fall further. The trends are all headed in the right direction, but much can still be done to turn 600 thousand consumers into 600 million.

Kat Harrison is Associate Director of Impact at Acumen.

First published: Acumen.
Asian off-grid solar: Using innovation to accelerate electrification

Asia is home to very diverse solar markets, ranging from highly developed ones - such as China and Japan - to less developed ones - such as Cambodia and Myanmar. The latter group of countries, similar to other developing regions, has long suffered from subpar electrification levels. However, despite the large number of people living without electricity and the favorable conditions for solar energy, the spread of (off-grid) solar PV applications have failed to keep up the pace with that of other major developing regions, like Africa. To get an insight into the current status of solar energy and the mechanisms set out to drive its development, we hosted a webinar - ‘How to bridge the electrification gap in Asia through off-grid PV systems?’ - and consulted local experts.

This article, which provides a summary of the main insights presented during this webinar, comes in preparation ‘Unlocking Solar Capital Asia’, our 4th conference examining the roots of bankability issues in the region.

Ingredient for success

“Asia’s electrification struggle is now being tackled through various solar products and business models which guarantee that solutions are tailored to local needs,” Laura Sundblad, program adviser at GOGLA, points out. The Global Off-Grid Lighting Association (GOGLA) is one of the leading, independent, nonprofit electrification advocates. Stand-alone solar products in the region include a spectrum of applications, spanning from individual solar lanterns (0.5-3 Wp), through solar home systems (up to 100 Wp) to community lighting solutions, as well as solar applications that improve value chain efficiency.

Since the average purchasing power in the region is rather modest, the right type of financial model is crucial for the sustainable acceleration of energy access. The spectrum of business models starts with prepaid and rental setups in which consumers have very limited ownership or commitment to the appliance; where these solutions can only be used on an occasional basis (Figure 1). Moving away from the solar-as-a-service aspect, are the perpetual lease and lease-to-own business models. The lease-to-own business model, which is the more wide-spread out of the two, includes monthly payments according to a preset payment plan which concludes in consumer ownership.

On the other end of the spectrum, are upfront sales and direct cash sales. The former is a business

![Figure 1: The spectrum of business models utilized for the sale of solar appliances. (Source: GOGLA)](image-url)
model that involves a financial institution dealing with the financial contract and a separate energy provider in charge of the energy contract. Even direct cash sales schemes include warranty and some level of customer relationships, as pointed out by Ms. Sundblad.

Affordability of these products and services, however, largely depend on how facilitating the involved companies are. One of the most crucial aspects of an adequate solar environment, is the presence of mobile money or other means of digital finance. The clarity and consistency of regulatory frameworks and national electrification plans are also crucial. Although these aspects are necessary, they are in itself not sufficient for success. The availability of appropriate capital and a skilled workforce, as well as a robust supply chain, are also key ingredients for success.

**Market watch: South Asia**

As a result of its vast network, not only can GOGLA provide a snapshot of the regional markets but also on the individual Asian off-grid markets. Out of the 8.07 million products sold in 2016, 1.41 million were sold in South Asia, corresponding to a revenue of US$ 35.52 million. East Asia and Pacific accounted for 96,456 of the individual sales and US$ 4.33 million in value, according to the company’s information (which excludes some data from non-GOGLA-affiliated providers).

In India, 400 million people subsist with little or no access to electricity access. Although grid extension has been rapid, the rate of population growth renders increased involvement crucial in the country. This is especially true if the government is to achieve its goal of universal electricity access by 2019. The sheer size and variety of the nation will require an adequate range of products and business models to see success.

Estimates for Pakistan's total electrification rates vary. 'Lighting Pakistan', an International Finance Corporation (IFC) program, has estimated that 144 million out of 197 million people lack adequate access to electricity. This number is made up of 75 million people with less than 12 hours of electricity a day and 69 million without any access.

Bangladesh, whose electrification rates are the lowest in the whole of South Asia, is actively trying to change this status quo. Through a concessional finance program spearheaded by the World Bank and other international participants, over 4 million solar home systems were installed in Bangladesh. The financing scheme is run by the state-owned ‘Infrastructure Development Company Limited’ (IDCOL) and, even though the program has achieved great success thus far, other government ‘giveaway programs’ and cheaper products are threatening the future of this initiative.

**Market watch: Southeast Asia**

Countries in Southeast Asia can especially be characterized by uneven electrification rates. Countries such as Singapore, Brunei, Thailand and Malaysia pride themselves in near- or full universal power access (Figure 2), whereas countries like Cambodia and Myanmar are on the other end of the spectrum with significantly lower access. Due to their archipelagic nature, Indonesia and the Philippines feature a contrasting mixture of both ends. While these two countries display high urban electrification rates, the access on remote islands are especially low.
While increasing off-grid development in countries like Indonesia and Myanmar are definitely noticeable, the off-grid system sales of 29,000 and 22,000 in H2 2016 are well behind the amounts needed for achieve the setout electrification goals.

While the many different markets have their own unique challenges in Asia, some vital elements necessary for continued development are shared across borders. These include ensuring the collaboration and communication among governments, DFIs and the private sector; increasing investment by improving business climate and reducing risk; and, lastly, developing adaptive solutions to meet the needs of diverse markets.

**Thinking outside of the box**

Using adaptive solutions to cater to local needs is especially important in Asia. Charu Chadha, a member of GSMA’s ‘mobile for development utilities’ initiative is an expert on the matter. Through the company’s initiatives she has sought commercially sustainable business models that leverage mobile to deliver affordable and improved energy, water and sanitation services in emerging markets.

Mobile technology is a platform that can be utilized for a wide range of tasks. Besides communicating through mobile services and using mobile money as a form of payment, mobile technology can also be used as machine-to-machine (M2M) connectivity, through which electrical appliances can be controlled and monitored remotely. Another potential future application that can have a disruptive effect of the Asian solar landscape, is utilizing mobile usage data as a method to determine credit rating for individuals whose creditworthiness could otherwise not be determined.

Further building on the unique potential of mobile technology, smart metered grids were developed in Nepal, that not only increased consumption rates, but also increased operational efficiency. Using mobile data, the right tariff plans were created and utilization was increased from the initial 40-50%. Another promising application of mobile technology is peer-to-peer energy tra-
Connecting dense, off-grid settlements can not only increase access but can also provide a source of income for the energy provider households. For this application, blockchain technology could provide a reliable way to manage transactions. Lastly, as more of a theoretical solution thus far, mobile technology can be used as a platform to establish a mobile-based e-commerce platform that is bundled with an instant loan. Such a system would take away a large number of the current hurdles and enable the upscaling of solar solutions in Asia.

While some countries are less in need than others, it is safe to say the Asia’s electrification efforts are far from being complete. Combining the right solar application with the right business model are vital to providing the solution for the diversity the Asian markets are displaying. In order to speed up this electrification process, adaptive solar solutions, similar to that of mobile technologies, will also be crucial.

Szabolcs Magyari is Research Analyst at Solarplaza.
First published: SolarPlaza.
Giving the poorest people in the world’s fast-growing cities access to affordable, clean energy supplies, while wiping out the use of hazardous solid fuels is essential for urban economies to grow on a warming planet, researchers said.

Some half a billion people in urban areas still cook with traditional fuels like wood, said a report from the Washington-based World Resources Institute (WRI).

It urged cities to boost access to solar power and other clean energy sources, and make buildings and domestic appliances more efficient.

"You cannot be a modern, prosperous city in the 21st century unless the energy access challenge is addressed," Michael Westphal from the WRI Ross Center for Sustainable Cities told the Thomson Reuters Foundation.

"Providing energy services for the under-served really will enhance the environment and the economy for the whole city. It’s only when everyone in the city has dependable energy that the city will thrive," said the report co-author.

Rising migration to already polluted cities means they cannot afford to rely on fossil fuel-based systems developed in rich countries, and should concentrate on clean, cheap energy sources that produce less greenhouse gases, said the report.

Up to 97 percent of people in cities in Latin America and East and South Asia had access to electricity in 2012. But in sub-Saharan Africa, the rate was less than 60 percent, with services often inefficient and unreliable, said the WRI report.

Around 95 million of the 131 million people in urban areas who do not have electricity are in sub-Saharan Africa, it added.

In 2010, as many as 550,000 people died prematurely from indoor pollution due to fuels such as wood and coal, underlining why cities should provide better access to electricity and gas, and promote efficient cookstoves, the report said.

Pricing is key when it comes satisfying growing energy demand. Residents of Nairobi’s Kibera slum spend up to 40 percent of their income on fuel, while high connection charges make grid power unaffordable in some cities, said the report.

SLIDING SOLAR COSTS

Slum dwellers are among those worst-affected by poor energy access, the report said. Some governments don’t want to provide infrastructure that could legitimise informal settlements, while lack of tenure and illegal electricity tapping are a hurdle for utilities, it noted.

In some regions, over 15 percent of electricity is lost due to inefficiencies or theft, while 20 percent is stolen in India, said the report.

The potential for solar energy in cities is considerable as equipment costs continue to fall, with community-owned systems helping make services available more widely, it said.

A scheme in Bengaluru, India, allows people to sell power back to the grid, while homeowners in
Gujarat are leasing roof space to solar power companies, it noted.

Pay-as-you-go schemes in Kenya, meanwhile, enable consumers to pay for solar systems over a year while buying units of electricity as needed.

Better energy supplies are also important to support the millions of tiny businesses people run from home, and improving the energy efficiency of public buildings like schools and hospitals can cut costs and pollution, the report added.

Sophie Hares is writer for Thomson Reuters Foundation.

First published: Thomson Reuters Foundation.
For most parts of rural Africa, sunset is synonymous to darkness. This has been the trend for so long that it is seen as the norm rather than the exception. Data shows that 622.6 million of the 1.1 billion Africans have no access to electricity (Washington Post). The urban electrification rate stands at 60 percent, with rural going at 14 percent. The situation has borne the need for diversification and innovation, so in comes off-grid solar. It is a highly effective system that enables access to basic electricity services. The system powers households through a battery-connected rooftop panel.

The sector has experienced impressive growth in the past ten years. Globally, it has grown from nearly nothing ten years ago, to more than 100 companies now actively focusing on stand-alone solar lanterns and solar home system kits – specially targeted at those not covered by national grids. By mid-2015, these companies had made sales of more than 20 million branded pico-solar products (defined as having PV panel smaller than 10W).

Africa, Tanzania, Ethiopia, and Kenya lead the pack in adoption of off-grid solar systems; in fact, they account for 66 percent of all the units sold in the continent. As a result, the various systems are no longer a niche product in the aforementioned countries. In Kenya, more than 30 percent of people living off the grid have a solar product at home. This is according to data produced by World Bank and Bloomberg in the past year.

Pushing the upsurge are the ‘pay-as-you-go’ (PAYG) firms that sell kits against small installments instead of lump sum payments with technology that locks the functionality in the event of nonpayment by a customer. Compared to selling the products for cash, these PAYG companies have attracted four times as much investment in just half the time. There are about 20 such companies that provide consumer financing active today, serving almost half a million customers, mainly in Eastern Africa.

A typical off-grid solar business product offering varies a lot, for they experiment with different business models and deliver a wide range of energy service packages. The service packages can vary from simple solar lanterns to solar systems greater than 200 watts. Many businesses, however, have some common factors. They offer a solar product, which is typically a home system consisting of a PV panel, a battery and control unit, two or three lights, a phone charger, and sometimes other appliances.

The customer typically makes an initial payment of around $30 for the basic home system, followed by regular payments of about $0.30 -0.50 per day for access to the energy services from smaller wattage systems, and upwards of $2 per day for larger systems. This cost is usually calculated so that it is competitive with the daily expenditure on stopgap technologies, thus allowing customers to save from day one. However, this only applies to the most common models because pricing formats can differ substantially.

Payments are often made via mobile money, particularly M-pesa in Kenya and Tanzania. There
are also alternative payment methods like scratch cards, direct cash payments, or mobile phone credit. The home system is usually enabled to operate by instructions received via built-in GSM chip or after the customer enters a code sent by SMS.

In addition, customers are typically charged per unit of time, not per kWh consumed. This means that if the sun is not shining or if consumption needs exceeding, then energy supply is transferred to the customer.

Depending on the business model, the customer either makes scheduled payments or can top-up their account at any time. When the account is empty or in arrears, the solar kit will stop functioning until a payment is made. The customer may either own the solar kit once a certain sum has been paid (rent-to-own model) or make continuous service payments.

It is suffice to say that off-grid solar systems have created new economic systems to exploit. The companies currently in the market occupy different parts of the value chain, which results in multiple growth strategies and, for investors, highly varied bets on where value is being created. Some companies occupy bits of the value chain, while others, such as Off-Grid Electric in Tanzania and Rwanda, are active across the full spectrum.

Here are some ways in which off-grid solar can be integrated into and transform the ways of doing business in Africa:

The first opportunity is for product developers. These include business-to-business PAYG integrators and manufacturers of off-grid solar products. Such companies develop activation technologies and integrate them with solar home systems; in addition, they usually offer a software back-end to manage customer accounts. The companies in this part of the business chain sell the product and license the software platform to their distributors against normal product payment terms. Many manufacturers of off-grid solar products are positioning themselves as PAYG manufacturers, bringing into force the relatively low barriers for entry. This action also produces the risk of tough competition, which is capable of eroding profit margins in this segment. Fortunately, manufacturers may be able to differentiate their products in the future by offering distributors high quality products. There is also a need for a more mature PAYG financing and distribution. The improvements in quality and value capture will most likely focus on making it harder for end-users to hack systems, as well as improving the software back-end to provide data that allows operators to cut service costs and default rates.

The second opportunity is for distributors. Distributors have to create value by building strong distribution networks and customer relationships, all while maintaining maximum flexibility with regards to the type of equipment they deploy. The focus here is investing in distribution networks and raising debt financing. The companies currently in this sector either have already established distribution businesses, or are aiming to build their own, which suggests that they could expand their offering beyond solar home systems at any given time. The opportunity does have its challenges though: the need to raise financing makes it hard for many of the specialized off-grid distributors to compete as PAYG distributors.

Service-platform developers have the third opportunity to position themselves as reliable middle-men by going one step farther than product manufacturers. The work here is to seek out partners who possess established, valuable customer relationships, and then leverage their infrastructure and data as much as possible. This can include using existing shops and staff for sales, as well as using data to screen customer applications. The platform developer provides the solar system, the operations platform, and a firmly integrated CRM system, which gives the distribution partner access to PAYG revenue with very limited capital expenditure.

Due to leverage from existing distribution networks and brands, platform developers may see very rapid growth in terms of households served once the partnership is proven. Although, because much of the value is captured by the distribution partner, platform developers will most likely seek to scale rapidly across different markets with various partners in order to grow their business. Their focus is likely to be on mass sales of a small portfolio of products, centred on solar home systems. In addition, they may seek to upgrade existing customers to larger systems or appliances.
The fourth business opportunity goes to **integrated service providers**. This group is the closest to the traditional utility-business model in the off-grid market. They work along the entire value chain to ensure that they can capture value at each node, and to also ensure that all pieces work together smoothly. Integrated service providers tend to oversee product development. They invest heavily in a local presence to guarantee distribution, servicing, and maintenance as well. Often times, this calls for heavy investment in local shops and distribution centres, and training of local staff. The aim is to build lasting customer relationships and serve as a full energy-service provider. Eventually, most companies following this strategy will offer their customers a full set of appliances that can lift them up the energy ladder—from simple lighting to more advanced services such as TVs and refrigeration, and possibly even productive uses for small businesses or workshops. Because they invest heavily in local presence, these companies usually require a high density of customers. As a result, many of these companies usually focus on specific regions and grow by extracting extra value from their customer base rather than rushing for geographic expansion.

Nevertheless, these opportunities don’t come without major challenges. One persistent thorn in the flesh is distribution. With increased competition and cheap generics entering the markets left, right, and center, last mile distribution is becoming more important as a value driver. This is even more the case for the emerging PAYG segment, which relies on an ongoing customer relationship. The distribution can create more value from this relationship too.

The current distribution models adopted by companies in the field are diverse, especially for cash sales. Some operate their own stores and train their own sales agents, but also leverage existing retail networks, savings, credit cooperatives (SACCOs), and partnerships with NGOs and companies. Other companies may focus on particular niches including: corporate employee offers with a particular industry, bulk sales to governments or humanitarian organizations, or choosing a specific franchisee for a new market.

The most successful models for distributing branded products have largely incubated the market that exists today. A great example is SunnyMoney’s school-based programme in Tanzania, Kenya, and other countries. It is largely responsible for sales of more than 1.7 million quality verified products and distribution through Total’s network of gas stations. A key target of many of the early adopters is to reach the rural poor who may not be well served by existing retail channels; hence they set up shops in smaller towns and send sales agents into schools and villages. This has also been vital for building customer awareness about solar as a category.

Experts predict that the manufacturing sector will probably become crowded soon, which will erode profit margins and shift value capture downstream. These are the same dynamics as in the cash-sale market. Meanwhile, integrated service providers are most likely to propel a smaller number of customers up the energy ladder in markets with a friendly business environment. Because cost reductions for portable lanterns will remain most popular in that segment, most PAYG solar kits are likely to remain solar home systems. Some lanterns are likely to be sold under PAYG as well, namely, to consumers not familiar with pico-solar. With these, consumer financing can build trust in the technology.

There are several firms offering off-grid solar services based in several countries. One of the most notable ones is M-KOPA, which is available in Kenya, Tanzania, and Uganda. Their method works by having a customer collect the system in an M-KOPA service centre, or an affiliated M-KOPA dealer, and make payments via M-PESA. Off-Grid electric is the other notable firm, and it plies its services in Tanzania and Rwanda. Mobisol is yet another firm and although it is based in Berlin, it services households in Tanzania. The last firm that offers off-grid services is Nova Lumos, which partners with MTN to distribute 80W Lumos Solar Power Station in Nigeria.

In conclusion, off-grid solar is likely to attract new entrepreneurs and investments in the coming years due to the following reasons: First, customers will become more familiar with the business model, thus reducing the cost of customer acquisition. Second, the government of countries without existing offerings may see success elsewhere and try to attract off-grid solar companies.

Off-grid solar, PAYG in particular, has the po-
potential to be relevant to established corporates in a variety of industries, which means some of them may fund or buy PAYG startups. Some firms have already attracted funds from different industries such as equipment manufacturers (Schneider Electric), utilities (EDF), mobile operators (Orange, Safaricom), and solar distributors that were previously focused on the grid-connected market (SolarCity). This overlaps with money transfer as well. Banking and financing business could also spark interest among financial intermediaries at some point, while beverage and pharmaceutical companies may be interested in off-grid solar solutions that can offer solar-powered refrigeration. A good example is Coca Cola, which already has a partnership with SolarKiosk.

Even without partnerships with such established players, it is possible that investors and entrepreneurs will push ahead and create these services from scratch, using off-grid solar as a door opener.

Entering the PAYG business is becoming more accessible to companies as solar kits and back-end software that enable PAYG become available off the shelf.

Apart from providing people with a cheaper and cleaner alternative to the traditional services that are currently relied on, the off-grid solar industry has had several domino effect consequences. Gaining access to clean and affordable energy saves consumers money, reduces exposure to toxic materials released when burning kerosene, and cuts greenhouse gas emissions. In addition, money and time that is freed up can be redirected towards doing more work or getting more education. Additionally, replacing kerosene reduces fire risks and may even improve the comfort of families and entire communities. These indirect benefits tend to be harder to quantify, but it is generally agreed that they are very likely to occur. This is sure to be an industry of the future, and African entrepreneurs should continue exploiting it.

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Eric Mutema, is a journalist based in Nairobi, Kenya.

Fiona D. Wollensack

The role of sustainable energy access in the migration debate

The world currently faces an unprecedented displacement crisis, which puts particularly the most vulnerable populations at risk. According to the UN International Migration Report, 244 million people worldwide were registered as living outside their country of origin in 2015. According to estimates, 740 million internal migrants moved to another place of residence within their country of birth. As a result, migration has been high on the agenda of the international community.

The Council of the European Union acknowledges that the lack of, or uneven, access to energy is part of the root causes of irregular migration. Irregular migration can be described as a “movement that takes place outside the regulatory norms of the sending, transit and receiving countries.” It includes unplanned mass migration, economically and socially induced migration due to vulnerability, poverty and lack of economic opportunities, and environmentally induced migration in slow onsets. Despite the acknowledgement of energy as a basic human need in Sustainable Development Goal 7 (Ensure access to affordable, reliable and clean energy for all), 1.1 billion people still do not have access to electricity. A remarkable surge in international activity in the field of energy development cooperation can currently be witnessed, with EU institutions and member states at the forefront. But what role does energy play in the decision to migrate? How does access to energy influence the decision to migrate? How can the lack of energy be addressed after migration has occurred? The EU Energy Initiative Partnership Dialogue Facility (EUEI PDF) under the mandate of its donors – the European Commission, Austria, Finland, Germany, Italy, the Netherlands and Sweden – has set out to investigate the link between energy and migration.

Energy is acknowledged as an enabler of economic activity and for the improvement of livelihoods. It is therefore assumed that some of the structural causes of irregular migration could be prevented through improved access to sustainable energy. Addressing access to energy as indirect driver of migration could, for example, help mitigating the more immediate effects of economic and environmental drivers of migration, such as (rural) poverty, food insecurity, insufficient economic opportunities, unemployment, and deficient healthcare and education services.

Sustainable energy access can alleviate economic drivers of migration by: upgrading value chains; diversifying economic structures and livelihoods; releasing time for paid work, childcare, social life and leisure, which is particularly important for rural women; and enhancing business productivity. Furthermore, access to sustainable energy has the potential to mitigate environmental drivers of migration, including environmental degradation caused by the inadequate management of natural resources, poorly planned urban development, climate variation or natural disasters. Mitigation...
gating these drivers reduces a population’s vulnerability, which often stems from a strong reliance on biomass and agriculture. Natural disasters, on the other hand, result in a sudden exacerbation of vulnerabilities and migration patterns. A rise in renewables can help increase resilience, decrease disaster risk, and enable swifter recovery as their provision is less dependent on fuel supply routes or critical grid infrastructure.

Regarding the humanitarian context, it must be noted that energy practices in refugee camps are often inefficient, polluting, unsafe and environmentally damaging. Worldwide, 89% of refugees do not have access to adequate lighting and rely on firewood for cooking and heating, causing premature death and deforestation. Additionally, humanitarian and development actors often take conflicting approaches in humanitarian contexts. Humanitarian interventions focus on meeting acute needs as fast as possible, whereas development interventions engage in transitional assistance on a medium- to long-term basis. Furthermore, governments of host countries may see the provision of sustainable energy access as an indicator of a settlement becoming formalised. They may interpret efforts to provide access to sustainable energy as a threat to their ability to provide economic opportunities and public services to displaced populations, which could cause social tensions with host communities. It is therefore essential to approach energy planning in a coordinated way, involving all stakeholders and linking short-term relief measures with long-term development programmes.

As outlined, the link between energy and migration is complex and intertwined with many aspects of the humanitarian and development agendas. Nonetheless, ensuring access to sustainable energy is central to improving living conditions and to stop people from being forced to leave their homes. Addressing the link between energy and migration includes tailoring development policies to migration patterns, and enabling energy sector specialists to contribute their sectoral expertise. It also involves rigorously understanding the drivers and causes of migration, and deploying this knowledge to ensure that measures are taken to provide sustainable, long-term solutions, and enable synergies and co-benefits for local, host and migrant communities. In this spirit, work on energy-migration linkages also calls for the stronger collaboration among stakeholders and partners, including across humanitarian and development communities.

Fiona D. Wollensack is Political Advisor at the EU Energy Initiative Partnership Dialogue Facility (EUEI PDF).

First published: IISD.
Andrew M. Herscowitz and Kathleen Auth

Electrifying Africa based on the U.S. rural electrification model

A historical approach to solving a modern problem

As utilities across the U.S. urgently work to restore power to the millions of Americans affected by Hurricanes Harvey and Irma, we are reminded of how difficult and dangerous life can be without electricity, even for just a few days. Approximately 600 million people in sub-Saharan Africa have never had access to electricity at all.

Power Africa, a U.S.-led initiative to double access to electricity in sub-Saharan Africa, is harnessing American experience and expertise to tackle one of the world’s biggest development challenges. This week, Power Africa visited the Adams Columbia Electric Cooperative, part of the Wisconsin Electric Cooperative Association (WECA), many of whose line workers volunteered to rebuild grids in Florida—applying the same skills required in countries like Liberia, where those without electricity suffered some of the worst impacts of the Ebola epidemic.

Less than a century ago, 90 percent of rural communities in the United States lacked access to power, depriving Americans of access to quality health care, education, and employment. The key challenge then was the same one we see in sub-Saharan Africa today: in remote areas, utilities face higher costs and a highly dispersed lower-income customer base. Success in the U.S. required a new business model and a strong political push from President Franklin Roosevelt, who saw rural electrification as a way to drive employment, enable more efficient agriculture, and bridge the urban-rural divide.

Rural communities across the U.S. established non-profit, farmer-owned cooperatives, taking out low-interest loans from the newly created Rural Electrification Administration (REA). In under two decades, 93 percent of US farms were electrified, and the default rate on loans was less than 1 percent. Today, 897 cooperatives serve 42 million people. NRECA represents their interests and provides technical assistance around the world, including in partnership with Power Africa.

So what can sub-Saharan Africa learn from the U.S. experience?

Learn from the cooperative model

A community-driven approach can help expand electricity to dispersed, low-income populations. With the applied expertise of groups like NRECA, African countries can advance this model where it makes sense.

Build consumer demand

Most newly electrified households consume very little power, making them a risky business proposition. In the U.S., the REA taught communities how to use and maintain appliances and provided credit for purchases from appliance manufacturers, including Power Africa partner General
Electric. In sub-Saharan Africa, off-grid companies are tackling this challenge by pairing solar systems with innovative off-grid appliances.

**Take advantage of new technology**

The year 2017 presents sub-Saharan Africa with opportunities to build beyond the U.S. model. New technologies—including cheap, mobile solar panels and prepaid meters—enable a more efficient, flexible approach and a chance to optimize the use of grid extension, micro-grid and off-grid solutions.

Power Africa brings together more than 150 public and private partners, including NRECA. With American leadership and private sector ingenuity, we can help achieve the same rapid electrification gains in sub-Saharan Africa that the U.S. saw not so very long ago.

Andrew M. Herscowitz is the Coordinator for Power Africa, a U.S. government-led partnership to double access to electricity in sub-Saharan Africa.

Kathleen Auth is the Deputy Director for Energy at Power Africa and leads Power Africa’s efforts to connect people to the grid.

First published: Power Africa.
It is tempting to think – given the record-breaking installations of solar PV in China, and on a different scale in Australia – that the world is well into the new age of solar.

But a striking new report from an independent source sheds new light on what awaits us. Importantly, it shows that the world has only just begun the age of solar, and has installed only a tiny fraction of what will follow.

The Energy Transition Outlook comes from DNV, a European-firm that provides independent assessments for both the fossil fuel industries (particularly oil and gas) and the renewable energy industry. You could say they have a foot in both camps.

That makes its detailed forecast for the impending energy transition striking. It holds no good news for oil – it says that industry production will peak in a few years and decline rapidly thereafter.

But it also suggests that the world’s energy consumption as a whole will peak within a decade – shedding forever the link between GDP and energy growth. And it says one of the biggest reasons for this is the efficiency of wind and solar. It notes that with fossil fuels, so much of the primary energy is wasted as heat.

And it predicts a big future for renewables, and solar in particular. That’s because wind and solar will be far cheaper than fossil fuels.

And in contrast to ultra-conservative forecasts from the likes of the International Energy Agency, DNV predicts renewables will make up 44 per cent of primary energy supply by 2050 and 85 per cent of electricity supply.

“Changes are coming so fast that it will surprise many people, even inside the industry”, one of the lead authors Sverre Alvik told Energy Post in an interview.

So here are a selection of our favourite graphs and a brief commentary with each:

The first highlights just how early we are into the age of solar. See 2017, it’s barely a blip on the graph. According to DNV, the world is producing and consuming only a few “exajoules” of solar a year right now, but over the next decades that will increase 80-fold.

The various colours are the regions of the world.
The second graph (above) is the amount of solar capacity being installed each year. Here it is seen that the construction growth rate is well under way, but will rise four fold to more than 400GW by the early 2020s and steadily increase to 700GW by 2050.

The next few graphs illustrate the anticipated share of solar PV in the power mix in various countries, and two key markets for Australia – China and India. It is important to note here that these graphs illustrate not the share of capacity, but the share of output, which is far more significant.

So, in case anyone (federal government resources ministers or coal mining lobbies, for instance) tells you that the two biggest energy consumers – China and India – will be focused on coal, here’s a couple of graphs to shatter that illusion.

The first of these graphs is China (above), showing that coal-fired generation (in the blue) has likely already peaked. Even more strikingly, it suggests that coal generation in China would be all but gone by 2050, replaced largely by solar, wind, hydro and other sources.

Even more dramatically, from the solar point of view, is this graph (above) on India, which shows India relying on solar for more than half of its electricity generation from about 2030, and an overwhelming majority by 2050.

Coal generation does not grow much beyond the current levels – which will shatter the dreams of those who think it will rise by a factor of two or three. So, while the country hauls itself up to be one of the most dominant economies in the world – it will largely be renewables powered, and mostly solar-powered.

Indeed, this next graph shows the capacity additions that are expected over the next 30 years. There is no boom in coal, only in renewables. That’s something to think about for the people making decisions about financing proposed thermal coal export projects.

And this graph above is what the technology share looks like in 2050 in the electricity market. Coal’s share? Just 2.7 per cent.
This final graph (above) illustrates the decoupling of the growth in GDP and population, and energy use and emissions.

Sadly, however, those emission reductions are not enough to meet the Paris climate target of limiting global warming to "well below" 2°C target. DNV says if we are to get close, it will depend not just on the complete decarbonisation of electricity, but the electrification of nearly all energy uses, particularly transport.

And if we are to meet the 1.5°C target, that more and more scientists now admit may be essential to avoid the worse impact of global warming, then we are already on the point of exhausting the world’s carbon budget.

DNV puts this at within four years, an estimate supported by research by other groups such as Climate Analytics, the Potsdam Institute, and reinforced by former UNFCCC secretary Christiana Figueres during her visit to Australia this week.

Which means the world will overshoot, and then find a way back to reduce the levels of global warming.

The interview at Energy Post with Alvik and Paul Gardner, who led the storage component, is interesting reading. Gardner says storage is currently being held back by regulations that limit the role that networks can play, which may also be true in Australia.

But these two bits caught our attention, the first on whether a 100 per cent renewable energy is realistic:

"It is possible to build a secure system with a very high level of renewable energy", says Gardner. "But in our projections we don't quite get to 100%. We see quite a bit of 'peaking' gas generation to go with renewables by 2050. We have a lot of wind, a lot of solar and a lot of gas plant that spends a lot of time doing nothing. Even when we include the backup costs for the gas-fired power, this still looks attractive."

And then:

"Gardner does add there is one thing that the model does not yet take into account, namely the effect that temporary surpluses of wind and solar power will have on the economics of renewables. 'We have not yet shown what the impact is of that.' However, he says, 'we will also need to decarbonise heat, so it makes sense to store the surplus renewable energy, for example to heat water with it or to convert it into gas, to be used for heating. It is not yet clear what the most economic route will be.'"

And, finally, because of the restrained demand, overall investment in energy won’t have to increase, despite the transition.

"Major investments need to be made", Gardner tells Energy Post, "but the amount of money the world spends on energy does not change much. The total number will be lower relative to GDP. That’s a pleasant surprise: we can afford the transition."

Giles Parkinson is a journalist of 30 years experience, a former Business Editor and Deputy Editor of the Financial Review, a columnist for The Bulletin magazine and The Australian, and the former editor of Climate Spectator.

Sunny Southeast Asia has double the solar energy potential of Northern Europe, but the market hype is not living up to the reality on the ground. Thailand leads and Indonesia lags in a sector direly needed to fight climate change and meet the region’s ballooning energy demands.

If just 0.1 per cent of Indonesia’s land area was used to generate solar energy, about 40 per cent of the energy demands of the vast archipelago of 260 million people could be met, according to data from the Solar Energy Research Institute of Singapore (SERIS).

But the uptake of solar in Southeast Asia’s largest economy is lagging in a region that—despite being twice as sunny as Northern Europe—is struggling to live up its enormous potential, experts said at the inaugural Unlock Solar Capital Asia conference in Singapore on Thursday.

"Indonesia is swimming in free sun and wind resources. It makes no sense to ship in diesel to fuel dirty generators to provide power for its 18,000 islands. But that’s exactly what the country is doing," said Assaad Razzouk, chief executive of clean energy projects developer Sindicatum Sustainable Resources, in a characteristically confrontational keynote presentation.

"Frankly, renewable energy is nowhere to be seen in Indonesia," he said. Indonesia is Southeast Asia’s fifth largest market for solar energy and, for its size and potential, the laggard of the region.

Thailand is by a wide margin the leader with 62 per cent of Southeast Asia’s total installed capacity of 3.5 gigawatts. The Philippines and Malaysia are the region’s second and third largest solar markets, followed by Singapore.

Solar uptake has been muted in Vietnam to date, despite "an enormous amount of hype" about the country’s solar potential, Razzouk said.

Meanwhile, Vietnam—like Indonesia—continues to invest heavily in coal-fired power stations to meet its growing energy demands, Razzouk told his audience of energy executives and financiers from around the region.

Malaysia is remarkable for the fact that the number of solar panel installations has actually declined in recent years, Razzouk said. This is partly the result of the end of a feed-in tariff that allowed solar panel owners to sell their energy back to the grid.

Amazing Thailand

The Association of Southeast Asian Nations (Asean) has set “ambitious” renewable energy targets, noted Thomas Reindl, deputy chief executive of SERIS, in the speaker session that followed Razzouk’s.

The region is aiming to produce 34 per cent of its energy from renewable sources by 2025—a total of 61 gigawatts. However, almost every solar market in Southeast Asia is still in "emerging phase", Reindl said.
One exception is Thailand.

The Kingdom’s big push towards renewables is largely a consequence of a dwindling supply of natural gas, which is expected to run out within a decade, noted Hemant Mandal, senior energy specialist, clean energy, advisor services, South Asia, International Finance Corporation.

Easy access to favourable financing schemes and the low cost of solar systems have helped boost Thailand’s solar sector, which is highly competitive and dominated by local players.

However, a slowdown in the number of power purchasing agreements (PPAs)—the contracts that underpin solar projects—issued by the government is tapering the market, Bangkok-based Santosh Kumar Singh, regional director, Southeast Asia, South Pole Group, told Eco-Business.

The government has become more “selective,” he said, and much of the growth in solar in Thailand now comes from independent projects, such as factory and warehouse owners leasing their rooftops.

Indonesia has the furthest to go. The country will need to add 3 gigawatts of solar annually if it is to help achieve this goal, Reindl said.

What’s stopping sunny Asean?

While a number of Asean countries, including Singapore, Cambodia, Laos, the Philippines, Thailand and Vietnam have reached grid parity—that is, the point when solar costs the same or less as conventional fossil fuel, and can compete on the national grid—government subsidies for fossil fuels are holding the sector back, said Reindl.

Fossil fuel subsidies in the region total $325 billion, while renewable energy subsidies are worth less than half that ($150 billion), according to International Energy Agency data.

As well as scrapping fossil fuel subsidies, feed-in tariffs offer a good way to speed up the adoption of solar, Reindl said. Now, there’s increasingly a move towards auctioning and net metering, as well as or instead of feed-in tariffs, to boost adoption, he added.

Although Asean’s renewables target may seem overly ambitious, Reindl pointed out that Germany had installed 1 gigawatt of solar energy capacity in a single month—the month after the country introduced a feed-in tariff.

“The speed of installation is not a factor. It’s purely about economics and the regulatory framework,” he said.

Beyond the hype

To limit planetary warming to within 2-degree Celsius and avoid the worst consequences of climate change, $1 trillion needs to be invested annually on renewable energy to electrify the world, Razzouk said. But at the moment, there’s a shortfall of $670 billion a year being invested in renewables, he said.

However, current global trends—such as the decline of oil and coal, the phasing out of fossil fuels-powered cars, as was recently announced in China, and the falling price of solar—point to “massive changes” that are disrupting the global energy market.

From now until 2040, an estimated US$10 trillion will be invested in renewable energy—some 82 per cent of the total to be spent on new energy generation over the next 23 years, Razzouk said.

"Southeast Asia has to do what it can to get its fair share [of the US$10 trillion]—but most countries in this region are doing very, very little about it," he said.

"We have to find a way to accelerate [renewab-
le energy uptake] in Southeast Asia, because the hype is simply not consistent with the reality on the ground."

“When you think about renewable energy and electrification in Southeast Asia, think disruption, think Black Swans. We have to think ahead of the market,” he said.

Robin Hicks is the Deputy Editor of Eco-Business, where he reports on the big stories in sustainability as well as manages Eco-Business’s network of writers across the region.

First published: Ecobusiness.
The African off-grid industry needs an urgent further development

The solar off-grid industry in Africa nowadays is dominated by international companies. They raise millions of grants or loans and get most awareness on conferences and publications. Sure, sometimes you can read about investment in so called "African startups", but if you look closer it’s often just a branch of an international company someone is talking about.

However, the establishment of local solar companies (SME), which work independently and are majority owned by domestic entrepreneurs, is important for sustainable job creation in the off-grid industry. But local companies have only low chance to raise awareness or to get funding.

The worldwide awareness for international companies who are active in the off-grid-sector in East Africa is tremendous. But did you ever hear about Anuel Energy Ltd. (Kampala) or Access to Solar Technologies Ltd. (Jinja)? Companies which are founded and led by local entrepreneurs, who have created jobs and are providing energy access for households, schools, health stations? They have the potential to become the future energy middle class in Uganda, but no investor is looking on them, no conference invites the CEOs to talk about energy access, no supplier offers them a substantial credit for growth.

Anuel Energy and Access to Solar Technologies are now fellows of Sendea, the program of the Stiftung Solarenergie to create awareness for local solar companies. Recently Sendea starts the support for two more fellows in Uganda: SunTap Ltd. (Kampala) and Sostap Ltd. (Mbarara). Subject to finance the Sendea concept will be extended to other African countries.

The Stiftung Solarenergie also offers a unique opportunity for local solar companies to search for and sell products: Mangoo Marketplace. Mangoo currently lists more than 1,000 products. Most of the products are listed with prices of local distributors. Main target of Mangoo is to improve the market transparency about prices and availability in Africa and Asia.

Sendea and Mangoo are some of the very few existing concepts to build local SME in the African energy access sector. But these efforts need to scale up urgently otherwise the off-grid industry faces the risk to follow exactly what in earlier centuries either missionaries or colonial officers did: with the intention to bring "development" to Africa they missed to strengthen the local forces.

I’m sure we all agree that there should be a significant difference between the "development" activities of past centuries and the off-grid industry in 21th century. Local small and medium enterprises (SME) are the main driver for innovation, poverty reduction, employment generation and social integration. Without a relevant SME structure in Africa, we will miss the crucial target to
initiate the sustainable growth of a local energy economy.

Building a powerful local SME sector is a duty for all players in the off-grid market. But it’s a special responsibility for investors. In 2004, the ground-breaking idea of pay-as-you-go-finance (PAYG) started for households in Subsaharan Africa with a first project in Ethiopia. In which country will we see the start of a ground-breaking new instrument to finance local SME for energy supply?

Harald Schützeichel is expert for off-grid energy in developing countries; Editor of Sun-Connect News.
First published: Sun-Connect News.
Rethinking the cost of off-grid power: Let’s do the math

Since the launch of Power Africa, the U.S. government-led initiative to double access to electricity in sub-Saharan Africa, we have seen off-grid, home solar systems transform countries, bringing electricity to millions of people for the first time. Yet some people have been dismissive of off-grid, home solar systems. The critique often begins with the idea that people are paying more than $1.00 per kilowatt hour (kWh) instead of $.10-$.20 kWh for grid power or that those who live in rural areas can’t afford electricity and shouldn’t be paying more than people in the cities for power. Even if the kWh cost for off-grid systems seems to be higher, that’s not the right comparison. We need to look at what people are able to do at those costs. We need to dig deeper and do that actual math. What you’ll find is that at times off-grid power can be even more productive than grid power, particularly when grid power is not even available.

Many governments currently do not have the resources to offer everyone grid power. Most governments are not yet in a position to provide hundreds of millions of people with access to grid power within the next year or even decade. Even if a household can afford the connection fee, they could be waiting years for the connection to be made. Once made, it may be unreliable, particularly for households at the end of small lines or in countries where there is too little power generation. That’s not to say that we all shouldn’t keep trying to get people connected to the grid. But even when connected for the first time, the customer doesn’t always have the upfront cash to purchase appliances. The connection does them little good as they’re not really using the electricity for anything but a few lightbulbs. Solar home systems, however, offer almost immediate access to electricity, and customers do not have to wait months or years for the grid to come to them. They can get connected to a solar home system in a day, along with efficient appliances that they can use immediately.

Connecting customers to the grid is costly. A grid connection in sub-Saharan Africa costs between $400 and $1,200, plus the costs of wiring a home and the regular required payments for power consumed into the indefinite future. A solar home system that can power a 32-inch television and radio, provide light and charge mobile devices, typically costs less than $2/day (based on Mobisol Kenya’s 200W “Elephant” system). In most cases, the consumer receives after-sales service, owns the solar home system and the appliances after a period of time without having to make further payments. While the Mobisol system costs approximately $700 per year over the first three years (or $2,065), the consumer owns the system and appliance free and clear after year three, so there is NO cost for the power or for the appliances after year three. A consumer also can easily upgrade to a larger solar home system as the customer’s demand for energy grows. With increased competition, the market now offers basic systems that include lights and phone chargers for $0.50 per day.
payable (M-KOPA’s Starter costs $130 payable within 1 year). In addition, the Pay-As-You-Go model allows consumers to pay what they can afford to while using their system making it accessible to low income families.

Many solar home system companies provide the appliances people want and need. Solar home systems help customers build credit and provide financing options for televisions, electric hair clippers, radios, etc. The distribution companies that sell grid power currently do not, and customers are required to purchase these appliances outright with high upfront costs.

Let’s take two households in Kenya—one near the grid (the On-Grid Family) and one in a rural area with no grid access (the Off-Grid Family)—and compare what it costs for them to fulfill their daily energy requirements over a three-year period. Let’s assume that they both want to power 8 light bulbs, a 32-inch television, a set of hair clippers, a clothing iron, and a 4-port cellphone charger.

### On-Grid Family’s 3-Year Cost
Converted to U.S. dollars based on approximate costs on Kenyan online website: achumi.co.ke

| Actual cost of grid connection¹ | $400-$1200 |
| 32-inch television             | $300       |
| 8 light bulbs (replaced over 3 years) | $20  |
| Clothing Iron                 | $25        |
| Electric Hair Clippers         | $40        |
| 4-port USB Charger            | $20        |
| Estimated monthly power costs² | $720       |
| **Estimated Total**           | **$1,525-$2,325** |

¹without subsidy & depending on location (includes back-home wiring)
²three-year monthly power costs calculation: ($105Kwh @ $120/month) x 36 months

### Off-Grid Family’s 3-Year Cost
200W solar panel home system, includes all appliances above based on Mobisol packages and product offerings³

| Deposit                          | $125  |
| Daily rate                       | $2    |
| Additional Appliances (estimated)| $1230 |
| **Estimated Total**              | **$2,065** |

³mobisolkenya.co.ke/mz/

In comparing the costs that the Off-Grid Family would have spent on energy, the on-grid system might appear to be less expensive for the first three years. But the off-grid system can actually be more attractive and provide significant co-benefits (health, education, etc.) for several reasons. First, the off-grid system and appliances are owned free and clear after three years, which means that there will be limited future power costs.

Importantly, the Off-Grid Family’s power system and appliances come with free installation, three-year product guarantees and service agreements.

The On-Grid Family, on the other hand, probably will deal with broken appliances, often destroyed by power surges from the grid, not to mention power shortages (load shedding, brownouts, blackouts). I recall spending more than $300 on surge protectors for electronic equipment and approximately $15/month on light bulbs when living in two different developing countries because of the wild power surges from the grid. From the perspective of a barber using solar-charged Mobisol hair clippers to run a business vs. a grid-connected barber who has to deal with power outages, the off-grid barber likely can run a more lucrative business. This analysis also does not account for the purchase of a back-up diesel generator or the cost of diesel to run it, which many grid-connected businesses and households have. The positive impact of bundling of both energy and energy efficient appliances as one offering is unfortunately yet to be fully appreciated.

Rather than thinking about how much power is needed to run appliances; it is more important to consider how much productivity you can get out of the power that you have. Off-grid solar home system companies have accelerated the development of super-efficient appliances that can squeeze every watt out of a solar panel. For example, as set forth in the chart below, the 19-inch television that the off-grid system uses may require just 10 watts of DC current. A standard 19-inch LED television, plugged into a grid-powered home, likely will consume more than 30 watts.

Power Africa continues to work with its partners and communities to identify the next highly efficient appliance families want to make their lives better. Power Africa, along with its partners, including Global LEAP, UKAID, and the Shell Foundation, is running a competition for the development of highly efficient off-grid refrigerators that can be powered with solar home systems.

So, next time someone puts down a solar home
system and says, "that's not real power" or that "the cost per kilowatt hour of a home solar system is 10 times the cost of grid power," stop and do the math.

Because it's really not more expensive, and it's available now.

Andrew M. Herscowitz is the Coordinator for Power Africa, a U.S. government-led partnership to double access to electricity in sub-Saharan Africa.

First published: Power Africa.
Investment in infrastructure can have a uniquely transformative power for Africa. Addressing the huge funding gap – estimated at almost $100 billion per year – by building roads, power, water, sanitation and the like will drive industrial development and create much-needed jobs.

Industrial development is still a critical step in Africa’s socioeconomic development. In a recent paper for The Breakthrough journal, Harvard Kennedy School’s Calestous Juma makes the case that “leapfrogging industrial development is not an option”. We agree. Indeed, many of the innovations we celebrate in Africa today reveal not just the continent’s entrepreneurial drive, but governments’ failures to get some basics right.

Mobile phone usage, for example, has soared faster in Africa than anywhere in the world. According to the Pew Research Centre, mobile phone penetration in Ghana rose from just 8% in 2002 to 128% today. Over the same period in the US, penetrations levels rose from 64% to 103%. But this increased rate of adoption stems in no small part from governments’ failures to build landline networks; people had to take matters into their own hands.

Mobile phone usage, for example, has soared faster in Africa than anywhere in the world. According to the Pew Research Centre, mobile phone penetration in Ghana rose from just 8% in 2002 to 128% today. Over the same period in the US, penetrations levels rose from 64% to 103%. But this increased rate of adoption stems in no small part from governments’ failures to build landline networks; people had to take matters into their own hands.

Mobile telephony isn’t the only example of this. Rooftop solar power is taking off less for environmental concerns and more for the lack of robust electricity grids. Citizens dig boreholes or install water tanks at home because they can’t depend on pipe-borne water. Drones may be the future of medical supply delivery because road networks are poor.

However, as corporate and private solutions fill gaps left by the government, the continent may be missing out on the bigger picture of economic transformation. The “leapfrogging” of landlines in favour of mobile phones is hailed as a great success in Africa. But it’s crucial to note that mobile telephony’s growth in Africa has less to do with innovation on the continent and more to do with inventions and innovations elsewhere.

The same is true of many consumer goods such as fridges, flat screen TVs, computers and a host of other electricals and electronics, mostly from China. Africans remain consumers of technology, even if the way in which new technologies are used sometimes gives an inaccurate impression that Africans are creating them.

Furthermore, as Africa’s economies become service-heavy, the continent may be missing out on the grit and organisational skills that come from making things. To build a Boeing 747 and all its six million parts or a smartphone from scratch tasks a country in ways that developing six million smartphone apps from existing code never can.

In his paper, Juma argues that despite its adoption of new technologies, Africa still lags behind in manufacturing and has not made major steps to move to the production of technologies. With a view to economic history, he says that Africa should invest in core infrastructure and engineering capabilities that would enable it to meet the needs of other sectors such as health, education, and agriculture.

Additionally, the ability to manufacture smart-
phones would ensure that the money spent on them remains within the continent. The role of infrastructure as the foundation for innovation and economic transformation has been overlooked, Juma laments.

Infrastructure and capacity development projects can have a transformative impact on the continent. But a critical step in the process on ensuring long-term value is to optimise local content in such investments – from inception to operation.

One such example is the Bridge Power project in Ghana. This billion-dollar, 400-megawatt power plant is a joint venture between Endeavor Energy and GE Power, both from the United States, and Sage Petroleum from Ghana. Sage is part of the Quantum Group, which has developed its capacity in part through international partnerships and is the technical lead in some aspects of Bridge Power. The Ghanaian company will no doubt absorb new skills and technologies from its foreign partners through the project.

Local content policies must be bold in their vision, but also progressive in their implementation. It takes time to build companies to the standards expected by serious multinationals. CDC, the UK Government’s development finance institution, runs a training programme to inform emerging market fund managers and indigenous companies on what good international outcomes look like from an environmental and social perspective. By equipping companies and investors with tools and an understanding of what success might entail, they can then find locally-appropriate solutions that work to these objectives. It also behooves governments to set clear, realistic milestones that allow projects to be completed on schedule while increasing local participation.

Africa’s dream of industrialisation is alive, well, and achievable. New technologies are a stepping stone but not the destination. To get to the destination, governments must create attractive environments, schools have to impart the right knowledge and skills, and businesses need to orient themselves to long-term value creation.

Rosalind Kainyah MBE is an advisor to global companies on responsible business investment and partnerships in Africa.

First published: African Arguments.
He developments in the off-grid electrification are enormous - and yet the sector has not managed (so far) to grow into a truly relevant industry. The reasons are diverse and vary from region to region: the conditions in India and Bangladesh with strong local productions and protected domestic markets are different than the ones in the sub-Saharan states of Africa.

Nevertheless, there are structural similarities that hinder the development of an off-grid industry. Here are the three most important:

1. **Structural discrimination in relation to central power generation**
   The energy industry in all countries is organized along the lines of the implemented energy generation and distribution. And it is usually designed as a central energy supply.

   It is a mistake to assume that the off-grid technology would be implemented as soon as it would be "competitive". Policies, strategic planning, regulations, and incentives are rather characterized by the understanding that "electrification" is understood only as a connection to a power grid with central power generation (whether renewable or conventional).

   As a result, statutory regulations and state programs inevitably involve questions in terms of grid connection, grid stability, central energy storage and central energy generation. Decentralized power supply has here, as always, only an outsider place: tolerated, but only as a (temporary) special solution.

   The observation of a structural discrimination of the decentralized energy technology is confirmed by the current hype in the implementation of large power plants in developing countries: wind parks, solar power plants and large hydropower plants are elements of a centrally organized power supply. Decentralized production - even though it is sometimes promoted in individual programs - remains, on the other hand, always of secondary importance: in laws, regulations, strategic plans - and above all, in the minds of the responsible actors.

2. **Homemade obstacles**
   It is often also the off-grid sector itself, which hinders this change into a serious industry. The sector still suffers from the fact that the development of viable markets is hampered under the pretext of a "social impact" - perhaps not directed but negligently. When, for example, international organizations such as USAID or UNCDF distribute millions of grants selectively to individual companies, they not only make investors insecure and distort local competition but also make the creation of a sustainable off-grid market difficult.

   In order to avoid damage to the off-grid sector, such grants for individual companies must be replaced by subsidies which are equally available to all market participants and thus serving the
market development. This requires a rapid rethinking and reorientation of the objectives of the granting institutions. However, it seems currently at least doubtful that this will happen.

3. Neglecting the local off-grid economy

Finally, a future off-grid industry would need a flourishing local B2B business, which would ensure the availability of decentralized products for local entrepreneurs. In the field of mobile solar lamps, it is fortunate to see that manufacturers do not build up their own local distribution network anymore but resort to local distributors. However, the solar home systems sector is still far away, at least as far as the larger SHS are concerned.

The one-sided concentration on the sales and financing model “Pay-as-you-go” (PAYG) proves to be a structural ballast, despite all the effectiveness of this instrument, because now, manufacturers are also acting as lending bank. As long as production, end customer financing and distribution remain in one hand, solar home systems are only available to a limited extent for independent, local distributors.

The consequences can be seen everywhere in Africa and Asia: numerous small dealers offer components (modules, batteries, LED, TV, etc.), the assembly of which then creates problems for the customer. The “do-it-yourself” systems usually work inadequately and only in the short term. This, on the other hand, considerably reduces the confidence of the population in the solar technology as a whole. The perfectly matched complete systems are in turn usually not freely available, but only in the shops of international PAYG companies.

There are indubitably many reasons why this is good so. However, this monopolization is detrimental to the development of an off-grid industry. Here, it is necessary to counteract and, in addition, to develop and strengthen the local B2B market.

Harald Schützeichel is expert for off-grid energy in developing countries; Editor of Sun-Connect News.
First published: Sun-Connect News.
In sub-Saharan Africa, a region rich in natural energy resources, there are an estimated 600 million people who currently do not have access to electricity. However, the rise of microgrids and advances in technology could be the answer to the region’s power woes.

According to market research company, BMI Research, 70% of Africans with access to electricity live in urban areas, while 28% reside in rural locations.

To date, the dominant approach to electricity access in Africa has been through large-scale grid rollout programmes. For those living in rural areas - often with no grid nearby - this approach cannot be the primary answer to electricity provision. Africa’s rural population is increasingly turning toward alternative off-grid solutions for their energy needs.

Fortunately, advances in technology are rapidly changing the options available beyond the grid. Falling solar technology costs and evolving battery storage technology have spurred the growth of micro-grid and standalone household systems.

The private sector is also seizing these developments as a major market opportunity for off-grid power generation and distribution.

Some microgrid companies have achieved success with solar, hydro and biomass generation systems.

However, other such companies are now opting to pilot systems with smart metering, remote monitoring and mobile payment capabilities. The latter could make scaling up easier.

**Associated challenges and best practice**

Besides scaling up, microgrid systems face other challenges such as implementation.

Despite their technical and operational similarity to the central grid, microgrids are typically not fully included in a country’s regulatory framework.

This makes rolling out microgrid systems challenging due to uncertainty around equipment standards, the ability to charge cost-reflective tariffs and the implications of the central grid reaching an area served by a microgrid.

As a result, private sector involvement remains limited and many microgrids have been government or donor-led and rely on a form of subsidy.

In Africa, Mali has had more success than any other African country in the development of isolated microgrids, with more than 200 diesel microgrids in operation. Increasingly, these diesel installations are being supplemented with renewable technologies to create hybrid microgrids.

On the other hand, standalone household system growth is being driven by scalable business
models that meet household needs rather than the slower-moving progress of centralised national energy policies.

Standalone household systems provide first tier energy access for an increasing number of people across the continent.

**Simplifying access**
Companies like Mobisol and M-Kopa are pioneering this space bringing renewable energy to people beyond the grid.

Their smart solar power solutions are big enough to run refrigerators and other household appliances, while also powering LED light bulbs and charging laptops and cell phones.

These companies have also been at the forefront of innovative ‘pay-as-you-go’ payment solutions, using systems such as M-PESA and Airtel MTN. But, standalone home systems are not the panacea.

For higher energy consuming customers beyond the reach of the main grid, microgrids would provide a more feasible full electrification solution.

For microgrids to be successful, factors such as rural population density, affordability, an anchor customer (such as mining companies in the case of the DRC) and a sustainable revenue/financing model are all important considerations. Equally important is that there is clarity at the level of national energy policies about the role that microgrids can play.

Just as access to reliable and affordable independent telecommunications systems allowed Africa to leapfrog state run, expensive and unreliable landline infrastructure, beyond the grid energy solutions will enable Africans to leapfrog antiquated, central energy grid infrastructure and be at the forefront in accelerating innovative off-grid energy technology.

Adam Bennot, junior associate, RisCura.
First published: ESI Africa.
Around the world, more than a billion people still lack access to electricity. This number is shrinking, down by one third since 2000, despite rising population levels, according to an International Energy Agency (IEA) special report on energy access, published today.

The report says that while coal has supplied nearly half of the progress from 2000 to date, its role is set to decline “dramatically”. This is because renewables are becoming cheaper and because the hardest-to-reach people are in remote, rural areas where off-grid solutions offer the lowest cost.

The report shows the number of people without access to electricity will shrink by another third by 2030, with 60% of these gains supplied by renewables. Furthermore, if the world commits to providing universal access by 2030, then renewables would bridge 90% of the remaining gap, the IEA says.

**Recent progress**

There have been spectacular gains in providing access to electricity this century, cutting the number without it from 1.7 billion in 2000 to 1.1 billion in 2016, the IEA says. Most of this progress has been in Asia, as the charts below show (blue, yellow and green lines and columns).

India has led the way, with 500 million gaining access to electricity. Sub-Saharan Africa now has the majority of people still without access, at 600 million, an increase over the past 15 years due to rising populations. Recently, this number peaked and started to fall (red line and columns).

**Fuelling gains**

The rate of progress has been accelerating, the IEA says, rising from 62 million people gaining electricity access each year during 2000-2012 to 103 million during 2012-2015.

Coal has been the main source of this new supply, generating 45% of the electricity used by people gaining access for the first time between 2000 and 2016 (purple pictograms in the chart, below).

There has also been a growing role for renewable sources of electricity, the IEA notes, with particularly rapid growth in decentralised off-grid
access (dark green pictograms). From 2000-2012, renewables provided 28% of new access to electricity. This figure rose to 34% during 2012-2016.

There are regional differences in the sources of new electricity connections. In India, for example, coal generated 75% of new supplies, against 20% for renewables. (This pattern is expected to reverse, see below.)

Sub-Saharan Africa has had the most rapid recent improvement in providing electricity access, rising from 9m new connections per year during 2000-2012 to 26m per year during 2012-2016. Most of this acceleration is due to renewables, responsible for 70% of new access since 2012, whereas coal has not supplied any new connections in this period.

**Future growth**

Looking ahead, the IEA says the number of people without access to electricity will fall to around 700 million by 2030, under its central scenario.

Asia will reach close to 100% access to electricity by 2030 (lilac, yellow and green lines and columns, below) and India will meet its aim of universal access in the early 2020s (blue). The vast majority of the 700 million still without electricity in 2030 will be in sub-Saharan Africa.

**Growing grid**

Around the world, the share of new electricity access supplied by renewables will nearly double to 60%, up from 34% over the past five years (green, blue and yellow columns, below). This pattern is even more extreme in India, where the share of new electricity from renewables will triple to 60%

Coal’s role in providing electricity access “declines dramatically”, the IEA says, providing power to 16% of those who gain access over the next 14 years. This compares to 45% during 2000-2016.

Note that the IEA has been criticised for repeatedly underestimating the rate of growth of renewables, particularly solar. This makes its outlook, in which renewables supply most new electricity access, even more striking.
Role of renewables

If the world wants to meet the Sustainable Development Goal (SDG) of providing universal energy access for all by 2030, then 90% of the additional electricity connections over and above the IEA's central scenario will come from renewables, its report suggests.

This reflects the fact that the hardest-to-reach populations are those least likely to benefit from grid expansion. For these people, decentralised systems, predominantly supplied by solar (yellow columns, below), offer the "lowest cost pathway" to electricity access.

The report, for the first time, uses geospatial analysis, at a resolution of one square kilometre, to assess the most cost-effective ways to deliver electricity access to sub-Saharan Africa, whether through grid or off-grid solutions. This analysis takes into account existing and planned infrastructure, technology developments, local resources, population density and likely demand.

It is this new analysis that suggests decentralised renewables will be the cheapest way to provide electricity access for sub-Saharan Africa’s rural poor. Note that research suggests Africa could more than meet its electricity needs, with renewable sources alone.

The IEA puts the cost of providing electricity access to everyone on the planet at an additional $391bn over the period to 2030. This would nearly double total spending, adding to the $324bn already expected to be spent under the IEA's central scenario.

The energy access-focused SDG also includes provision of clean cooking services. The IEA says this can best be met using liquefied petroleum gas (LPG). As a result, providing universal energy access would increase CO2 emissions by 70m tonnes. This would be more than offset by savings of 165MtCO2 equivalent due to reduced methane and nitrous oxide from biomass used for cooking.

The report says:

"Achieving universal energy access is not in conflict with achieving climate objectives. The relatively small increase in total primary energy demand and the central role of renewables in our Energy for All Case means that global energy-related carbon dioxide (CO2) emissions increase by just 70 million tonnes (Mt) relative to the New Policies Scenario in 2030 (0.2% of the global level)."

Conclusion

The large numbers of people without access to electricity are a frequent point of contention in debates over how to address climate change.

Some proponents cite China and India’s reliance on coal to bring electricity to their populations. They argue that coal is cheap and must be part of the solution for the remaining 1.1 billion people that still lack access to electricity.

Not everyone agrees on how best to meet the needs of these people, who are mostly in sub-Saharan Africa. In a November 2016 interview, Dan Kammen, professor of energy at the University of California, Berkeley and a former science envoy to the US State Department, told Carbon Brief that coal has been given too much credit as a solution to extreme poverty in Africa.

"Coal doesn’t even deliver the thing for which it’s really been touted for, and that is, bringing people out of poverty because somehow it’s this least-cost fossil fuel source... I really cringe a bit when I see people touting mega fossil fuel projects as the obvious, first thing to look at...Distributed clean energy, time and time again today, has proven to be better, cheaper, more socially and environmentally positive."

As a July 2017 World Bank blog explains: “In many rural areas in Africa, impacts on economic development of grid extension in the near term may be very modest, while off-grid technologies can be more cost-effective for meeting the most highly-valued basic household needs.”

In further support of the benefits of off-grid systems, it says:

"The major downside of off-grid solar is that the
relatively low amount of supplied electricity limits what those systems can do for the productive use of electricity. However, electricity usage patterns in newly electrified areas in rural Africa are often such that solar is able to meet those demands. Even in grid-covered rural areas, households and micro-enterprises use electricity mostly for lighting, phone charging, and entertainment – which can easily be provided by solar panels.”

Regardless of these details, today’s new IEA report shows that coal’s role in expanding electricity access is set to decline dramatically. Renewables, both on and off the grid, will provide most new connections, as the population without access falls by another third to 700 million.

If the world hopes to meet its goal of universal electricity access by 2030, then the IEA report suggests it is solar – not coal – that will bridge the gap.

Note on definitions
The IEA report defines electricity access as a minimum of 250 kilowatt hours (kWh) per rural household per year. This excludes the more than 23m “pico solar” units sold since 2010. The report explains:

“People relying on ‘pico solar’ products, mainly solar lanterns which may include mobile phone chargers, are considered to be below the minimum threshold to count as having [electricity] access. Nevertheless, there are significant benefits for the poor associated with pico solar products.”

You can see the range of solutions it considers in its report in the graphic, below.

Illustrative technology options for providing electricity access and the range of uses they can supply. Source: IEA special report on energy access.

The IEA says there is a “general paucity” of data on access to electricity. Its report is based on its own statistics, national statistical agencies, other publicly available data and a network of contacts in government, multilateral development banks and elsewhere.

Dr. Simon Evans is deputy editor and policy editor of Carbon Brief (www.carbonbrief.org).
First published: Carbonbrief.
Nikhil Jaisinghani

The decline of the off-grid population since 2000: The real numbers

The International Energy Agency (IEA) recently released its Energy Access Outlook 2017 report. At a high level, the point was that from 2000 to 2015, investments in national grid infrastructure made a significant dent in the global off-grid population. The chart showing their findings is presented below:


This is an exciting graph. It indicates that efforts to extend grid infrastructure have been tremendously successful. However, like any good academic exercise, it is good to double check the figures. Unfortunately, not only do the numbers not add up, the conclusion is not consistent with reality either.

Let me pull out the following numbers for confirmation:
1.7 billion people, 600 million of which were in India, lacked access to electricity in 2000
2. Population growth in India from 2000 to 2015 was just under 200 million.
3. 500 million people gained access to electricity in India between 2000 and 2015
4. 1.1 billion people lacked access to electricity in 2015.

I will rely primarily on World Bank data, accessible at data.worldbank.org for this exercise. The World Bank has electrification data up until 2014, one year short of the 2015 cut off used by IEA. We can still compare the 2000 figures and have any trend over 15 years should be able to be confirmed over 14 years as well. In addition, I will also challenge the official data from India which was not generated through field collections but through political process and will rely only on field generated data to calculate the off-grid population in India. More on that later.

First, let us look at the 600 million figure which IEA states were living off-grid in India in 2000 people. The two relevant figures are population and % of people with access to electricity. The below graph two graphs give us these numbers.
Chart 2: Global and India population, 2000 to 2014

Chart 3: Global and India % of total population with access to electricity, 2000 to 2014. The pink line is a trend line for the official India electrification figures.

Let’s use the data from the population and electrification graphs above to figure out how many people were off-grid in India in 2000. The population was approximately 1 billion and the electrification rate was about 60% - that implies 400 million people were off-grid in India in 2000. But the IEA reported India’s off-grid population was 600 million in 2000.

In addition, the article states that India’s population growth was less than 200 million from 2000 to 2015. But according to the World Bank (graph below), it was closer to 300 million.

Finally, India’s official statistics imply very steady progress. The blue line is actual electrification rates by year and the pink line is a trend line. They are almost a perfect match! However, you will note a few things. First, there are two years which fall significantly below the pink trend line. These are 2001 and 2011. These are special years in India as they are the years the census was done. In other words, those are the only two years in the graph above where actual data was collected. The other years, the figures were constructed through a political process rather than a data gathering process. If they aligned, we could accept them. However, from 2010 to 2011, the number of people in India officially living off-grid increased by 100 million. From the invent of electrification until 2000, India was able to provide electricity to 600 million people. Then in 2012 alone it provided electricity to 130 million people (12.5% of its population). These figures are not a reasonable reflection of reality and the 2011 figures were constructed by a valid process and are thus dependable. We can estimate that the official data was off by approximately 120 million in 2012 and that this figure has increased even more so since then. Based on my analysis of these numbers and my experience in India, a better estimate of the off-grid population in India today is 400 million opposed to the official figure of 250 million.

The data from Sub-Saharan Africa (SSA) is similarly flawed, though not to the same degree. But even putting deviations in the SSA data, if we correct the figures based on what we know from India alone, the off-grid population in 2000 would be reduced to 1.5 billion while the off-grid population in 2015 would be increased to 1.35 billion. Adding in the deviations from SSA, the 2000 and 2015 figures are nearly identical. Instead of reducing the off-grid population by 35% in 15 years, the off-grid population appears to have reduced only slightly if at all.

However, building this analysis off of the flawed foundation provided by IEA isn’t a dependable way of analyzing the situation. Instead, we can again look at the World Bank data. Based on global population and access to electricity rates, the World Bank’s data implies that the off-grid population in 2000 was 1.37 billion. Using the same data, plus the correction for India mentioned above, the off-grid population in 2014 was 1.21 billion. That is a reduction by a bit more than 10%. Certainly that is positive progress, but it is significantly slower than what IEA implied. Further, the World Bank data shows that the off-grid population in SSA increased by 50% from 2000 to 2015 while based on our estimates above the off-grid population in India held steady. The two regions with the greatest off-grid populations have shown no progress.

This story is more sobering. Though many more
people have access to electricity now than in 2000, many people who "gained" access to electricity either migrated to an urban setting or were born into an electrified house. That still translates into people having access to electricity, but it's also a bit of cheating to claim that electrification investments are actively expanding and reaching un-electrified communities and households.

The grid continues to fail to reach off-grid communities. Grid infrastructure is too expensive. It isn't the cost of energy production that is prohibitive, it is the cost of energy distribution. The grid is that distribution cost. Over time, the communities that will need to be reached will be further away, harder to reach, more remote, less accessible. Insufficient transmission infrastructure and limited power generation will result in greater power shortages. These will slow down electrification. At the same time, population growth is compounding, meaning the size of the challenge will be growing. A number of off-grid companies have sought to solve this problem, offering lower cost solutions which can be rapidly scaled in rural, remote, hard to reach locations. But these solutions have yet to be brought into the fold of national electrification strategies.

The world needs an electrification strategy that isn't that old, stagnant strategy some World Bank economist wrote back in the 60s. We don't need to dust it off and update the figures. We need to rewrite it. A previous article in Sun Connect concluded that policy makers committed to an outdated electrification paradigm are one of the three main hindrances to the further development and financing of an off-grid energy delivery sector. And based on what we have read here, that means those policy makers are also the number one hindrance to finding the solution to rural electrification that we have sought for so long.

Nikhil Jaisinghani is Co-founder, Executive Director at Mera Gao Power.

First published: Sun-Connect News.
Micro-entrepreneurs are one of the most common jobs in developing countries, almost 93% of Small to Medium businesses are micro-enterprises. Glorified hustlers, these are jobs in the informal economy – unregistered, provide only subsistence earnings, and are focused mostly in sales. For example, a woman makes samosas from home and sells them out of her window to her neighbors. A man fixes bicycles and repairs them for people in the community. The income is sporadic, unreliable, and completely dependent on the needs and wealth of their neighbors. Furthermore, micro-entrepreneurs have options to get access to financing: microfinance itself, which is the only financing industry that targets investing in women.

Another problem with this narrative is that the stories on women's economic empowerment are also focused on the micro-entrepreneurs, such as a woman who sells solar lanterns in her village and can now afford to pay for her kids' school fees. While these are noble initiatives, it's still a harmful narrative for women's entrepreneurship.

The organization I founded, ENVenture, seed invests in rural Ugandan small to medium energy businesses. ENVenture is the first investor in Juliet Gibbs's company CARES. Her background is in Microfinance and energy access, having completed in Master's degree in Italy, with an impressive resume with experience as a Grameen Bank Fellow in Bangladesh, and having worked for UNDP, VSO, GVEP International and other international NGOs in leadership positions. She is seeking start-up capital for her energy business CARES, whose mission is to combine the breakthrough potential of solar technology with a deliberately community-centered sales network to promote health and wealth to the most remote communities in Uganda. Currently her business is small, but she has the vision and the capability to turn this from a small business to large-scale enterprise, supporting hundreds. She is a Ugandan entrepreneur worthy of serious investment and deserves a chance to sit at the table with men entrepreneurs.

When we talk about gender equality across the value chain, we need to re-shift our attention to the top of the value chain, and not simply focus on
microfinance markets. This is very difficult to do when economic systems were designed to support patriarchal societies; however, the energy access sector requires more than just soundbites on women’s empowerment. We need more women executives, CEOs, and heads of energy companies generating wealth, and more gender and energy initiatives like the Goldman Sachs 10,000 Women Program. Until that happens, we will continue to see women entrepreneurs delegated to gender panels at energy conferences.

Aneri Pradhan is the Founder and Executive Director of ENVenture, a US non-profit organization with operations in Uganda. Her expertise is on last mile distribution, clean energy access, and social innovation, with previous experience working at Facebook’s sustainability team, MIT Media Lab, and the United Nations Foundation.

First published: Sun-Connect News.
Governments that fail to use clean, off-grid energy to help get electricity fast to the 1 billion people living without power - mainly in Africa and South Asia - are missing opportunities to improve lives and boost development, energy experts said Thursday.

The United Nations has set a target for everyone to have access to sustainable, affordable energy by 2030.

One way of doing this is to expand national power grids, a process that can take decades and often misses out rural areas, clean energy campaigners say.

Research from the London-based Overseas Development Institute, published on Thursday, showed that speeding up access to off-grid electricity, such as solar home systems and clean energy mini-grids, can bring significant benefits.

If households in Bangladesh, Ethiopia and Kenya replace kerosene lamps with solar-powered lighting they could each save about $10 a month, said report author Andrew Scott.

"Add that up for a year, and you're getting to quite a significant freeing up of income that could be used for other purposes," he said, adding the figure varies according to country, household consumption and fuel prices.

Switching from dirty fuel to solar can also give children at least 15 minutes of extra study time each day, he said.

And cutting kerosene use brings large reductions in black carbon emissions, equivalent to as much as 330 million tonnes of carbon dioxide emissions a year in Ethiopia, roughly the same as the emissions from 60 million passenger vehicles.

The three countries studied together account for more than 180 million people living without electricity, according to clean energy groups Sustainable Energy for All (SEforALL) and Power for All which backed the report.

The report is the first attempt to develop a framework that can quantify the financial, educational and environmental dividends for households that get quick access to clean, off-grid power, said the organisations.

Rachel Kyte, CEO of SEforALL, a body set up to help reach the U.N. energy goal, said data on how people are held back by staying in the dark is a powerful weapon to persuade governments to act fast.

"When you walk into that minister's office ... you've got to be able to say ... this is the opportunity cost to your people of not helping them get access to affordable, reliable, clean energy now," she said on the sidelines of U.N. climate talks in Bonn.

The research, which draws together evidence from existing studies, was unable to measure the benefits of clean energy access for small businesses or health.

Kristina Skierka, CEO of Power for All, a campaign that promotes decentralised renewables in
countries including India and Nigeria, said these energy sources could be provided in weeks or months - far faster than connecting people to national grids, which often rely on fossil fuels.

Many energy-poor countries are hoping to become middle-income countries, she noted, but officials may not realise the extent to which helping citizens get clean, off-grid power can generate jobs and improve health and education.

"It's a lack of knowledge," she said. "These governments care about people having better lives ... We want to close the information gap."

Kyte said countries still needed to work on expanding their national grids and shifting them to clean power, but at the same time they should ramp up deployment of small-scale solar systems, especially in rural areas.

"This is a very workable solution for isolated communities," she said.

Megan Rowling is a correspondent with the Thomson Reuters Foundation and the editor for Zilient.org, based in Barcelona.

First published: Thomson Reuters Foundation.
Dimitrios Mentis and Sanjoy Sanyal

Open tools and data are quintessential to inform decision-making in the energy field

Lack of data is holding back the changes in planning and investment that are needed to scale decentralized energy.

Today, decentralized energy is often provided by private organizations who see a business opportunity in providing services to unserved and under-served populations with the additional incentive of creating positive and social impact. However, these organizations suffer from several challenges which hinder their ability to propagate these solutions rapidly. In a blog post in the Inclusive Business Hub, Mitali Sahni of Simpa Networks recognized the challenge of slow penetration of these products:

“A big reason for this is the lack of knowledge about the customer segment that is being catered to. In any industry, a clear understanding of the customer’s attributes, behaviours, needs, willingness and ability to pay, and customer segmentation is the basis for the development of a compelling product offering and sales planning... Unfortunately, very little research has been carried out to date in scientifically understanding the needs, motivations and beliefs of target customer groups in the embryonic energy access sector.”

The problem of scientifically looking at the question of how best to deploy decentralized renewable electricity products to address universal electricity access can then be broken up into two questions: how can electricity utilities plan for decentralized options and where can businesses and impact seeking investors focus their relatively scarce resources on?

The importance of geospatial planning in energy access

To address the planning question, it is essential to complement traditional national energy planning tools with geographic information systems (GIS) that account for local energy-related and socio-economic characteristics. Within the electricity sector, the use of GIS data and associated analytical tools can be beneficial in conducting strategic planning as well as prioritizing and rationalizing decision making related to energy infrastructure. However, this type of tools and information is not widely available, making energy access efforts resource intensive. Another hindrance in expanding energy access has been the high transaction costs incurred by regular data aggregation, as there has been no established mean of dissemination of open data through platforms.

Open tools and data are thus quintessential to inform decision-making in the energy field and help bridge science, technology and policy at different levels and in a transparent manner. This will enable users to repeat an analysis and allow planners to carry out new applications.

In this direction, KTH in collaboration with partners has developed an Open Source Spatial Electrification Tool (OnSSET) that estimates investments and technology needs to reach universal
access to electricity using 16 Geographic Information System (GIS) datasets such as population density, proximity to power infrastructure, and energy resource availability. Already, planners are putting the open source electrification tool to use. The World Bank and ESMAP are using it to identify cost optimal Electrification Pathways. ABB, an industrial partner on the OnSSET project, has decided to use the tool to identify market opportunities. The International Energy Agency and UNDESA are using it for informing energy access supply strategies. Academia at other universities are using it as well.

But energy access solutions should not only be selected based on a least cost comparison but also on current affordability and potential development impact. To do so, the WRI in collaboration with partners is introducing web-based maps that can help energy entrepreneurs and electricity planners identify potential markets for distributed clean energy. The recently released Tanzania Energy Access Maps visualizes data related to energy need (percentage of households lacking access to electricity), economic buoyancy (measured by percentage of households owning of livestock, radios and iron roofing) as proxies of ability to pay for or invest in clean energy), mobile phone penetration, indicating potential to adopt pay-as-you-go service delivery models.
The tool draws on both publicly available data sources and data collected from surveys and interviews. Users can explore these attributes by region or district to find areas most viable for electricity access implementation efforts. Regions and districts that lack electricity but are economically buoyant are likely to have residents with the economic freedom to invest in clean energy. These areas are likely to attract private investment in clean energy. Conversely, areas that lack access to electricity but are economically vulnerable are least likely to attract private investments. Public support will be needed to meet electrification needs in such areas.

These and other geospatial energy access models are useful planning tools. However, to scale up we need to build capacity within country stakeholders to collect useful data, develop and use maps. This will allow stakeholders and planners to set up their own energy access models according to their requirements and tap onto the growing expertise within the sector. Further, the creation of data standards to facilitate data sharing and reuse as well as comparability across countries and models constitutes a crucial next step. Finally, integrating such geospatial models to powerful interfaces (such as Google Earth) will lead to increased usability.

Why we need new approaches to provide access to energy

About 1.1 billion people lack access to electricity, according to the latest IEA's Energy Access Outlook: mainly in Sub Saharan Africa and South Asia. The importance of energy services for economic and social development is recognized in the Agenda 2030 for Sustainable Development: a set of 17 sustainable development goals. The 7th SDG focuses on a concerted global effort to ensure access to affordable, reliable, sustainable and modern energy for all by 2030 and targets the elimination of energy poverty, which otherwise would remain an incessant threat to the attainment of Agenda 2030. Modern energy services are a necessary condition for improving quality of economic conditions, health services, education, gender equality, indoor environment of the currently un-served and under-served populations.

The goal of universal energy access is attainable because of the rapid improvements of renewable energy. The development of standalone – distributed – renewable energy products have the ability to provide energy to communities where the costs of providing services by traditional methods is not feasible or cost prohibitive. However, energy utilities – in particular- electricity utilities do not necessarily have the capacity to adopt decentralized renewable energy systems. Moving from planned, centralized electricity systems, towards fluctuating, decentralized and cost effective renewable energy production necessitates considerable modifications in the energy infrastructure and investment in planning methods.

Dimitris Mentis is a Team Lead at the World Resources Institute where he manages the development of the Energy Access Watch. Sanjoy Sanyal works with the World Resources Institute as a Senior Associate Clean Energy Finance.

The United Nations Millennium Development Goals may pledge to achieve universal access to electricity by 2030, but nearly half of Africans lack access to energy. With inconsistent or non-existent access to the grid, solar services in Africa have taken off as nearly 10 percent of the continent now use off-grid clean energy to light their homes. As prices for solar panels and appropriate battery technologies fall, the mobile “pay-as-you-go” system pioneered by companies like M-KOPA and Off-Grid Electric appears increasingly appealing; however, their early promise is unlikely to meet long-term economic growth.

Although small-scale solar providers focused on the rural off-grid market have been the darlings of the development world, they generate just enough electricity to power more than a few basic appliances such as light bulbs, fans, and televisions. These improvements are undoubtedly an important improvement, but the vision for energy access should embrace a more comprehensive and robust potential. Improvements in quality of life and productivity should be the centerpiece of the agenda for powering Africa. A sustainable vision is required to identify feasible, durable solutions. Unless government and industry stakeholders invest in larger renewable systems, we will continue to champion an unsustainable model of sustainable development.

While African governments have increasingly framed renewable energy as the linchpin of their climate change and development strategies, solar energy still remains largely dependent on public sector capital from sources like the World Bank and the African Development Bank. At present, Africa lacks sufficient investment to fund enough energy projects to achieve universal energy access by 2030. In 2015, the African Progress Panel found that current energy-sector investments in Africa are about US$8 billion a year—less than one-sixth of the US$55 billion per year required to meet electrification targets. And even those funds won’t meet the renewable energy sector’s financing needs.

According to a recent Power for All report, only 11 percent of World Bank energy access funding and 1 percent of African Development Bank funding went to decentralized renewables between 2011 and 2014. With climate mitigation funding in flux due to the U.S. withdrawal from the Paris Agreement, Africa’s solar industry must rapidly develop more capital-efficient ways to reach consumers outside of the grant-based or subsidized rural electrification model or risk future impediments to growth.

Solar companies providing subsistence-level energy to consumers with poor economic prospects have provided an important basis for the industry’s development. Investors betting on the off-grid rural market are right about the transformative impacts of models like M-KOPA, which enables customers to repay the cost of a $200 entry-level solar system over time. These systems provide the means for children to read at night, and they improve household health by reducing reliance on dirty fuels like kerosene. However, if
these investors hope to generate long-term growth and improve economic livelihoods, solar systems must be able to generate enough output to power products like refrigeration, which improve food security, or irrigation and agricultural machinery, which enable productivity in the increasingly promising smallholder-led agricultural industry in sub-Saharan Africa.

Likewise, water heating is a staple and important aspect of daily urban living. Enhanced access to electricity shouldn’t just be a stop-gap solution: it should provide a means of reducing poverty and create better conditions for healthier, more financially stable lives in the long-term. As governments and development partners work to catalyze Africa’s green revolution, energy generation must play an essential part of the story. In Kenya, for example, energy accounts for nearly 15 percent of agricultural input costs. Harnessing enough energy to enable customers to expand their discretionary income is a critical path to improving the customer experience while also helping the energy industry’s profit margins—everybody wins. Electrification efforts that focus solely on basic solutions will not uplift the continent as a whole.

For renewable energy to create scaled impact, greater focus is needed on urban and peri-urban locales, which are often neglected in the race to power Africa. The sheer number of customers in urban areas means that efforts to improve electrification among all residents will reduce marketing and distribution costs. Although the electricity deficit is most stark in rural villages, the continent’s most developed cities from Nairobi to Johannesburg also confront irregular power, which, given the rapid urbanization trends in Africa, will become an ever-greater problem as more slums spring up on the urban periphery.

According to the Honourable Akinwumi Ambode, Governor of Lagos State, nearly 86 people enter Lagos every minute of the day—a rate 10 times that of New York. As new settlements crop up, the grid has yet to keep pace with the scale of development. Because the cost of solar power has gone down by 80 percent since 2010, renewable energy solutions have become an increasingly appealing option to expand access to energy in urban environments, the primary drivers for Africa’s economic growth. In these environments, community-level mini-grids and individual solar home systems are models that can deliver higher returns for customers and solar providers alike. Expansion of solar provision in urban areas can subsidize the costs of expansion of solar power in rural communities, and translate into a more commercially sustainable approach to achieve universal and, equally as important, reliable electricity access for more Africans.

As hubs of innovation, urban areas also offer more opportunities to experiment with various types of solar solutions on a large scale. It is hard to imagine testing a scalable power system in a small village—distribution and maintenance would be expensive due to infrastructural and access issues, and piloting a scalable system in a population-limited area is difficult.

Urban settings are ideal testing grounds because research shows that innovation in urban areas grows at the same rate as populations because it increases more opportunities for personal interaction and leads to exposure to new ideas. Directing more investment towards urban energy solutions can improve local resilience by helping balance the over-stretched power grids found in most African countries, and facilitating nationwide energy efficiency.

Expanding electrification in rural Africa is an important step towards building an inclusive future, but the solar industry’s preoccupation with last-mile off-grid solutions will not deliver transformative growth for the continent. Empowering entrepreneurs at a scale that enables them to grow their businesses and generate more economic employment will require firms and investors alike to balance urban with rural concerns, and immediate energy access with a longer-term, sustainable vision.

Ademola Adesina is the Founder and CEO of RenSource, a West Africa-focused distributed energy service company.

First published: Renewable Energy World.
I’d like to think that there is a general key for unlocking Sustainable Development for rural communities, using renewable energy, training and developing market based value chains. Let me show you why I think so.

The following challenges are quite common in rural communities:

1. Women and children in particular get health problems from indoor air pollution caused by traditional cooking (4 mill people die prematurely annually because of this, according to WHO).
2. Firewood is getting difficult to obtain near the community due to deforestation, forcing women in particular to walk long distances. It is risky for the women, and their families suffer.
3. Farmers lack fertilizers, resulting in small harvests, minimal income, and sometimes malnutrition for the family.
4. Families and businesses lack power and proper lighting, preventing access to information and use of efficient tools.

The above challenges may seem hard to resolve, but can in fact be resolved by renewable energy technologies, which is why they are also referred to as sustainable energy technologies.

The traditional way

During a visit to rural Liberia a few years back, I was introduced to the main income source for a village – “cane juice” - alcohol made from sugar cane, in what they called “the mill”. Having observed their current practices, I could not help thinking that a few changes in their practice could make a huge difference in the energy situation for that village (which currently did not have access to modern energy sources).

Their practice was to squeeze the juice from the sugar cane by using an old machine. Having squeezed out the juice, they threw the straws (bagasse) away in heaps. Then, when they wanted to get rid of the heaps, they set fire to them. Later in the process, when heating the fermented juice to make the alcohol, they used firewood that was sometimes hard to find nearby.

The burned heaps indicating the amounts of bagasse being processed
The machine for crushing - notice e.g. the entrance for the sugar cane in the machine

The distillation area with fire for heating up the fermented juice. Notice the firewood burning

Using bagasse as fuel and converting the diesel engine to run on alcohol

The observations induced some thoughts. Firstly, that by throwing the bagasse away and setting fire to it; they wasted a lot of energy. Actually, 2/3 of the plant energy is in the bagasse. If they instead had chopped the bagasse and dried the chips, they could have used those chips as fuel instead of (or in addition to) the firewood, and thereby saving themselves the trouble of finding firewood as well as saving the forest. In addition, while heating the fermented juice, they could e.g. produce power from the heat via a combined heat and power unit (CHP). Even further, by converting the diesel machine to run on alcohol, they could use their own alcohol as fuel and thereby save both money and the environment.

Using the Waste for producing cooking gas, power and fertilizer

Similarly, wastes of different kind were lying around in the village and in the bushes around the village, and there were no toilets. If that waste instead had been used in a biogas plant, they could have got rid of wastes that attract flies and cause health problems. In addition, the smokeless biogas could be used for cooking instead of open fire, thereby avoiding health problems caused by smoke.

Alternatively, it could be used for producing power via a generator. Finally, the biorest (the digested biomass) could be used as fertilizer on the fields, improving agricultural and other produce, and preventing deforestation due to depletion of the fields and clearing of new forest areas.

Using other local resources

Communities have different natural resources. In addition to bio resources, most communities could also utilize solar energy, either to produce power or to produce hot water, which both could be valuable supplements to the described bio energy.

Developing the value chains

Technically the above should be possible, but there are plenty of examples that show that the best intentions fail unless the value chains around the technical equipment are in place too. Being in place means e.g. that related spareparts and services have to be available when needed. To ensure this, value chains should be managed on a commercial basis - as someone’s livelihood. Only by providing the necessary spareparts and doing the related services, his or her livelihood will be sustained. Like others in the village have their livelihood on growing the rice and the sugar canes, this business could be the ‘Sustainable Energy Business’ (SE business) in the village. This means that the value chains around the technical equipment need to be developed.

Building the market

A business requires not only someone to offer
products and services, but also informed customers with purchase power. In a village where knowledge of renewable energy and money is limited, it would be necessary to increase the knowledge and purchase power of people. That could be done by training in sustainable energy, and in parallel introduce services related to the SE business, where the villagers are paid for services to the SE business, and vice versa. Typically, paying villagers for collecting waste and making fuel chips, while charging them for cooking gas, power and fertilizers. After a period the villagers would become informed customers with purchase power - hence a market would develop.

**Conclusion**

By using the natural resources in the community to produce fuel, cooking gas, power and fertilizers, and developing the market based value chains around the technical equipment, I’d like to think that this is a general key for unlocking the door to Sustainable Development in rural communities.

Hans Martin Førsund, CEO, Oslo, Norway, has legal background and more than 30 years of experience from public and private sectors, nationally and internationally. Currently heading NIDECO (Norwegian International Development Company), providing sustainable energy in developing countries.

First published: Sun-Connect News.
How do we get to 100 percent renewable power for the poor?

Leaders of government, business and communities from around the world will gather together in solidarity for global climate action at the One Planet Summit in France Tuesday. The summit marks two years since the Paris Agreement was adopted and, with a focus on climate finance, is a timely opportunity to highlight the vast potential that adequate climate finance can unlock across the developing world.

Not only do many developing countries urgently need to adapt their infrastructure and systems to deal with the impacts of climate change, and find solutions to address its unavoidable impacts, but poor and vulnerable countries also face the unique and unprecedented challenge of lifting their people out of poverty in a sustainable manner, without relying on fossil fuels.

This is where renewable energy comes into play.

Over 1 billion people worldwide lack access to basic electricity. This has wide-ranging impacts on health, communication, productivity, education and wellbeing. Renewable energy has the potential to close this gap and meet the electricity needs of the world’s poorest without exceeding the planet’s limited remaining carbon budget.

But it goes beyond that — renewable energy is the answer to all needs, including enhanced farming, food processing, local businesses and industrialisation.

The people-centred, smart-energy systems of the future can be and will need to be 100 percent renewable energy.

These renewable energy systems will be the most important means of driving meaningful economic development across all our communities. Innovative approaches to renewable energy that empower people through enabling households or communities to generate their own power are proliferating.

From household solar systems and biomass burners that create power from excess waste to micro-hydro systems that power community mini-grids and larger wind farms and solar installations, an increasing range of technology is becoming available at increasingly cheaper prices.

The challenge lies in making these solutions available to those who need it the most.

Many developing country governments lack the resources to provide renewable electricity to all. Instead, non-governmental organisations and businesses often lead the charge, particularly in the solar sector, with products such as portable solar lights or solar home systems sold cheaply in large numbers, but the need to profit makes it difficult for businesses to reach the poorest of the poor and those in remote and rural areas.

Access to finance for governments, business and NGOs is sparse. The perceived riskiness of the decentralised renewables sector leads to higher interest rates and a lack of finance available in local currencies.
Given the challenges facing renewable energy, there is a need for greater in-country support to develop the policies and regulations behind the ambitious goals of many developing countries. It is important that this is a true capacity building effort, building local institutions and businesses to enable them to learn and replicate what works in their country and region.

At COP22 in Marrakech last year, the Marrakech Global Partnership on Renewable Energy and Energy Efficiency was launched. This partnership is designed to form the ‘roof’ atop the pillars of key regional initiatives in Africa, Latin America, the Small Island Developing States, and the 47 poorest countries in the world known as the Least Developed Countries (LDCs).

It will accelerate the global energy system by helping initiatives on renewable energy and energy efficiency through sharing information and best practices, enhancing transparency and communications, identifying gaps, improving institutional capacity and enabling the scaling up of finance and support. As with any house, construction of the Marrakech Global Partnership has begun by laying a firm foundation and building each pillar from the ground up.

As this work takes place, there are some great successes the Global Partnership can learn from: in Bangladesh over 5 million solar home systems have been installed through funding from the national Infrastructure Development Company Limited; Nicaragua is currently on a journey to 100 percent renewable energy; and in East Africa the cost of solar home systems has fallen so low that households on less than $1 a day can afford to light their homes with clean electricity.

The regional initiatives seek to replicate these successes. In the LDCs, for example, the LDC Renewable Energy and Energy Efficiency Initiative (REEEI) is being developed to provide support for renewable energy through stimulating the use of energy for sectors such as agriculture and small businesses, strengthening energy planning and national institutional frameworks, tackling policy and regulatory barriers, facilitating bottom-up local investments and supporting innovation.

The Marrakech Global Partnership will play a key role in advancing the interests and building the capacity of the regional initiatives it unites. To flourish, however, initiatives like REEEI need bespoke donor finance that facilitates a bottom-up, capacity building approach that utilises local expertise rather than international consultants, addresses the gaps and shortfalls in global funding and private sector investment, and provides the patient in-country support that enables local people and institutions to learn and replicate what works.

Renewable energy will enable developing countries to leapfrog to energy systems that not only provide electricity to millions of energy-poor households, but also strengthen public sectors and foster thriving economic development, while averting a massive ramping up of greenhouse gas emissions through the use of polluting fuel sources.

The aims of the One Planet Summit are to take tangible and collective action, to innovate, and to support one another. Support from the global community for initiatives like REEEI and the Marrakech Global Partnership offer tangible and innovative ways to work collectively – rapidly moving beyond the fossil-fuel based economy of today to the clean, green economy of tomorrow that is fundamental to ensuring a safe and prosperous future for all.

Tosi Mpanu-Mpanu, the lead climate negotiator for the Democratic Republic of Congo, is a former chair of the Least Developed Country climate negotiating bloc and sits on the board of the Green Climate Fund.

First published: Thomson Reuters Foundation.
Off-Grid Living
In the scorching sun, Alphonce Abok keeps an eye on his fields of watermelons growing near the banks of the Sondu River, one of the major channels feeding into Lake Victoria.

"I hope with enough water this time around I will harvest my watermelons," said the farmer from western Kenya. Not so long ago, he said, his efforts failed as he couldn't get enough water to the crop.

In July, however, he purchased a solar-powered irrigation pump that he now hopes will give him a much more reliable harvest.

The equipment, from Futurepump, which imports irrigation kits from India, draws energy from an 80-watt solar panel mounted on a metal frame. The solar power then drives a motor that pulls water from a river, well or storage tank.

Abok used to use a diesel irrigation pump that cost nearly $10 a day in fuel to run, and often drained his budget, as well as being noisy and smoky, he said.

His new $637 pump required a $414 down payment, with $25 a month repayments until it is paid off.

The price tag can make the pumps hard to afford for many small farmers, but Futurepump, based in Kisumu, has set up loan programmes with banks and micro-finance institutions to help buyers acquire the equipment, said Charles Ahenda-Bengo, the company’s general manager.

The firm also hopes to eventually begin manufacturing the solar irrigation kits locally, to help cut costs, Ahenda-Bengo said.

Cheaper than losses

The solar pump was designed specifically for small-scale farmers who can’t afford the irrigation technology used by large farmers, but who increasingly need to irrigate their crops as rainfall becomes more irregular, he said.

So far, the company has sold 200 pumps in Kenya. Another 350 have been sold in other East African countries, Ahenda-Bengo said.

Rachael Opiyo, another farmer who bought one of the solar pumps with her savings this year, fears the high up-front cost may keep many farmers from investing in the technology.

But Ahenda-Bengo said the kit, which is guaranteed for five years, is less expensive if considered over its potential lifespan – and cheaper than losing crops repeatedly.

Joshua Okundi, another farmer who has bought a solar pump, said the device is saving time as well as cash, as the diesel pump engine levels don’t need to be topped up.

"With the solar irrigation pump my work is easier since I don’t have to monitor it every time. I just place the kit in the farm and leave it to continue pumping water," he said.

Government irrigation push

Patrick Nduati, the principal secretary for irriga-
tion in Kenya's Ministry of Water, said the government is not charging value-added tax on such solar kits, and that the country's draft National Irrigation Policy proposes offering more incentives to farmers to buy such devices, including lower import taxes.

Irrigation has the potential to boost and protect production on many small farms, Nduati said. Already the country has about 3,600 smallholder irrigation projects covering 168,000 acres, or about 42 percent of the country's total irrigated area.

But while solar pumps are a welcome addition in Kenya, Nduati said, they have not always worked in conditions where the sun doesn't shine. Farmers like Abok and Okundi believe adding a rechargeable battery to the kit could help solve the problem.

But Ahenda-Bengo said adding more features would defeat the solar kit's purpose by making it harder to transport and use. The current relatively simple kit, he said, is easy for farmers to repair themselves.

Nduati said the government plans to boost agricultural production in Kenya, despite problems with drought, by placing 100,000 additional acres of land under irrigation each year through the year 2030.

That would be managed, in part, by boosting spending on irrigation to around 2 percent of the national budget, and finding new water sources by harvesting rainwater and re-using waste water, he said.

Benson Rioba is a journalist based in Nairobi who writes for the Thomson Reuters Foundation about climate change issues.

First published: Thomson Reuters Foundation.
A borehole dug by herders in a desperate attempt to survive Kenya’s last severe drought has been transformed into a lifeline for thousands of children and animals as a new drought hits, thanks to the addition of solar pumping and water storage.

The well has become an oasis in the impoverished drylands of eastern Africa where charities say back-to-back droughts are threatening the lives of millions of children.

Originally built to meet the needs of 12 herders and their families, the upgraded borehole now provides water for thousands of people and livestock living at the foot of Pelekech mountain in Lokore region in Turkana County.

As a result, herders can bring home their livestock every day to drink water, which they say is a blessing. "It is usually a disaster when animals are taken miles away from home in search of pasture and water because most of our children depend on milk for survival - and if there is no milk, it could mean death for them," said Jacinta Akiru, a 65-year-old mother of five from Lokore.

The Kenya Red Cross Society last month predicted the number of Kenyans without enough to eat would almost double by April to 2.4 million from 1.3 million, mainly in the country’s north and along the coast.

Not run dry
At first, after sinking the well, the herders’ families drew water by hand using a bucket and rope, and could only fetch enough for their immediate domestic needs.

"When we started this project, it was in a desperate move just to see if we could find some little water for domestic consumption," said Angeline Namudang, the treasurer for Lokore Community Disaster Management Committee, the group which sank the borehole.

The herders used to spend weeks or even months away from home in drought periods, looking for water and pasture. They often returned to find their children, left behind with relatives, were malnourished or even dead.

That changed when a solar pump and water tanks were installed in 2013, with the help of international NGO Veterinaires Sans Frontieres Germany. The well now supplies water kiosks and animal drinking troughs in two villages.

"This has been like a revolution to us," said Lotit Agirai, who has six wives and 30 children. "Having access to water for domestic animals closer to home is the best thing that has happened to me," said Agirai, now in his 70s.

He used to trek with herds of livestock more than 30 kilometres across the border to Uganda’s Karamoja area in search of water and pasture.

So far, 625 households are using the water facility. Each household has on average seven members, and about 150 animals, including goats, sheep, camels and donkeys.
Households pay 300 Kenyan shillings ($3) a month for water - 100 Kenyan shillings ($1) for domestic use, and 200 Kenyan shillings ($2) for animal access.

The money pays for maintenance and two watchmen to guard the facility day and night.

The borehole has never gone dry, and is still producing water during the ongoing drought which meteorologists say is the worst since 2011.

**Disease protection**

Access to safe water means fewer cases of waterborne diseases such as diarrhoea, dysentery and typhoid, especially during drought conditions, said Purity Ndubi, the nurse in charge of Waso dispensary in Isiolo County in northern Kenya - another arid part of the country.

"We always have a spike of these cases during droughts," she told the Thomson Reuters Foundation.

The same happens to livestock, according to Johnson Wamalwa, the chief livestock officer in Turkana West sub-county.

"During such periods, many animals from different places share the same drinking points, which makes it easy for infectious diseases to spread," he said.

Thousands of domestic animals have already died in the country’s north because of drought-related diseases, fatigue from trekking long distances, and lack of pasture.

Between December and January, more than 6,000 goats and sheep died of goat plague in Laisamis sub-county in northern Kenya’s Marsabit County, according to Michael Baariu, a local veterinary officer.

The plague is a highly contagious viral disease, and often fatal to sheep and goats.

However, the residents of Lokore are at peace. None of their livestock have died since the onset of the drought in mid-2016.

"We are also optimistic that our children will remain healthy till the end of the drought season," said Akiru.

Isaiah Esipisu is a freelance contributor for the Thomson Reuters Foundation, with an interest in climate change issues.

First published: Thomson Reuters Foundation.
At the end of 2014, the number of displaced people reached an unprecedented 59.5 million, a near 40 million increase in the span of one decade, primarily due to conflict and war. As the number of displaced individuals steadily increases, there is a decline of provisions for basic human needs. Many of these provisions are being met inadequately and inefficiently through ad hoc alternative resources which are usually unreliable and have high potential for causing damage to health and the environment.

Energy access is one crucial provision which demonstrates this issue. Access to clean cooking, lighting, heating, and clean water is essential and one that has huge potential.

The problem
Access to energy is very limited within refugee camps and is an ambiguous topic as there is limited data. In-depth research of energy usage within refugee camps has only recently been accumulated, however it is not sufficient enough for implementation within policies.

Health Issues
- Many refugee households primarily use detrimental forms of fuel such as firewood, LPG, charcoal, or kerosene as a form of energy.
- An estimation of 20,000 forcibly displaced people die prematurely every year as a result of pollution from indoor fires.
- Others suffer from varied health problems such as lung or eye diseases.

Environmental Damage
- There is around 13 million tonnes of carbon dioxide (tCO2), which is emitted from displaced households a year.
- Deforestation is also a major issue: 64,700 acres of forest (equivalent to 49,000 football pitches) are burned each year by displaced people living in camps, often due to a lack of alternative solutions.
- Globally, solid biomass cooking is responsible for 18% of global GHG emissions.

Long-term Camps
- Camps such as Dadaab or Kakuma in Kenya have been there for almost a quarter of a century now with populations of 356,014 and 153,959 displaced individuals.
- The average length of time as a refugee is 17 years (UNHCR, 2004) and they continue to have temporary status.
- Many current energy resources are only viable for short-term camps.
- Long-term Camps’ usage of the current
energy resources causes further damage to health and the environment.

- This is a growing issue as the number of displaced individuals steadily increases.
- Women and girls frequently experience intimidation and violence when collecting firewood. As many as 500 displaced Darfuri women and girls were raped while collecting firewood and water within a five-month period in Sudan (Chatham House).

**Short-term provisions can hinder**

**long-term solutions**

**The solution**

Many organizations have now given new approaches to energy usage, which are more sustainable and are not detrimental to health. UNHCR is recognizing the newer forms and methods of energy production and attempting to modify "in an effort to reconcile its energy practices with the UN’s commitment to carbon neutrality in its operations by 2020" (Chatham House).

**ACE 1 Ultra-Clean Biomass Cookstove**

Introducing efficient and reliable appliances such as the ACE 1 will give refugee camps varied benefits and long-term cost-savings.

- The ACE1 helps deliver:
  - Food security
  - Reductions in CO2 emissions
  - Reduction of deforestation
  - Benefits to health
- Basic electricity for LED lights, mobile phones, etc.

- Gasification; burning a variety of fuels without smoke
- Portability; enabling people to use it anywhere, including in transit.
- Reduction household pollution, diseases, and the risk of house fires.

**Health Solutions**

- Appliances such as the ACE1 are able to provide smokeless cooking, reducing the number of deaths and health problems.
- Reduces lung cancer, acute lower respiratory infection, pneumonia, heart disease, and eye diseases.
- The ACE1 effectively eliminates black carbon emissions, reducing harmful particulates to negligible levels (IWA tested).

**Environmental Solutions**

Displaced individuals rely on local forests to provide them wood to fuel their needs. The consistent use of firewood is supplying to the rapid loss of the woods. Deforestation continues to be a major issue in refugee camps as it is the easiest and most accessible fuel resource.

- The ACE1 requires 70% less fuel to run in comparison to the traditional cooking methods.
- Potential to reduce CO2 emissions by 2-4 tonnes per year.

**Long-term Camps**

- Solutions such as the ACE1 gives camps such as Dadaab or Kakuma an appliance which is durab-
le, reliable, and reduces costs.

- We can improve access and supply innovative, sustainable appliances such as the ACE1 through awareness and demonstrations.
- Giving displaced individuals the option and access can lead to more viable inventions, building more Eco-friendly and healthy societies.
- Distribution of clean cook stoves and fuels will boost gender equality by helping to protect women and children from hardships, protect from sexual assault or abuse and help to empower women.

The distribution of the ACE1 can lead to better lives across many borders, especially within refugee camps. The increase in the number of refugees and displaced individuals are continuously rising and the issues indicated will only lead to further complications. Distribution and guidance of cleaner, more sustainable, and cost-effective solutions are in dire need. Alternative sources such as the ACE1 clean cookstove are able to solve numerous critical issues concerning health, the environment, gender equality, and long-term refugee camps.

Christina van Norden, Marketing and Communications at African Clean Energy.

First published: African Clean Energy.
It is a hot and cloudless morning, a sign that it will be sunny right through the afternoon. Joseph Mailu moves along rows of fruiting mango trees with a long pole in his hand, harvesting the mature fruits.

The succulent green mangoes drop inside a net tied to the tip of the pole which prevents them from falling on the ground and being damaged.

The quality of the fruit is a big concern to farmers and traders hoping to sell to the lucrative export market. But now farmers in Nziu are benefiting from two innovations – solar-powered cold storage, and biological pest control – to help protect their harvest against the effects of climate change.

Even with the careful skills of professional harvesters like 31-year-old Mailu, efforts to access high-end markets used to be difficult for many farmers in Nziu, a village in Makueni Country, some 250 km (150 miles) from Kenya’s capital, Nairobi.

But the new cold storage facility, which preserves the farmers’ highly perishable fruit and stops it from going rotten before it reaches consumers’ tables, is making things easier.

The state Department of Agriculture estimates that 30-50 percent of harvested fruit in Kenya goes to waste due to poor post-harvest handling.

The majority of Kenya’s smallholder farmers lack proper cold storage to preserve the quality or extend the shelf-life of their fruit, leaving them at the mercy of middlemen who buy their produce and earn most of the profit.

With low-cost cold storage, however, about 150 of Nziu’s farmers now can keep their harvest refrigerated while they scout for prospective buyers.

The refrigerator, the first of its kind in Kenya, was built in late 2015 by the Rockefeller Foundation and TechnoServe, a nongovernmental organization, under the YieldWise program, an initiative aimed at cutting post-harvest losses among local mango farmers.

The facility is fitted with four solar panels, an inverter and a car battery which enables it to store power to keep running during the night hours.

Makueni County is semi-arid and hot, especially during the mango harvesting season in January and February, but the cold storage room can reduce the ambient temperature from 35 degrees Celsius to as low as 17 degrees, which slows the ripening of the mangoes by several days.

John Musomba, a farmer in charge of the refrigerated storehouse, said it can store up to 3.4 tonnes of mangoes.

Organic pest control
But mango growers have to contend not only with the heat, but also with pests that can ruin their crops.

Bactrocera dorsalis, a species of fruit fly originating in Asia, has become a huge problem in Africa as a result of the warming effects of climate change.

Leopold Obi
As solar refrigerator keeps mangoes cold, farmers’ profits heat up
The flies are a menace to many mango growers in the region, destroying more than 60 percent of farm fruits and leading to an annual loss of up to $2 billion to farmers across the continent, experts say.

Musomba, who has 2 acres (0.8 hectares) of mango trees, uses several biological control measures to control the flies.

"In the past we sprayed chemical pesticides to control the flies, but buyers turned down our produce due to high chemical residues. But since we switched to organic farming, traders are now trooping around here for our fruits," he said.

Countries like the United States ban horticultural produce from African countries where invasions of the B. dorsalis fruit fly have been reported, said Ivan Rwomushana, who leads the fruit fly integrated pest management program at the International Centre of Insect Physiology and Entomology (ICIPE) in Nairobi.

Rwomushana says ICIPE is training farmers in several biological methods to control fruit flies, including pheromone traps to capture and kill male fruit flies, and parasitic wasps.

Sunday Ekesi, interim director of research and partnership at ICIPE, said the organization is also developing a treatment that involves immersing mangoes in warm water for 45 minutes to kill any fruit flies on the fruit surface.

Mamadou Biteye, Africa regional managing director for the Rockefeller Foundation, argues the Kenyan government should develop policies to support wider use of such interventions. "Farmers don't make any profit if they lose half of their harvest at the farm level, therefore such policies which facilitate access to finance and technology for farmers are very critical," Biteye said.

The foundation is investing $130 million over the next five years to support post-harvest management initiatives.

The farmers in Nziu know how valuable that could prove.

"With the organic control interventions in addition to the cold storage facility, I now harvest and sell 250 tonnes of mango fruits in a year," Musomba said – more than twice the 100 tonnes he harvested two years ago when these tools were not available.

Musomba says that the farmers in the collective who use the cold storage facility can sell their mangoes for 20 Kenyan shillings ($0.20) a kilo, far more than the 2 shillings per mango that they used to get when selling hastily to brokers before the fruit could rot.

Leopold Obi is a freelance journalist based in Nairobi, Kenya, specialising in agriculture, food security and climate change.

First published: Thomson Reuters Foundation.
Daniel Lin

How a Pacific island changed from diesel to 100% solar power

On a recent Wednesday evening on the island of Ta’u—one of the outer islands in American Samoa—most of the people in all three villages are at pese—or church choir—practice. The annual island-wide youth group showcases are coming up and each choir senses the pressure of having to perfect their routines.

For the Faleasao village choir, there is added pressure from being the smallest village on the island. But this year, the underdog choir believe they have a special routine that will blow away the competition. Their secret weapon: Disney’s Moana. Specifically, an adapted version of the song "We Know The Way," complete with synchronized dance moves to mimic life as voyaging islanders.

In a nearby home, a TV is tuned to a local Samoan news station, but the sound is muted. The only noise is the low humming of a box fan and the distant singing of the village choir. Musu Fuiava Mutini happily hums along, glued to her tablet device. Mutini, 82, is a village elder who has seen her home change immensely through the years.

"Before, there used to be lots of people living here," she says. "But in the time of Hurricane Tusi in 1987, everything was destroyed. Most people moved away, to Pago Pago [capital of American Samoa] or the U.S." She pauses and sighs, caught in a distant memory. "This island is very different now."

In many ways, islands like Ta’u are a microcosm for our planet. Space and resources are both limited and the success of human communities depends on the effective management of these critical components. In looking toward a more sustainable future, the hundreds of residents of Ta’u have put their faith in a new solar energy project, which some say they would like to see replicated around the world. (See how Pacific islanders are living with climate change.)

The solar revolution

In November, Ta’u saw the completion of a new solar-powered microgrid, which shifted the entire island’s energy generation from 100 percent diesel fuel to 100 percent solar. (The island’s population varies with the season but usually falls between 200 and 600 people.)

The solar project was installed by SolarCity, a California-based company recently purchased by Elon Musk’s Tesla. The $8 million project was funded by the U.S. Department of Interior and the American Samoa Power Authority (ASPA).

Located on seven acres of land on the northern coast of the island, the system includes 5,328 solar panels, generating 1.410 megawatts of electricity. The energy can be stored in 60 Tesla Powerpacks—large batteries that allow Ta’u to stay powered for up to three days without any sunlight.

Installation of the panels wasn’t easy—Ta’u is some 4,000 miles from California. Extra considerations had to be made for the island’s extreme humidity and likelihood of severe tropical storms.
As a result, the system was built with the capability of withstanding Category 5 hurricane winds.

The last time Ta’u underwent an energy revolution was in 1972, when ASPA constructed a diesel power plant and provided island-wide electricity for the first time. Prior to that, kerosene lanterns were the primary source of evening light. For the few families who could afford it, small home generators were a luxury. For everyone else, life moved at a slower, simpler pace.

Introducing diesel generators to Ta’u essentially introduced a new way of life. Suddenly, lights turned on with the flick of a switch and the list of activities around the villages and inside homes increased drastically. With electricity also came new ways of preparing and preserving food, thus changing local diets. Pretty soon, the loud humming of diesel generators became a part of the island’s soundtrack.

The modern island dilemma

Even with the relatively small amount of energy consumers on Ta’u, the offset of fossil fuels from switching over to solar power is significant: about 110,000 gallons of diesel, not to mention the amount of fuel it takes for shipping. These numbers can make a strong argument for bringing these types of renewable energy projects to island communities, but the reality is that there is still trepidation around the idea of uprooting the status quo.

“There are islands that have conferences upon conferences where all they talk about is sustainability,” says Danielle Mauga, one of ASPA’s engineers, when asked about the decision to proceed with this multi-million dollar project.

“A lot of other islands are working towards the same goal, yet this island has managed to achieve a major milestone by being able to claim energy independence with solar power,” says Mauga. (Learn about a solar microgrid in Haiti.)

Aside from the environmental concerns of burning diesel fuel, another side effect was the loss of the self reliance of old. Instead, people on Ta’u relied on the shipment of food, supplies, and drums of oil.

That left them at the mercy of shipping schedules. Although a supply vessel is supposed to arrive every fortnight, delays due to weather and mechanical problems are frequent, sometimes even stretching for months. Rationing of food and fuel is a regular occurrence.

Many other Pacific islands face the same reality of dependence on imported goods and energy.

The community perspective

But since switching over from diesel power to solar power, life on the island of Ta’u has gone on as usual. People in all three villages resumed their daily routines—work, tending to the plantation, going to church, resting, repeat—without missing a beat. In fact, when ASPA and SolarCity officially “flipped the switch” for the solar power plant (and simultaneously switched off the diesel generators) in November, the lights around the island barely flickered.

When the diesel power plant was built over four decades ago, the changes were immediately felt by the community. This time, the new solar facility—though just as monumental of a technological shift—does not have the same life-changing sensation for consumers of the public utility. Switching from kerosene lanterns to a light switch is a much more obvious disruption to daily island life than switching from diesel to solar power.

But this is exactly what makes the Ta’u solar energy project a success, say the project’s backers. People can go about their normal routines without any interruption, even though everything has changed behind the scenes.

And yet, it seems as though everybody on this little island is aware that they are a part of something special. Ask anyone in Ta’u what they think about the project and they will probably mention one of two things: relief that they no longer have to rely so heavily on unreliable shipments of fuel, and an understanding that 110,000 gallons of diesel fuel is no small amount.

The project has also seemed to sow the seeds of sustainability. In the island’s classrooms, children yell out buzzwords like “Going Green” and “Saving the Planet” when asked to reflect about solar energy, while adults see it as a boon that will save them money and stress in the long run.

Looking up from her tablet, village elder Mutini says the solar panels may help brighten the future of the island. “I think these new changes to the island are good blessings,” she continues. “Maybe the changes will bring more people back here again.”
A roadmap for the future?
Just as ancient Polynesians once viewed the ocean as a set of pathways between islands, Samoans today also have a deep sense of interconnectedness with the world beyond their shores. Technology, connectivity, and travel options have improved exponentially, thus making the distance between even the remotest islands seem closer than before.

The solar project on Ta’u may also help inform conversations that are taking place on other islands around the world. Communities want to know if renewable energy is worth the investment, if the technology is reliable, and if people will respond well. Ta’u’s elders hope their future will more closely resemble their distant past, when people were self-sufficient and living in harmony with their environment.

Dan Lin is a regular contributor to National Geographic and the Associated Press.
First published: National Geographic.
Elisa Wood

Resorts that use solar plus storage: When the scenery’s right and the grid isn’t

The Nicaraguan resort Rancho Santana has won accolades from the travel press for being world class; problem is, the local electric grid is not.

Located on 2,700 acres, a three-hour drive from the airport on the remote Pacific Coast, the luxury resort is connected to a central grid that offers spotty and expensive power. Nicaragua is a nation that’s been notoriously slow to fully electrify. Only 77 percent of the population has access to electricity, up little from 71 percent in 1990, according to the World Bank.

The solution? Rancho Santana will soon join the growing number of resorts that use solar plus storage and other microgrid-like solutions.

Resorts may not be the first candidates that come to mind for microgrid-like solutions. The technology tends to be associated with critical facilities – like hospitals, military installations or data centers – or electrification for the poor in places like rural Africa and India. But resorts that use solar plus storage are on the rise, as remote vacation spots try to attract green leaning patrons and guarantee their comfort.

Richard Branson’s Necker Island microgrid is probably the most publicized. But there are many other examples, as different as New England retreats and African luxury outposts.

At Rancho Santana, a local energy performance contractor PELICAN introduced the idea to the resort’s management. PELICAN will install an 800-kW PV system that will be integrated with a 200-kW (four-hour) flow battery by Texas-based ViZn (pronounced ‘vision’) Energy, along with back-up diesel generators. The system will use controls by Japanese manufacturer IHI.

“Our annual utility expenses are growing and we are exposed to significant peak demand charges, so we had to find a way to sustainably reduce our energy costs without impacting the sensitive environment at the resort,” said Rancho Santana CEO Matt Turner.

The solar plus storage system will help the resort save more than $250,000 per year on utility bills, according to Turner. “Using the non-toxic ViZn batteries for the energy storage not only alleviates any of the environmental concerns, but also provides excellent ROI,” he said.

Mike Grunow, vice president of marketing for ViZn Energy Systems, said that the project was originally intended to be solar alone. But upon examining the load shape, the developer saw strong cost advantages to adding storage. The facility faces tremendous spikes in electricity costs from 6 to 9 p.m. when demand rises because residents arrive home and turn on their air conditioning and electronics.

The solar plus storage system will allow the resort to charge up during the day with the solar panels and then discharge the energy in the early evening, limiting the resort’s need to rely on grid power at a time when it is exceptionally expensive.
The developer expects to install the system this summer and achieve a project payback in six and a half years. The resort will fully own the system. ViZn will provide a 20-year maintenance contract on the battery.

"Electricity in Nicaragua is amongst the most expensive in Latin America and many C&I customers there are on a grid tariff with a peak rate between 6 pm and 10 pm when the energy usage spikes," said Ron Van Dell, ViZn president and CEO. "There is also no net metering for excess solar electricity, so our four-hour battery is a strong match for the market because it enables customers to install larger PV systems, get significantly cheaper energy than the grid rates, and mitigate elevated energy and demand rates during the evening network peak."

ViZn describes its energy storage system as a self-contained solution that does not require cooling systems and experiences zero capacity fade over 20 years. The flow battery also can perform both rapid, high-power discharges and slower, long-duration releases at lower power, ViZn said. This allows the battery’s users to stack applications and incorporate multiple value streams.

A nine-year-old company, ViZn also is providing a 2-MW flow battery – the largest in North America – for a project underway with the Ontario Power Authority.

Elisa Wood is the chief editor of Microgrid Knowledge.com.

First published: Microgrid Knowledge.
T he off-grid energy sector is well-equipped to talk about the customer value proposition or social impact to end-users of access to modern energy. What has been lacking is robust, credible, evidence on this. That's not to say that there has not been a lot of work by social enterprises, NGOs, and donors to understand the impact, but that there has been a lack of academic research to assess this. This has sometimes meant that it is harder to influence policy, direct funding or investment, and attract capital into the sector confidently.

Back in 2012, SolarAid set up their Research & Impact department and started the task to do just this. Getting feet on the ground to listen to people living off-grid, reaching out to customers using solar lanterns, and setting up large-scale research projects with key players like Stanford, Berkeley, and UNCDF to start answering the bigger questions around the links between solar lighting and poverty, education, health, and movement up the energy ladder.

In 2016, Acumen rehomed this work as an opportunity to continue Acumen's work in energy and continued focus on this sector. Acumen have been investing in energy since 2007, making more than 20 investments in companies providing access to brighter, cleaner, cheaper, safer energy solutions from biomass-powered mini-grids to pay-as-you-go solar home systems to improved cookstove designers and distributors.

Acumen recently launched the Energy Impact Series which will share the results of this academic research work, ending with results of Acumen's Energy Lean Data project. This is Acumen's first deep-dive into a specific sector, looking at the impact of energy access using the GOGLA harmonized impact metrics or the GACC indicators alongside other questions developed by the Lean Data team at Acumen.

The first results shared are from the research conducted by ETH Zurich with 1,400 households in rural Kenya. The key findings?

1. Solar lanterns save low-income customers money from diverting spending on baseline methods such as kerosene for lamps, batteries for torches, or candles. Families in the study halved their monthly spending on energy saving 1-2% of total household spending. A small but significant change for those living on less than $3.10 per person per day.

2. Low-income customers are highly price sensitive; we knew this intuitively, but the research shows just how much small changes in prices disproportionately change purchase rates.

3. While customers are sensitive to price, their spending on energy is inelastic as it is seen as a necessity. This is highlighted by the fact that the poorest households spend a large amount of their income on energy – around 10% for the poorest families.

4. While there is often concern that products
or services given free are not valued by customers and therefore behaviour may not change, this study found that solar lights were universally accepted and adopted. Participants in the study had similar usage patterns regardless of whether they received the light free or purchased it.

Do solar lights dramatically reduce poverty? No, probably not on their own, but they can reduce energy poverty, and they can certainly contribute to opportunities for families to redistribute income to more immediate needs such as food, or more developmental desires such as spending on education and health.

Kat Harrison is Associate Director Impact at Acumen.
First published: Acumen.
Mary Atieno was often forced to sell her tilapia well below the market rate because she had to get rid of the fish quickly in the searing heat bearing down on her village on the shore of Lake Victoria. Lack of electricity meant Atieno was at the mercy of commercial fish buyers and made little or no profit because she could not refrigerate her catch of tilapia and Nile perch.

Poor rural communities, like Muhuru Bay in western Kenya where Atieno lives, are often far from markets where they can sell their produce and lack basic infrastructure and electricity despite rapid electrification elsewhere in the country.

Atieno’s fortunes changed when British-based charity Renewable World joined forces with community groups and a private company to set up solar micro-grids, small local power networks not connected to the national electricity grid.

With a grant by British charity Comic Relief, fishing cooperatives in the area received solar freezers to chill their catch rather than having to resort to preserving it with smoke, a practice that makes the fish more chewy and harder to sell.

"With the deep freezers, we can store fish for up to four days while we source for a profitable market," Atieno, a 43-year-old married mother of four and secretary to Ngore Mtakatifu Women Group, told the Thomson Reuters Foundation.

With its year-round sunshine, solar power is ideally suited to Kenya where electricity access surged to around 60 percent in 2016 from 27 percent three years before, according to government data, due to a drive to achieve universal access by 2020.

Remote areas such as the lakeshore settlements on Lake Victoria lag behind though, experts said.

"For a long time, some of these settlements along the lakeshore have been neglected," said Herick Othieno, a solar energy expert at Maseno University in Kenya.

"It's only recently that power started getting there," said Othieno, who led the creation of Renewable Energy Solutions for the Lake Victoria Environment (RESOLVE) with Renewable World and its local partners.

Soil in the area is poor and hard to cultivate, leaving commercial fishing in Africa's largest lake as one of the few alternatives to make a living.

Increasing access to solar power is helping to lift local people out of poverty by improving their income and sparking business opportunities beyond fishing, experts said.

Community power

The Muhuru Bay community solar hub is one of six that RESOLVE established on the lakeshore, with their power capacity ranging from 1.5 to 2.0 kilowatt (KW) which can be expanded and support up to 50 connections.

Users pay a connection fee and are charged by
the hour for using the technology as part of a pay-
as-you go system for off-grid electricity that has
become popular across Kenya and many other
countries in sub-Saharan Africa.

Thirty households are connected to the system
in the Muhuru Bay area, managed by community
organisation Ngore Renewable Energy and Auxilia-
ry Project (REAP) and benefitting 1,400 people,
including small businesses.

"We also have some running barber shops and
phone charging businesses with the solar power," said Lucas Okoth, REAP’s chairman.

The micro-grids installed by Renewable World
are simple steel frame structures that hold the
solar panels and a control box housing batteries, a
charger and energy distribution systems.

Each grid has a smart meter connected to mo-
bile phone-based money transfer service M-Pesa
through which customers make their payments
before they are transferred electronically to the
solar hub’s bank account.

The fishermen have also been able to cut costs
by using solar rechargeable lamps on their boats
during night time fishing.

They now spend 200 Kenyan shillings ($1.94) a
day, a quarter of what it used to cost them to fuel
their fishing lamps with kerosene, said REAP’s O-
koth.

Villager Lovis Odhiambo said his home is
healthier since he has become a customer as he no
longer has to use sooty and smokey kerosene
lamps and his children are more comfortable stu-
dying at night thanks to solar lighting.

It is also cheaper - he used to spend 50 shillings
a day on paraffin compared to the 200 shillings he
now spends every month on solar power.

"The table cloths were always dirty with soot
and the smoke was irritating to the eyes. Some-
times it felt like we were short of breath and the
house would smell of the paraffin," said Odhiam-
bo.

A solar "graveyard" no more

The amount of solar energy captured into the
national grid is currently negligible despite the
government’s call for investments in renewable
energy sources.

Kenya’s Energy Regulatory Commission (ERC)
identified high initial capital costs and low awaren-
ess of the potential opportunities and economic
benefits offered by solar technologies as some of
the reasons.

Some projects also fell into disrepair despite
receiving large subsidies.

"In the past they used to say Africa was a 'gra-
veyard of failed solar projects' because of all the
100 percent subsidised installations which broke
down and never got fixed because no mechanism
was put in place for operation and maintenance," said Charlie Miller, director for national pro-
grammes at Power for All.

"That’s really starting to change now," said Mil-
er, whose coalition of more than 170 public and
private organisations campaigns for universal
energy access by 2030.

Moraa Obiria is a freelance contributor for the
Thomson Reuters Foundation, based in Nakuru,
Kenya.

First published: Thomson Reuters Foundation.
Imagine for a moment that the light used in your home was a poison. One that could damage your lungs, irritate your eyes, even impact the health of your unborn child. You’d think twice about flicking on that switch. Kerosene lamps—used by an estimated 290 million people across Africa—contribute to household air pollution. Such pollution is responsible for more deaths a year than tuberculosis, malaria and HIV combined.

Fortunately there is a solution that promises to make a big impact on improving household air quality. Solar products such as lanterns and rooftop systems offer a pollution-free, cost-effective alternative for lighting homes through the night. They can replace dimmer, older, dirtier forms of lighting, such as kerosene, which expose users to potentially severe health risks from smoke and soot. Solar is becoming increasingly popular in developing countries, led by the success of Acumen investees such as d.light, SolarNow and Dergy amongst others.

Despite decades of kerosene fuel usage, it is only relatively recently that there has been a recognition that smoke from kerosene lamps and cookstoves might present a serious health risk. Studies have associated kerosene use in homes with tuberculosis, and poor neonatal and maternal health. As a result the fuel is strongly discouraged by the World Health Organization (WHO) for household use.

While we know solar holds incredible potential for the poor, there is little research on how switching from kerosene to solar impacts a family’s health. In partnership with SolarAid and researchers from the University of California, Berkeley, and with funding from Google, we set about addressing this gap in knowledge. Our study in Busia County, Kenya, was focused on quantifying changes in exposure to fine particulate matter (PM), a common air pollutant, and carbon monoxide (CO) following a switch from kerosene to solar.

The study used a range of methods to measure exposure. These included traditional survey-based data collection but also a range of sensors that gathered precise information on pollution levels. Devices were fitted to kerosene and solar lamps to monitor duration of usage. Temperature changes were used to record the use of kerosene lamps. Solar lamp use was tracked by a sensor connected to the on/off switch. Instruments were fitted across the house to measure household concentrations of both PM and CO. And to measure personal exposure to PM and CO, two participants—typically the mother and a school pupil—wore vests containing light-weight monitors for 48 hours.

Here’s what we learned:

Kerosene users believe the fuel affects their health. More than nine out of ten of all household members said that kerosene lamps affected their breathing. A quarter of adults reported wheezing and three fifths of the children reported waking up at night to cough. Every child we spoke to complained that smoke in their eyes made it harder for them to read.
People prefer solar to kerosene. Our study gave three solar lamps to kerosene-using households. One month later, sensor-based measurements indicated that all houses had reduced their use of kerosene lamp by at least 90 percent, indicating a clear preference for solar above kerosene. Measurements also showed that this transition was rapid, occurring within days of receiving the solar lamps.

Solar users experienced a meaningful reduction in exposure to household air pollution. Prior to the introduction of solar lanterns, kerosene use was associated with substantial exposure to PM in both adults and schoolchildren. Reduction in exposure following the distribution of solar lamps averaged 73 percent among schoolchildren and 50 percent among adults. This finding is encouraging. This was a relatively short study, but if solar lamps continue to be used in place of kerosene lamps, it is likely that there would be health benefits as a consequence of the reduction in air pollution.

Achieving a "safe" level of exposure to pollution would require reducing use of other dangerous fuels. Unfortunately, kerosene is not the only potentially dangerous fuel the poor use on a daily basis. Our study found that, according to WHO standards, adults who made the switch to solar were still exposed to an unsafe level of pollution in their homes. This was in large part due to the use of "traditional" cooking stoves—open fires, typically burning wood or charcoal—which are also a major contributor to household air pollution. Therefore to achieve acceptably low levels of exposure for everyone in the family, it will be necessary to reduce other sources of pollution alongside kerosene.

To our knowledge, this is the first study of its kind to look specifically at the dangers of kerosene. By comparison, the negative impact of cooking indoors with firewood and charcoal has been studied extensively. This research is an important first step towards understanding how kerosene affects the health of low-income families. We believe that these lessons are vital for governments, businesses, and members of households responsible for making decisions that will impact the health and well-being of their families. If we want to reduce the scourge of household air pollution, it is essential to eradicate the use of kerosene. To that end, solar energy is our best bet.

Kat Harrison is Acumen’s Associate Director of Impact.

First published: Acumen.
The more central energy is to our lives, the more crucial it is to provide equal access and distribution for all to secure Kenya’s future.

Increasingly, what we are realizing is that this accessibility is made problematic and the lack of it exacerbated by the growing poverty gap in spite of modern technological advances.

Yet, access to electricity remains one of the foremost indicators of advancement and equity in many developing economies.

Sustainable development in any society is dependent on equitable distribution of resources — key among these being energy — and we must be sure of our capacity as a country to provide this in order to realize our own development goals.

Ensuring economic sustainability means increasing the participation of women, mainly affected by poverty, in economic activities geared towards improving our livelihoods and GDP.

However, because poverty is gendered, it means that currently the reality is that men and women do not have equal access to energy.

The division of labour which is also gendered, is also a major contributor to the energy poverty because of historical perceptions of Women’s labour and contribution to the economy VIS a VIS that of men.

The division of labour determines who accesses energy and whose labour is given priority in terms of energy consumption. This has an impact on skill enhancement, capacity to produce or grow labour and the gains expected.

Kenya is one of the countries in Africa that has shown leadership in embracing renewable energy and dedicating substantial resources towards finding sustainable energy solutions.

We have seen deliberate efforts to encourage accelerated investment in renewable energy development for instance, by formulating a feed-in-tariffs policy for independent power production in clean energy.

But how do we ensure equitable distribution of renewable energy once we increase production? How do we use renewable energy as a vehicle for equitable growth across the country? By focusing on women’s access and consumption of it.

According to the United Nations, women spend an approximate 14 hours a day on both economic and domestic tasks. On average, they take up 53 per cent of the total burden of work in developing economies.

This is more evident in rural areas where women will spend their long hours tending to their families both as bread winners and caretakers.

Giving these women access to energy, through renewable energy, means preserving their human capital and consequently improving the quality of their lives.

Strenuous tasks such as water hauling, cooking and cleaning chores, for example, will be made more manageable, increasing these women’s capacity to be more productive for their own development and that of their families.

A 2013 World Bank study showed that 80 per cent of farmers in Kenya are women and a good number of them are either the main bread-earners...
or contribute significantly to the well-being of their families through their farming activities.

However, agri-business has over the years faced a lot of challenges especially with harsh weather and unpredictable weather conditions, high cost of input and transport as well as high cost of energy.

This has negatively impacted the land and labour in agriculture and for women especially, the possibility of earning substantial incomes through farming.

The introduction of renewable energy solutions however has come as a relief for some of them. Not only is it more affordable, but it offers a way for them to mechanise some of the farming activities that are laborious and lengthy.

Phylis Wakiaga is the CEO of Kenya Association of Manufacturers.
First published: Business Daily Africa.
Does providing energy access improve the lives of women and girls? Sort of.

Lessening the burdens of women and girls in energy poor communities takes much more than simply giving them access to improved energy sources.

We’ve all seen the photos of women and girls in developing countries carrying large bundles of wood on their backs, transporting the fuel they need over long distances in order to prepare meals for their families.

Women are recognized to be more prone to the burdens of energy poverty because they’re responsible for tasks that would be made easier and safer if they had access to better energy sources, like liquid petroleum gas (LPG), modern cookstoves, and electricity. These tasks include cooking, small-scale agriculture, and participating in income-generating activities. So, if the burdens of energy poverty on women and girls are so clearly recognized, it’s easy to assume that simply providing access to these sources will make their lives better.

A literature review I recently did looks at whether providing energy access to women and girls is proven to actually help them. What I found is that it’s a complicated issue. Although there is some evidence of women benefitting from access to energy sources like electricity and modern cookstoves, there are many other barriers that prohibit full relief from energy poverty, even once energy access is established.

Here are some of the interesting findings from the literature review that explain why providing energy access to benefit women and girls’ lives doesn’t always lead to desired changes:

1. Households still use traditional energy sources, even when they have access to improved energy sources. Previously, it was believed that as a family’s income rises, they move up an “energy ladder,” gradually adopting more improved energy sources. The reality is that families combine the use of traditional sources with improved sources as their income and access increases, to either save on costs or due to preferences.

2. Men’s decision-making power in many families means that they get to decide what the energy is used for. Due to gender inequality in much of the developing world, often only men have a say in what types of appliances are purchased once access to improved energy sources is established. This may mean that, even with electricity access, women can’t use the electricity to ease the burden of cooking or their other tasks. Men often see energy as a way to increase leisure time and quality of life, and to help their children’s educational success, and they may make purchasing decisions based on these views.

This doesn’t always help women, who often view improved energy access as a means to reduce their workload, improve health, and reduce expenditures.
3. **Energy access doesn’t change the fact that women are mostly responsible for household tasks.** Even if improved energy access does lessen women’s burdens in fulfilling their household responsibilities, energy access itself doesn’t mean that women are no longer responsible for those activities. So, it is important to acknowledge that energy access doesn’t lead to a more equitable division of responsibilities around the house.

4. **Sometimes, improved energy access means that women have less leisure time than they did before getting access to that energy.** Electricity in the house means that the time to complete household tasks for women is essentially extended. It was found in many circumstances that rather than spending the evenings relaxing, as many men do, women in electrified households spent is working on their microenterprises. Although the flexibility that comes with more time to complete work can be seen as a good thing, it is important to realize that access to electricity often means women work more, not less.

So what does this mean for how energy access projects should be designed? Here are three recommendations based on the complexity of the issue:

1. Energy access projects should involve women in their design and execution.
2. Project designers should also account for local cultures and contexts when thinking about energy access projects.
3. Energy access programs should be combined with other development objectives, like access to credit for women, economic growth more broadly, and – probably most relevant—women’s empowerment.

Rebecca Rewald is the Coordinator for Aid and Agriculture at Oxfam America.

First published: Oxfam America.
In May, a 2 MW solar plant was commissioned to supply power to the Azraq refugee camp in Jordan. The plant, funded by the IKEA Foundation, will supply free power to Syrian refugees fleeing the brutal, 6-year civil war. A similar project is underway to power the Zaatari refugee camp, the biggest refugee camp in Jordan.

UNHCR, the United Nation’s refugee agency, described the solar plant’s impact on the residents through the words of a refugee named Fatima, a 52-year-old single mother from rural Damascus.

“In Syria, we were used to a particular lifestyle, and then we were disconnected from it when we became refugees,” she said. “For someone who is used to having electricity, you cannot imagine how difficult it is to live without it.”

“Before [the solar plant], when we cooked a meal we had to throw the leftovers away because there was no safe way to store food,” Fatima explained. “When we got too hot, we had to pour water on our clothes to keep cool. Now we can listen to music or have a cold glass of water, and daily life no longer ends when the sun sets.”

90% unelectrified

The Moving Energy Initiative, a collaboration seeking to meet the energy needs of refugees and internally displaced people, estimates that 90% of all refugees in camps do not have electricity access. Of the 17 million refugees in 2016 under the UNHCR’s mandate, 50% were living in private accommodations, 25% were in refugee camps, and 20% had an unknown living status.

Limited and short-term funding remain one of the main challenges inhibiting energy access in refugee camps. A lack of funding has inhibited the UNHCR’s work in providing energy access as the available funds have gone first to more immediate medical and food needs. The UNHCR’s operations in Syria and South Sudan, which together account for 40% of the 17 million refugees, were short 10% of the required funds for operation.

Host governments often do not want to encourage permanent construction within the camps; instead, governments take the politically expedient option of treating the camps as temporary, overlooking the reality that the average refugee spends 17 years in a camp.

Building a solar system or perform proper long-term maintenance on solar lighting and efficient cookstoves requires multi-year funding and planning. This kind of long-term is challenging to facilitate in refugee camps.

Lowering costs, improving safety

Nearly 85% of the 24 refugee camps run by the UNHCR use diesel generators to meet some or all of their administrative power needs. In the Dadaab refugee camp in Kenya, camp administration and infrastructure alone account for around 20% of total energy spending each year. Given the high cost of diesel, many camps can utilize solar and battery storage to lower the energy costs of their administrative operations.

Owen Grafham, Project Manager at Chatham House, informed pv magazine about recent deve-
Developments using solar to displace diesel generation. "We are soon starting a project working with International Rescue Committee in Kakuma Refugee Camp in Kenya to shift health clinics serving refugees and the host community from diesel to solar power. This will show that renewable energy technologies can save money that can instead be reinvested in other vital services."

For the refugees living in the camps, the introduction of efficient cookstoves and solar lanterns will also improve their health and safety. Based on the World Health Organization, an estimated 20,000 forcibly displaced people die prematurely every year as a result of pollution from indoor fires. Efficient cookstoves reduce smoke and indoor air pollution while cooking.

Since the cookstoves use less wood, they also require the collection of less firewood. Firewood collection is done principally by women and is a dangerous task. A study conducted by Médecins Sans Frontières, an international humanitarian organization, found that over a five-month period in Sudan, 500 displaced Darfuri women and girls were raped while collecting firewood and water. Solar lighting within refugee camps can also improve safety and lifestyles as many refugee families choose to stay in their tents when darkness settles.

Lost liberty

In many countries, the refugees' legal rights are few or non-existent. Additionally, it is common for refugees living in camps to need a travel permit to move outside of the refugee camp.

Refugees cannot legally work in most countries, which often results in a black market for labor where refugees are paid substantially less than citizens. The lack of legal rights and the inability to work depresses their incomes making it even more difficult to access advanced energy services.

Uganda is the best example of a country that empowers refugees by allowing freedom of movement and work. The Refugee Studies Centre in Oxford recently found that in Kampala, Uganda's capital, 21% of refugees run a business that employs at least one other person. Around 40% of those employees are Ugandan citizens. This study and others have shown that restoring rights to refugees not only improves their lifestyle but also the lifestyles of the host country's citizens.

Daniel Zubke is Off-Grid Correspondent.
First published: PV Magazine.
Gita Devi lives with her family of seven in Kargara, a small and remote village in the Sonbhadra district of Uttar Pradesh. On a typical day, she wakes up at the crack of dawn to collect firewood for cooking. She walks nearly four kilometers from her home to reach the closest patch of forested land.

The forests have thinned over the years, making it harder for her to find sufficient firewood. Gita returns after an hour and a half with barely enough firewood to last her family two days. She then spends an hour cooking on a smoky clay stove, with equal amounts of firewood and dung cakes, after which she begins cleaning the copious amounts of char left behind by the biomass fuels. The afternoon is spent preparing dung cakes for the next day.

The rest of Gita’s day is spent collecting water, preparing the next meal and completing other household chores. Rather than accompany her brothers to school, Gita’s six-year-old daughter helps her mother with these chores, and takes care of her ailing grandmother.

Time poverty and gender disparity
Gita’s narrative reflects that of many women in rural India. A recent study by OECD found that women in India work nine hours a day on average, compared to seven hours a day for men. Most of this time is spent on unpaid activities, such as household work and caregiving for the elderly or for children, leaving little time for paid labour or social and leisure activities. This scarcity of discretionary time is referred to as ‘time poverty’.

While unpaid labour by women is a global phenomenon, the problem is particularly acute in India, where women’s unpaid labour hours are second only to women in Kazakhstan, and the tasks performed by them are particularly intense and arduous, such as carrying water and chopping firewood.

Tackling time poverty of rural women is an important lever in closing a larger gender gap. Women’s time poverty and their status in society are intertwined. The huge burden of unpaid labour placed on rural women’s time is a manifestation of gender disparity in rural India, stemming from strongly enforced gender norms.

Unpaid work, such as household chores, is not accorded much value, economic or otherwise. It becomes the responsibility of those with lower status within the household, who are typically women and children. The burden of this work limits women’s ability to participate in paid labour (which contributes to the economy of households) or in social activities (which improves their standing in the village), thus feeding back to their low status.

Cooking and related activities, such as gathering fuel and cleaning utensils, constitute a substantial part of this unpaid labour. During the course of a study on understanding energy uses and sources from the customer’s perspective in rural Bihar and Uttar Pradesh, we at FSG, realised that rural women were spending nearly four-and-a-half
hours every day on cooking and related activities. This translated to over a quarter of their waking hours, or half the total time spent working by Indian women. Much of this stems from a single, critical choice: nearly 80 percent of women in rural India use free biomass fuels such as firewood, dung cake and agricultural waste, as their primary cooking fuel. Free biomass fuels take time to gather and prepare, and are highly inefficient to cook with.

A clean solution
The solution may lie in time-saving clean energy applications for cooking, such as LPG [1], electric cookers and solar cookers. But the potential of these clean energy applications as a means to address time poverty for rural women has either been underestimated [2] or overlooked [3]. This knowledge gap raises a pertinent question: What is the true impact of clean energy use for cooking on rural women’s time poverty?

We found that women using LPG for cooking spent three hours less than those who used solid biomass fuels. We compared the time saving stage by stage, in order to arrive at a more representative estimate of the time saved by LPG users, as compared to biomass fuel users.

LPG users saved the one-and-a-half hours otherwise spent gathering cooking fuels. We found that roughly two-thirds of households used a combination of two or more biomass fuels for cooking, as they lacked energy security and preferred multiple options for cooking fuels, in case of shocks to availability or affordability of a fuel. Therefore in addition to gathering and chopping firewood, women in these households also gathered and prepared dung cakes.

While studies have shown LPG to be more efficient, saving most rural women an hour of cooking time, what is less known is that LPG users also save an additional half an hour on cleaning utensils.

Reducing time poverty is a strong marketing proposition that appeals to rural women
It is evident that clean energy applications for cooking have the potential to substantially reduce time poverty for rural women. But despite its promise, clean energy use for cooking remains limited. A study in South Asia concluded that LPG is an aspirational product and it would be the first choice of cooking fuel for almost all women; how-

Figure 1: Typical allocation of waking hours by biomass fuel users and LPG users [4]
ever, uncertainty over its availability, high cost, difficulty in cooking traditional food items, and concerns around safety were limiting its wider adoption.

FSG’s research found that even though the number of LPG adopters has increased sharply over the last three years, largely owing to the government’s Ujjwala scheme, many beneficiaries dropped out after their first cylinder because they were unable to afford regular use of LPG.

There was little awareness about solar cookers among rural households in the sample, and while a few households had seen electric cookers, these were found to be unviable due to unavailable or unreliable electricity supply.

It is important to shift the narrative and view access to clean cooking energy as a gendered issue. Clean energy applications for cooking have long been ‘sold’ to rural households with the premise of better health and no indoor pollution. Our research found that reduction in time poverty, and the associated drudgery and discomfort, were more tangible benefits that resonated with rural women.

The evidence presented here calls for a concerted effort from all stakeholders to address the awareness, access and affordability barriers that prevent adoption and continued use of clean energy in cooking, and to reach women (and their families) with a new value proposition: solving the problem of time poverty.

[1] LPG has been included in the category of clean energy applications as it burns relatively cleanly with no soot and limited sulphur emissions. It is included in the Government of India’s clean energy initiatives as well.


[4] Assumes that the total number of waking hours is 16.

Akshay Kohli is a Consultant at FSG based in the Mumbai office. Chandrima Das is an Associate Director at FSG in Mumbai.

First published: idr. Indian Development Review.
One thing is for certain: the women of Inga are self-sufficient. They grow avocados, oranges, bananas, cassava, nuts and beans. They harvest medicinal plants to tend to their sick. Nearly everything they consume comes from their own land.

These women work hard to make ends meet; their husbands are unemployed and agriculture has become their only source of income. They have been abandoned by the Congolese government and starved of essential services, including water, energy, schools, hospitals and roads. Yet these women have been able to survive for decades because of the river and forest.

And though their industriousness is impressive, they have been waiting for decades for promised electricity and jobs that would make their lives easier.

These women live near the Inga Falls, rapids on the Lower Congo River in the Democratic Republic of Congo. In the 1970s and ’80s, the Congolese government built two large dams, Inga 1 and 2, to harness power from the river. The government promised the dams would bring jobs and electricity to villages in the dam’s vicinity. More than four decades later, neither has materialized.

“They give jobs to people from far away, not to our husbands and children,” says a woman. Though the mothers spend a lot of money to send their children to school, the children end up joining their mothers in the field.

Electricity access has proven elusive as well. To this day, the villages of Kilengo, Lundu, Lubwaku and Mvuzi 3 have no electricity, even though they fall within a 20-kilometer radius of Inga 1 and 2 dams. Some women have lived all their lives without ever bringing a light bulb into their homes. They use firewood and charcoal to cook, and candles to light their homes.

None of the villages has running water. At Camp Kinshasa, a former workers camp that is now inhabited by a mix of displaced people from Inga 1 and 2, former project workers and their children, girls must queue for hours to fill their buckets with water from the only tap located in the village, which serves over 10,000 inhabitants.

Despite these challenges, the resourceful women of Inga have carved out lives and livelihoods for themselves. But now they’re facing a new threat.

Though Inga 1 and 2 were spectacular failures, DRC has set its sights on a new project on the Congo River: Grand Inga. The Congolese government plans to try and exploit the river’s potential yet again by building the world’s largest proposed hydropower plant. The first phase of the project, Inga 3, will send power thousands of kilometers away while yet again bypassing the people at Inga.

My organization’s economic analysis of the project shows that it will likely plunge DRC deeper into debt, while doing nothing to help ordinary people.

It may, however, throw ordinary people, including the women of Inga, out of their homes. In 2014, the World Bank estimated that the dam will displace nearly 10,000 people if built — women, men and children whose livelihoods entirely depend on the river, land and forest.
We met with women from Kilengo, Lundu, Mvuzi 3 and Camp Kinshasa, all villages that would be affected by Inga 3. They told us that life is not easy in Inga, but at least families can make a living. “Here we have fruit trees. If we move elsewhere, where would we get money to buy fruits for our children?” says Ngimbi, a woman from Mvuzi 3. Another woman described caring for a paralyzed family member; she wondered how the family could move this person if they were relocated.

The women all described facing the same challenges: no electricity and uncertainty about what the future holds. Each woman had a story to tell. “Where would we go?”

At least here we can farm, sell our products, and use the money to send our children to school,” says a woman from Kilengo.

It pains me to think of what will happen to them if they are relocated. The population of this camp has grown over the years; some long-time residents have been waiting for compensation for the effects of Inga 1 or 2 for over 50 years. They don’t deserve another setback. “No to Inga 3, first we want to reap the benefits from Inga 1 and 2,” the women told me.

Their struggle is not only about access to energy — they are also fighting a corrupt and unjust system. It is a system that places them at the bottom: They are the last to receive energy or any other benefits from development projects. Why should the DRC government send energy miles away while the people whose livelihoods have been destroyed to make way for the largest energy plants in the country live in the dark?

I believe that development should begin at the bottom — a “trickle up” effect. Many infrastructure projects occur in rural areas, where people are poor and vulnerable. And DRC, despite being resource-rich, is one of the poorest countries in the world. History proves that these projects leave affected communities worse off, trapped in a cycle of poverty. What if Inga could benefit the Congolese women first, the women who work hard to send their children to school?

Energy access is a human right, whether one lives at Inga or at Kanyabayonga in Eastern DRC. It is also our right to fight a system that we believe will not bring development to our nation, but continue to extract our resources for the benefit of others.

Is it right to sacrifice the lives of women, children and men to provide power for the few elites? Or should we rethink this model of development? Let’s say no to Inga 3, and yes to energy that will light up Kilengo, Lundu, Mvuzi 3 and many other villages across the DRC.

Ange Asanzi is International Rivers’ Africa Program Associate. Born in DRC, she now lives and works in Pretoria, South Africa.

First published: International Rivers.
Beatrice Marpe is a women’s leader in the remote village of Tokoishi, about 100 kilometers south of Kenya’s capital, Nairobi. The job of a Maasai women’s leader is usually to help solve marital issues, but Marpe, 55, has taken on a new role: solar ambassador.

Being a solar power advocate is about more than renewable energy for Marpe; it’s personal. Her husband died 11 years ago after being killed by leopards in the night while he guarded their livestock. In the past, the men of the village used bonfires, spotlights and kerosene lamps to keep predators away from their cattle at night. Now, solar lights have been introduced to the village to ensure the wild animals stay away without anyone having to stay outside to deter them.

It was German-based company SunTransfer that first brought solar energy to Kajiado county. The company now helps provide power to 500 homes.

Samuel Njoroge, the SunTransfer manager in the region, says the company offers customers a pay-as-you-go financing model that allows families to purchase a solar energy system via an installment credit. With the money saved that would have been spent on kerosene lamps, the credit can be paid off within three years.

When SunTransfer approached Marpe with its solar power idea in July 2014, she agreed to try it, and found that it worked.

Now when other women visit Marpe’s home, she explains how solar energy works and encourages them to take it up too. Once women are interested, they convince men to agree to the idea.

“This has been working very well, and the men are now getting more involved,” Marpe says.

“Solar energy comes with a lot of benefits apart from the light that scares away the wild animals,” Njoroge says. “Compared with kerosene and firewood, the cost is low. [People] are also able to watch TV, something that is rare in this area.”

Clean Cookstoves in Tanzania

In neighboring Tanzania, Loise Loseku, who lives in Enguik village, is taking things a step further: She’s installing solar panels herself, a task that would traditionally be seen as men’s work. The 29-year-old mother of six has been doing this work for six years.

Loseku is part of the Maasai Stoves and Solar Project, which has introduced solar power and clean-burning cookstoves to the community. Women are trained to distribute and install the panels and stoves in their manyatta (traditional mud houses). In a week, Loseku can serve four homes, sometimes more. Customers pay $11 for each installation, a subsidized rate under the program; the actual cost is $52.

Robert Lange, a retired physics professor from Brandeis University, founded the project in Tanzania to promote the use of clean energy in rural, remote villages.
Smoke from open fire and traditional cookstoves poses a serious threat to health, particularly for women and children. The World Health Organization has found that, worldwide, more than 4 million people die prematurely from illnesses attributable to household air pollution.

In sub-Saharan Africa, more than 80 percent of the population, or nearly 728 million people, depend on solid fuels such as charcoal and firewood for cooking, more than any other region in the world. The agency estimates that by 2030, 1 billion people in sub-Saharan Africa will depend on biomass as their main energy source.

Lange told News Deeply the cookstoves emit 90 percent less smoke than a traditional wood-burning cooking stove, alleviating chronic coughing and head congestion, primarily in women and children.

Local women play a significant role in running the program and help guide its direction on the ground. "We chose to use women because after conducting a few workshops in the villages, we realized that women were more willing and open to the idea than men," Lange says.

In each village, the women work in groups of five to 10. They are selected for the roles by the other women in the community, who assemble to meet with the officials from the Maasai Stoves and Solar Project, then select who should be in the installation group, based on leadership skills.

"We meet every month with project officials and women groups from other villages to share ideas and discuss the way forward," Loseku says.

"Within these working groups, the women elect their own leaders, who manage them and organize their daily work. The women are trained in approximately 10 days to install the stoves and solar panels," Kisioki Moitiko, the project manager in Tanzania, says.

Loseku says the program allows her to earn extra money for her family, as well as helping her community.

"I am now able to provide for my family too instead of only relying on my husband to sell his livestock in order to provide for us," she says.

"People now come to us inquiring about solar because they have seen it work well at their neighbor's home."

Christabel Ligami is a freelance Kenyan journalist based in Nairobi.

First published: Women’s Advancement Deeply.
In developing countries, the arrival of reliable clean energy tends to have a disproportionately positive impact on women. No longer do women and girls have to spend hours gathering firewood, or breathe in the fumes from smoky cookstoves. Electricity at the flick of a switch frees up women to do other things. But how do we measure the impact of this kind of empowerment of women? A new study of a solar electrification project in Benin, West Africa, demonstrates how access to energy empowers women, and provides a methodology to assess gender impacts of other development projects.

Jennifer Burney from the University of California San Diego, US, and her colleagues spotted an opportunity to measure the impact of women’s empowerment during the roll-out of a rural solar electrification scheme in the Kalalé region of Benin, West Africa. The Solar Market Garden project is a photovoltaic pumping and irrigation system aimed at expanding agricultural production for local women’s farming groups, to remove the need for hand-watering of crops.

Following a small pilot study, the project was scaled up in 2013 and rolled out to eight villages. Burney and her colleagues surveyed all members of the women’s agricultural groups in the eight Solar Market Garden villages, and eight matched-pair comparison villages without Solar Market Garden, along with a random sample of 30 nonwomen’s group households in each of the 16 villages.

Surveys were carried out soon after the installation of the Solar Market Garden project, and then one year later, with household questionnaires asking about nutrition, household decision making, sharing of chores, measures of independence, religious freedom and household finances.

The study showed that the Solar Market Garden significantly positively impacted women’s empowerment, particularly in terms of giving women economic independence.

“We observed real structural changes in households,” said Burney. “Once women are getting to participate in investment decisions, the whole household dynamic has changed.” The women who benefited from the Solar Market Garden project gained new decision-making powers, more physical independence, economic independence, self-confidence and respect at home. Some of the changes were quite a surprise. “I was not anticipating that men helping out would be such an important factor,” said Douglas Taren from the University of Arizona, US.

Unlike previous studies where empowerment was defined before the study began, this research asked a wide variety of questions about lifestyle and then used the answers to analyse what had changed and whether the changes could be considered empowering for women.

“The nice thing about this strategy was that it captured what mattered locally and captured those changes, and it is a method that can easily be replicated elsewhere,” said Burney, who published the findings in Environmental Research Letters (ERL).

Kate Ravilious

Solar electrification empowers women
In this case, it’s clear that the arrival of a small-scale clean energy scheme had a positive impact on women’s empowerment, but whether it was the electrification alone that was the trigger is not so clear. “This study can’t tell us whether a totally different project, such as small business loans, would give the same amount of economic boost to women and the same empowerment impacts,” said Burney. “We hope that others will start to use our methodology to test these kinds of questions.”

Kate Ravilious is an award-winning independent science journalist, based in York, UK. She is a contributing editor to environmentalresearchweb.

First published: environmentalresearchweb.
Business
The problem is evident: Africa’s off-grid industry is dominated by multinational companies. Local solar companies often fail due to the lack of finance and in fact to not getting access to investors. But local small and medium enterprises (SME) are the main driver for innovation, poverty reduction, employment generation and social integration. The lack of small and medium enterprises (SME) in developing countries is a significant obstacle - commonly referred to as “the missing middle”.

Good news! USAID designed a new funding opportunity specifically to address that problem. The message: USAID announces a $4m fund, specially designed for off-grid start-ups in Africa who face problems to access capital.

Good news for African Start-ups? Let’s have a look on the two main conditions:

1. Applicants must demonstrate a financial commitment from a private investor (equity or debt) that is at least twice the funding requested from USAID. For example, under an award, if an investor commits $1 million in funding, USAID could award $500,000. Preference will be given to higher ratios of demonstrated investor commitment to proposed USAID funding.

2. Enterprises should be early stage or early-growth stage, with an existing track record in one or more African markets.

These are two conditions which clearly cannot be fulfilled by the companies USAID pretends to support, i.e. real African start-ups having problems to access private investors. Instead, the new funding is an excellent model for all the multinational off-grid companies, who right now already dominate the off-grid market.

No question that these companies also need money for their growth. On the other hand, however, these international companies are in a position to procure capital from investors. And they have done this very successfully in the past: double-digit millions USD were collected. USAID also already donated Millions of USD to these companies in the past months.

Of course, USAID can continue to subsidize multinational companies instead of building local solar markets. But it sounds strange if these subsidies are then announced as a support for local start-ups.

Harald Schützeichel is expert for off-grid energy in developing countries; Editor of Sun-Connect News.
First published: Sun-Connect News.
Chapter 1: From 20,000m. An Overall Operational Context

Imagine you want to start your own solar distribution company, and your plan involves collecting small amounts of money from people every week. This might seem reasonable until you realize how geographically dispersed your customers often are. And even if you solve the money collection problem, you still need to figure out how to apply the payment data to the entire fleet of metered solar devices (because they’ll refuse to turn on otherwise).

Keep in mind that while some of these devices are small and portable and could presumably be carried to a point of sale for some sort of activation, others, like solar water pumps meant for agricultural irrigation, are heavy and bulky and not easily moved.

One way to solve this problem is with people power: build a large agent network, send them out into your geographic region, and ask them to collect money and activate the solar devices. There are certain advantages to this high-touch approach. Your repayment rates will probably be pretty good because your agents will get to know their clients fairly well and the social pressure of paying someone standing right there is more difficult to ignore compared to, say, a phone call asking for money.

On the other hand, there are also a number of drawbacks to this approach. Training costs for agents can be high, and managing employee turnover can be challenging. Sparse populations require more time and energy spent on travel, increasing the cost of collections. If your agents are collecting cash payments, you need to figure out how to get the money to physically flow safely to your offices.

The good news is that, in many emerging markets, mobile network operators (MNOs) have deployed quite a bit of infrastructure in terms of both technological and human capacity. Their large human-powered operations were created because most of their customers tend to prepay for cellular connectivity in small, affordable amounts.

Sounds familiar, right?

Chapter 2: From 10,000m. Examining Prior Parallel Art

In last chapter, we learned that building a solar distribution company in an emerging market shares many of the same operational challenges that mobile network operators (MNOs) face. Here, we’ll discuss one approach they use to overcome some of their operational challenges. Of course, not all solutions from MNOs can be directly applied to solar distribution, but it’s still worth understanding this prior art to use it as inspiration for PAYG solar technologies.

At the time that these MNOs were building out their operations, their markets were predominantly cash economies. In order to scale their busi-
nesses, they needed to make it super convenient for as many people as possible to transact with them as often as possible. The only way to reduce the amount of friction per transaction was to build out a huge point-of-sale network, with a wide geographic reach, operated by humans, and designed to collect cash.

But what do their customers actually receive in exchange for the cash? How do you actually load more airtime or data onto a specific phone? These points of sales are often simple kiosks, meaning there is no computer system to record a transaction or do anything else automatically.

One solution might be for the kiosk operator to call into a call center confirming that a transaction has completed successfully, and that the MNO should then load more credit onto the customer’s phone. This approach has the obvious drawback of requiring even more staff for the call center, and the less obvious drawback requiring the operator to figure out how to physically transport the cash from thousands of kiosks back to central headquarters.

It turns out there’s a simpler solution that compensates for the impedance mismatch between a high tech cell phone network and a low tech operational environment, which is to convert virtual electronic "inventory" of airtime and data into actual physical inventory. Now, this inventory can be distributed and sold at wholesale prices to a distribution network of kiosk owners, who apply a markup, and sell it just like any other piece of physical inventory, like chewing gum or bottled water.

Say hello to the humble scratch card.

The concept here is both simple and elegant. Network operators print zillions of these cards, which are then sold at thousands of locations. Each card has a secret code that is revealed by scratching off the weird silvery stuff. The end customer then enters this code into their phone. The backend computer systems receive the code, verify it, and finally add credit to the customer’s account.

The cards are not only durable but, more importantly, enable an extremely low-friction customer purchasing experience. They can be bought for cash, in fairly small granularity, whenever needed by a customer. There’s no latency introduced at the time of sale, and no waiting around for a computer system or call center operator to add credit to your account. They can be stored and consumed when convenient.

From the MNO’s perspective, scratch cards are a pretty good compromise to achieve widespread market reach if you’re trying to bootstrap an entire infrastructure. They’ve made it easy and affordable for their customers to buy service in discrete chunks. In the process, they created a market where none existed previously. There are drawbacks, such as the overhead of printing and physically distributing the cards. And, of course, the major concern from the MNO perspective is ensuring and protecting the integrity of the codes.

Hopefully we’ve set enough of the broader context around this particular problem space. In our next installment, we’ll be taking a closer look at the keycodes themselves.

Chapter 3: From 1000m. Centralized vs Distributed Security

In the last chapter, we provided some of the context for why keycodes and scratch cards are a good solution to the impedance mismatch between a high tech product offering and a low tech operational environment.

But what’s in a keycode, really? And are keycodes and scratch cards the same thing?

Fundamentally, a keycode provides a user authorization to system resources, whether it be cell network airtime or, in our case at Angaza, clean solar energy.

Thinking of a keycode as a security token is useful because it allows us to perform the standard “usability versus security” tradeoff analysis when designing a keycode system. Here is where it's
important to understand the operational differences between a mobile network operator and a pay-as-you-go solar distributor.

In a mobile network, the resource to protect is access to the network itself. The network operator wants to grant access to the network to anyone who has paid while denying access to everyone who has not.

Although a special device (e.g., a phone) is required to access the network, the real value is not in the device, but rather in participating in the network.

So, the network operators usually don’t care about securing the phones which are at the edges of their operations. Instead, they care about protecting the central resource—the network—and the practical result is that their keycode systems are designed around the availability of a centralized authorization mechanism.

In fact, while scratch cards are an integral part of the network operators’ keycode systems, it’s important to understand that they’re just a small part of a larger picture.

In this diagram, we are assuming that the user has a mobile phone and access to mobile money. This assumption is often the case in many of our operating territories, but not always. In any case:

- Notice how the network operator is still involved. When a user wants to make an installment payment for their device using mobile money, the payment goes through the Network Operator, and all of the money being transferred stays inside their mobile money system.
- The Angaza Hub receives a notification that

In the above diagram, the network operator distributes the scratch cards to the points of sale, just like any other sort of physical inventory. The customer buys a scratch card, types the keycode into their phone, the network operator validates it, and finally allows the phone to access the network.

The key aspects here are:

- the keycode is validated centrally, by the network operator, not by the phone
- the scratch card is merely a method of distributing the keycode to the customer
- ownership of the scratch card is proof of purchase

Additionally, what may not be obvious from this diagram is that:

- the input method—the phone—has a radio and is connected to the network
- the customer may only purchase scratch cards on an ad hoc basis
- the codes from any scratch card may be entered on any phone
- each code is unique, and may be used only a single time

In contrast, when designing a metered system for product financing, the goal is to ensure the device’s usage is authorized, else it should be prevented from turning on. The devices may not be able to directly communicate with any central authority. Adding a GSM radio to a device, for example, is cost prohibitive when that device retails for less than $150. This constraint is one of several that make this problem more difficult.

This constraint implies that the devices themselves must be able to validate the codes, which pushes the authorization mechanisms all the way out to the edges of the system. That problem is considerably more difficult to solve, for reasons that will become apparent later.
a payment was made successfully. This notification is, in other words, a receipt. Again, no money has been transferred out of the mobile money system at this time.

- The receipt is proof of a purchase. The Angaza Hub sends the keycode to the user, usually via an SMS, when that proof is received
- The user physically types the keycode into the solar device. If the keycode is authorized, then the device is enabled.

Again, some non-obvious points about this type of system design:

- The only time that a user needs cell phone coverage is the short period of making a mobile money payment and receiving the keycode SMS. After receiving the SMS, the user is free to travel the “last mile” back to their house, where there is no electrical grid and potentially no cell coverage.
- The solar device is not consistently connected to any sort of network at all, and must be able to decide on its own whether a keycode is valid or not.

If you take anything away from this post, it’s the difference between the security mechanism of a mobile network versus pay-as-you-go solar.

- Mobile Network = Centralized Gatekeeper
- Pay-As-You-Go Solar = Distributed, Per Device

As we’ll find out, the distributed nature of validating keycodes for a pay-as-you-go solar device is the dominant factor in the design of the overall keycode system. In our next installment, we’ll finally start exploring the design space.

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1 "Not turning on unless payment data is pushed onto the device" is the key idea behind technically enforced pay-as-you-go solar devices and Angaza’s specialty. The specifics of how this works is out of scope for our keycode blog series, but for an overview, please do check us out: http://www.angaza.com

2 Often referred to [interchangeably] as a “keycode”, although as we shall see in a future blog post, there is a big difference between “codes on a scratch card” vs “a fully functional keycode system”. For what it’s worth, Angaza focuses on the latter.

3 It turns out there is a lot of science behind this weird silvery stuff!

4 Scratch cards come in a variety of different face values, to accommodate a wide range of individual consumer cash flows.

5 All prices are quoted in USD PPP.

6 Angaza supports many types of operational work flows, including pure cash, but for clarity, this article focuses on mobile money scenarios.


8 In this specific context, the solar device isn’t connected to a network because it is inexpensive and doesn’t have a GSM radio, so the technical challenge of keycode authorization must be done purely in the device itself, and can’t just ask a server somewhere. However, even more expensive devices with a GSM radio that could communicate directly with a server, could benefit from independent authorization in situations where the GSM connection isn’t currently working. must have some way of independently validating keycodes in order to prevent replay attacks.

Alex Chiang is Senior Software Engineer at Angaza. First published: Angaza.
Training, mentoring and funding: three key steps for supporting micro entrepreneurs in the energy field in emerging economies

Diane Le Goff

1: Training to start off in the right way
Raising awareness around entrepreneurship to limit the risk of failure

To formalize, structure and develop their activities, electricians need to gain some practical knowledge about entrepreneurship. Since many start their activities without any idea of business management, development or communication, the Access to Energy program of Schneider Electric, has developed awareness raising modules. As well, our multiple training partners are actively developing activities to promote entrepreneurship and provide their trainees with insights on how to run their potential ventures.

2: Mentoring as the key for success
Mobilizing local actors and sharing knowledge

The key factor of success for entrepreneurship is a real program to accompany and advise. Even after training, entrepreneurs need to be accompanied and advised by mentors, either people who launched their own ventures or people having a recognized expertise in the field, such as professional organizations or incubators. Entrepreneurs particularly need to have visibility on the regulatory framework at stake as well as on the potential business opportunities in local markets. To mentor more effectively these entrepreneurs and help them address the market, gathering them in economic interest grouping can also be an opportunity.
Providing entrepreneurs with managerial tools  
Managerial tools are also essential to run a business. We experienced this in our mixed-gender entrepreneurship program in Brazil, where women and men entrepreneurs were equipped with starter kits in business management, such as an account book after having been trained on electrical installation.

3: Facilitating access to finance for development  
Finally, entrepreneurs need to have access to finance to start their business. However, it remains very difficult today in developing countries, where half of them are underfinanced[1], with unmet credit needs estimated between $2.1 and $2.5 trillion[2].

Putting entrepreneurs in relation with potential funders & fostering tailored forms of funding  
Fortunately, public, private, and hybrid initiatives aiming at providing funding solutions for entrepreneurs, are growing. A major need for the entrepreneurs is to get to know these funding opportunities through organizations that play a role of relay. Microfinance institutions and their microloans’ offer can for example address the needs of informal entrepreneurs in energy.

Programs supporting entrepreneurship are more successful when they involve various support instruments and manage to create ecosystems locally[3]. Therefore, partnerships between the public, associative and private sector will be a key element of success.

Want to find out more?
- Read our White Paper “Addressing the needs of social and micro-entrepreneurs in the energy field in developing countries” (2017)
- Join our "Access to Energy by Schneider Electric" LinkedIn group


Diane Le Goff is Project Manager - Access to Energy Training and Entrepreneurs at Schneider Electric.  
First published: LinkedIn.
Four out of every five Ugandans lack access to grid electricity. This constrains their opportunities for work, education, or operating a business. Around 35 million Ugandans, 97% of the population, rely on traditional and relatively inefficient energy sources such as wood, kerosene, fuel, and charcoal to cook their meals and light their homes. The poor are affected the most, since they spend a large portion of their family income on energy costs (approximately 13%, equivalent to $99 USD per year, according to a 2015 report by the Global Alliance for Clean Cookstoves 2015).

Over the course of their lifespan, solar off-grid energy solutions can help reduce the rural poor’s spending on energy services, while delivering superior lighting services as compared to traditional, fuel based lighting.

However, the high first cost of solar products can impose a constraint for adoption of products. Financing off-grid solar energy systems is a promising market based solution to reduce energy poverty globally. The convergence of solar home system markets and technological advancements of mobile money and pay-as-you-go (PayGo) based financing models have shifted how off-grid energy products can be offered.

UNCDF’s CleanStart Programme, in partnership with SolarAid/Acumen and the Schatz Energy Research Center (SERC), is conducting research on energy adoption patterns, an examination of what some have called the energy ladder. The research seeks to determine how people finance their solar systems and the channels customers use to purchase them (e.g. cash purchase in the store, microfinance loan, or mobile phone enabled PayGo finance). Additionally, the research will investigate the drivers of solar product adoption, particularly the role of flexible financing tools in influencing customers’ purchase behavior.

This blog series reveals some of the early outcomes of the study. Our first blog showed that dissatisfaction with traditional energy sources and the regular grid generates significant market opportunity that solar off-grid energy firms can potentially tap into. In this blog, we explore ways in which marketing and information sharing drive...
solar product purchase decisions of customers.

**Exposure to Multiple Sources of Information**

Not surprisingly, most solar end-users in Uganda were exposed to multiple sources of information before they purchased a product (see Figure 1). We asked 600 phone survey respondents about prior experiences and information that influenced them to purchase the off-grid solar products they owned. Collectively they mentioned a total of 875 information effects related to 726 products that they owned. Three information and marketing sources were particularly influential in driving end-user uptake.

**Figure 1: Responses for multiple-choice question, “What prior experiences or information influenced you to purchase each of the solar products that you own?” Source: Survey responses for phone baseline survey, May-June, 2016, Energy Ladder Research Total number of phone surveys: 600; Total number of prior experience and informational effects that led to a purchase: 875**

1. **Direct Marketing by Solar Off-grid Organizations**

   The results confirm that direct marketing by solar companies is a powerful source of buyer persuasion: 85% of respondents stated that information from solar businesses, including sources such as sales calls, demonstration campaigns, and radio advertising, affected their purchasing decisions. This indicates that in-person engagements with potential buyers are influential and can be leveraged by sales staff to explain product features, benefits, and flexible payment options such as micro-credit and pay-as-you-go (PayGo).

2. **Demonstration Effect**

   Among the product buyers in the study, 22% stated that their purchase decision was influenced by seeing a solar device in a “real” application in an acquaintance’s home. This helped lower their risk perception and increased their comfort in making the purchase. Seeing the product in an acquaintance’s house may have also had aspirational effects, contributing to a desire to purchase the product.

3. **Referrals by Thought Leaders and Peers**

   The third most commonly stated influence comes from purchase recommendations by thought leaders and referrals by other satisfied customers. Thought leaders, such as a teacher, headmaster, or religious leader, are perceived as knowledgeable and holding accurate judgment. Purchase recommendations coming from a teacher, for example, are treated particularly trustworthy and reliable.

   Approximately 19% of our face-to-face survey respondents stated that a teacher or a headmaster recommended them to purchase a solar system. In fact, organizations retailing solar energy products recognize this and often recruit teachers as sales
agents or target this customer segment with tailored marketing campaigns.

Existing satisfied customers present another powerful source of influence. A satisfied customer is more likely to recommend solar products to their relative or acquaintances. Indeed, 87% of the survey respondents during face-to-face interviews mentioned they had recommended an acquaintance to purchase a solar system!

The fact that direct marketing, demonstration, and referrals drive purchasing decisions has implications for solar product development. First the quality of products becomes important because ‘good referrals and demonstrations’ may lead to enhanced sales, but bad ‘referral and demonstrations’ may easily stop market expansion. Likewise, providers could encourage and reward the sharing of positive customer experiences, for example, by offering referral discounts or by featuring customer testimonials in marketing campaigns. In doing so, caution must be applied to avoid aggressive sales practices that flood the market with weak quality products. Third, the financing component was not seen as a key reason to purchase the product and, thus, while PayGo may enable easier product financing, there is still a need for direct marketing and service delivery. While there is expressed demand for solar energy technologies, many customers indicated that there was no sales agent or retail point in close proximity, thereby reducing sales because it is too difficult to make a purchase.

Richa Goyal (SERC), Arne Jacobson (SERC), Robin Gravesteijn (UNCDF): The Energy Ladder Research – an initiative launched by UNCDF’s CleanStart Programme in partnership with SolarAid/Acumen aims to address these and several other questions. Researchers at the Schatz Energy Research Center (SERC) are conducting the research through a mix of quantitative and qualitative research methods, including 600 phone interviews and 114 face-to-face interviews with users of solar energy products in two regions of rural Uganda. This year-long study explores customer adoption and financing behavior of off-grid energy solutions.
Eric Verploegen

A toolkit to identify sustainable, market-based energy solutions in off-grid areas

Energy access is essential for providing nutrition, clean water and sanitation and can significantly contribute to increased productivity and economic development – and, by extension, poverty alleviation. However, roughly 1.3 billion people worldwide lack access to the affordable modern energy products and services needed for reliable heating, cooking, mechanical power, transportation, lighting and telecommunications.

Multilateral and national aid organizations recognize this and their strategies to increase energy access understandably tend to focus on the regions that have the largest populations with the most acute energy needs. The private sector, on the other hand, naturally focuses on the most attractive markets for the products or services they sell. It is reasonable for aid organizations to serve beneficiaries in the most efficient way possible and for businesses to target profitable markets. At the same time, the energy needs of people in less-populated regions or otherwise challenging markets may be overlooked and their needs for affordable, renewable energy solutions – such as efficient cookstoves, solar lighting, water pumps and mechanical devices – unmet.

A toolkit to assess needs

In 2015, in an effort to increase energy access for more people in off-grid areas, MIT D-Lab began working with Mercy Corps to develop the Energy Assessment Toolkit. Our goal is to create a means by which organizations with strong connections in off-grid communities can assess local energy needs and select and implement market-based solutions that meet the energy needs of community residents and businesses.

Expertise in the energy sector is not a criterion for organizations considering using the Energy Assessment Toolkit, but a strong presence in the community and the ability to take action based on the opportunities identified are essential. Organizations that have used the toolkit include community-based businesses, nongovernmental organizations and civil society organizations. They all have ongoing programs in off-grid regions and are looking to further develop energy access programs that leverage their existing connections with communities.

We hope that by providing an actionable roadmap, organizations will be able identify energy products and services that could benefit the community, and might not reach them otherwise.

What the toolkit includes

The Energy Assessment Toolkit, which is open-source and available online, includes surveys and interview guides that an organization can use to gather information from a range of stakeholders, such as community residents, business owners, government officials and others. The kind of information the surveys and interviews explore inclu-
des:
- Current energy access and expenditures
- Aspirational energy needs
- Existing supply chains
- Community institutions and stakeholders (private sector, government, NGO)

The toolkit is modular, allowing the organization conducting the assessment to determine the scope and scale of the study. In addition to the data collection tools, the toolkit includes data entry and visualization tools that can be used to analyze the data collected as well as to guide the design of the assessment plan by identifying technologies and business models that effectively address the most pressing needs in a specific community or region. The goal is to enable organizations to collect the information needed to make informed decisions about how to meet the specific needs in their community through market-based initiatives. (Note: This community-based assessment approach is not intended to replace studies that track energy access on a national level or to generate market intelligence reports for external organizations looking to expand their business or programs into new markets.)

The Energy Assessment Toolkit is part of a larger suite of initiatives developed as part of the MIT D-Lab Off-Grid Energy Roadmap. D-Lab is also working on developing and curating resources to help organizations identify technologies and business models that can meet the needs of off-grid communities and guidance for designing pilot programs and market deployment.

Using the toolkit
We began piloting the toolkit in 2015 in El Salvador with ASAPROSAR, an NGO in Santa Ana that provides health, education, environment and economic development programs, and went on to conduct trainings with Mercy Corps country staff in Mali, Nigeria and Niger, where we iterated and improved the toolkit to better meet the needs of local teams.

The assessment Mercy Corps conducted in Mali identified the need for households to reduce the money spent on cooking fuel, and that the major reason why efficient cookstove technology had not reached this market was the lack of supply chain infrastructure due to security issues in the northern part of the country. Mercy Corps is now helping facilitate the distribution of cookstoves by connecting manufacturers in southern Mali to wholesalers and entrepreneurs in northern Mali. This pilot program could be implemented quickly because Mercy Corps Mali already had a program training entrepreneurs in the regions where communities could benefit from cookstoves. Mercy Corps has experience working with a wide range of local and global commercial actors to help test and demonstrate business models that have the potential to scale up to meet the energy needs of off-grid communities. In this case, all they needed was to identify the need and the product suppliers and they were ready to go. This was a great example of a local organization, well-connected in a community, with the capacity not only to conduct the assessment but also to implement an appropriate solution.

Conclusion
MIT D-Lab is well known for its work in Creative Capacity Building, an approach to international development that trains people in resource-poor settings around the world to create or adapt technologies that will improve their lives and strengthen their communities. In this way, people become active creators of technology, not just recipients or users of technology. The Energy Assessment Toolkit approaches development in a similar way; it views organizations with a strong local presence as powerful agents of change and provides the tools and training necessary to assess community needs and implement the right solutions to meet the energy needs of the community in which they work.

Eric Verploegen leads the MIT D-Lab Off-Grid Energy Group.
First published: Nextbillion.
Women play a key role regarding both local development and energy management in emerging economies[1]. They are very active entrepreneurs: they are estimated to own 1/3 of the enterprises of Africa[2] and more than half of the enterprises in some countries like Ivory Coast (61,9%)[3]. However, these enterprises are often associated with higher risks and precarity as women lack the tools, which could enable them to grow[4]. In addition to this, they are often the primary managers of energy in communities in emerging economies. They are the ones in charge of providing energy sources for the households. However, they are not represented as economical actors in energy-related fields in developing countries[5]. Women are also the first exposed to the sanitary risks associated with pollutant sources of energy such as kerosene.

Hindrances preventing women to launch a career in the energy sector
- Livelihood and cultural gender schemes: Women tend to become mother early which can prevent them from developing a formal activity or continuing school. There are also often excluded from the labor market, where opportunities in rural areas can be rare and difficult to access for them because historically reserved to men;
- Lack of training and hard skills: suffering from discrimination on the ground of their gender regarding access to training, they usually stop school earlier than boys and they rarely undertake technical training for professions which are considered “manly”, such as electrician;
- Lack of soft skills: due to their lack of training and to gender norms, women often do not have the skills needed to develop a business (e.g. communication and public speaking, interrelation skills for commercial negotiations, stress management, leadership...);
- Access to labor market and funding: often excluded from conventional labor markets and funding schemes, they are prevented to launch their own activity in the formal sector.

Provided with the right skills and tools, women entrepreneurs in energy can drive economic & social development and foster tailored solutions for access to energy.

Energy access should be an opportunity for women entrepreneurs to secure an income, decent employment and enhance their social status by enabling them to drive the sustainable development of their communities[6].

Success stories from inclusive programs supporting women in their path to entrepreneurship through training, mentoring and access to microfinance have shown that there is a great potential for development[7].

This success is explained by the personal and familial follow-up offered to the women including literacy and soft skills development and support regarding childcare. These schemes help women
overcome the gendered based barriers that they face.

**Supporting women entrepreneurs to work at all stages of the energy value chain**

However, most of the programs targeting women entrepreneurs in energy are focused on non-technical activities (like the resale of solar products). At the Access to Energy Program of Schneider Electric, we believe that women should also be offered the opportunity to access careers requiring hard-skills to be present at all the stages of the energy value chain.

Thus, we support local organizations specialized in women empowerment and skills development, critical actors for change, they create inclusive ecosystems offering training, mentoring and funding to enable women to become entrepreneurs. We also provide our other local partners with incentives to become more gender aware by promoting good practices and fostering bottom-up dynamics for gender equality. An example that illustrates Schneider Electric contribution:

**Brazil - Entrepreneurship program with a gender lens in partnership with educational institutions and NGOs**

Men and women are trained together in basics electricity and system photovoltaic operation and provided with the adequate tools to launch their own activity, information on the regulatory environment, and starter kits in sales, services and communication. It enables them to structure their business and obtain their first commands. Vector of social progress, this program creates the conditions for mutual understanding and recognition. When working together with women, men tend to abandon their potential prejudice against women workers in energy. In the meantime, women are given the proof that they are totally capable to work as electricians and provided with the skills and tools that they need to do so.

Feedbacks show that trained women perform very well as electricians. However, a lot remains to be done regarding social acceptability for women in energy as they are not always taken seriously and they sometimes face insecurity when operating in some countries. The Access to Energy Program wishes to go forward on this matter and to play a double role of economic empowerment and advocacy for gender equality.


Diane Le Goff is Project Manager - Access to Energy Training and Entrepreneurs at Schneider Electric.  
First published: Linkedin.
Remote microgrids in the Himalayas offer lessons for the rest of us

This year, Global Himalayan Expedition (GHE) continued its success by electrifying Shadé, one of the most remote villages in the Zanskar Valley and perhaps all of India. The team, representing over 13 countries, trekked over 60 miles to reach the village.

While the electrification was impressive in its own right, there are lessons to be drawn for microgrid proponents everywhere.

Lesson 1: Social entrepreneurship can (and does) work
People are often surprised when hearing GHE is a social enterprise, not a not-for-profit. However, I have witnessed first-hand the advantages and cost savings of working as a business. In remote areas without mobile communication, decisions must be made quickly to ensure the safety of the team. Additional regulatory requirements would put these processes at risk.

As a social enterprise, there is a need to create a self-funding, sustainable business model. Social enterprises cannot blindly install what donors want, but work with the recipients (aka customers) to determine what works best. Rather than an endless pot of donor money, GHE must actively seek partnerships. If anything, there is probably even more opportunity for co-branding with corporate sponsors.

Perhaps most importantly, as a social enterprise on a very tight budget, there is a strong incentive to minimize costs and generate value for money. Interestingly, the need to save money arguably drives better, more localized development.

Lesson 2: Develop local talent
While the trip to Shadé helps generate press and therefore partners, GHE is electrifying over a dozen villages in 2017. Unlike many non-government organizations with expensive foreign expats and consultants, GHE makes this happen by developing local talent.

The vast majority of installations are completed by local electricians working for GHE, some of whom were cooks prior to joining GHE, who speak the local language, have the knowledge and skills to quickly navigate the harsh terrain, and have a vested interest in the development of their communities and region. In every village, at least one local is trained to maintain the batteries and panels. Not only is someone using the system most committed to maintaining the equipment, this also saves the extraordinary expense of sending someone from a distant city.

Similarly, GHE, through a locally identified entrepreneur, operates a service center shop in Leh where those with installations can service their microgrids, purchase replacements and upgrades. The shop also has two local women as service engineers who have been trained at Barefoot College in India. Not only are there spin-off employment benefits to the local community, the development
of locals minimizes GHE’s costs and engenders a strong sense of mutual respect. It helps to get away from the utility mindset into one that maximizes local value.

Lesson 3: Adapt your business model

Too often, microgrid organizers talk about competing directly with utilities, but retain a utility mindset for revenue generation and costs.

Traditional utilities tend to charge on a per kilowatt basis, a reflection of the historical costs associated with fossil fuel consumption, which scaled for every kilowatt used. However, for a wind, solar, or small hydro system with effectively zero marginal costs, this model no longer makes sense.

Instead, a monthly connection fee should be charged, to recoup a reasonable rate of return on the initial capital investment (for a social enterprise or non-profit, sponsorship may mean the rate of return is actually below the cost of capital).

Charging a monthly fee better matches revenues and costs and is more predictable for both the provider and consumer. Perhaps most importantly, it eliminates the extra costs associated with meters (the physical meter itself, meter reading, fraud detection, etc.).

Many otherwise economically viable small connections become non-viable when these ‘overhead’ costs are included. The model of eliminating this overhead is applicable everywhere. In GHE’s case, there is a nominal fee of 100 ₹/month (about $2 USD), which is invested in a fund to replace the system. Though the battery systems are projected to last five or more years, some customers have already saved up enough to cover the replacement cost in two to three years. This extra revenue can be invested elsewhere.

Capturing economic benefit

While almost everyone recognizes the economic benefit of electrification, it is often difficult to capture that benefit. Mountain Homestays, the livelihood initiative of GHE, seeks to help locals directly capitalize on the newfound benefits of electrification. One or two nights of homestay revenue is enough to fund the connection fee for an entire year. Other sources of revenue include local crafts and organic produce. By helping customers generate revenue from their new electricity, entrepreneurs can ensure they are paid for installing remote microgrids.

In this case, the social enterprise now depends on tourism as its major revenue source to sustain and scale itself. Combining tourism with energy access supports the enterprise with a sustainable business model and the rural community with sustainable development.

One final way to both minimize costs and maximize the environmental benefit of microgrids is a focus on minimizing consumption. GHE provides 3 W LED bulbs with their microgrids, which means that a 250 W panel and two 100 Ah batteries is sufficient for multiple homes. While DC microgrids like GHE may not be practical in every setting, the overall ethos of helping customers minimize consumption can be an active part of a microgrid installation. This is also made possible by charging a fixed cost, as opposed to the per kWh business model of the utility, which creates an inherent conflict between energy efficiency and utility profitability.

Remote microgrids can be installed in a way that is both economic and socially conscious. Global Himalayan Expedition illustrates one viable business model, but there are lessons for purveyors of microgrids everywhere.

Alexander Hogeveen Rutter is professional engineer.

First published: Microgrid Knowledge.
Young people growing up in rural Africa need jobs where they live, so they are not forced to join the growing ranks of poor seeking work in cities or to make dangerous journeys to reach Europe, the United Nations’ food agency said on Monday. By 2030, there will be about 1.3 billion 15 to 24 year olds on the planet, some 100 million more than in 2015.

Most of that increase will be in rural areas of sub-Saharan Africa, the U.N. Food and Agriculture Organization (FAO) said at the launch of its annual State of Food and Agriculture report.

Industrial and service sectors in African and South Asian cities have not grown enough to meet the demand, and won’t absorb the millions of new job seekers wanting to escape grinding poverty and hunger in their rural homes, FAO said.

"In Africa, every year 10 to 12 million youths join the labour force, but we have only been providing about 3 million jobs ... So it is not a surprise that they try to cross the desert and the Mediterranean looking for a better opportunity," said FAO director-general José Graziano da Silva.

Rural areas are not doomed to be poverty traps and could thrive with more investment in farming and food industries and better infrastructure linking farms and rural businesses to meet the rising demand for food in cities, the report said.

"People can get out of poverty even if they stay in rural areas," said Marco Sanchez-Cantillo, acting director of FAO’s Agricultural Development Economics Division. "There are parts of the world where rural transformations have lifted hundreds of millions of people out of poverty," he told the Thomson Reuters Foundation.

Countries in East and Southeast Asia have been able to boost incomes in both cities and the countryside in the past 20 years.

"In Vietnam most of the rural poor have exited poverty while staying in rural areas ... Latin America has many examples too," he said.

As urban populations grow, so will their demand for food, so farmers need to produce more at a time when climate change is bringing erratic rains and affecting crops in many parts of the world, the U.N. agency said.

Currently 80 percent of food in sub-Saharan Africa and Asia is produced by small-scale farmers, according to FAO. With the right kind of investment in rural infrastructure and farming, young people could find jobs on farms but also in food processing, transport and storage.

In June, several African governments pledged to restore degraded land, invest in agriculture and create "green jobs" for young people in a drive to reduce unemployment, fight radicalisation, and stem the tide of migration to Europe.

Alex Whiting is journalist and member of the Thomson Reuters Foundation’s editorial team. First published: Thomson Reuters Foundation.
Is a subsidy on LED lighting economically viable?

The governments in many countries have been nudging their citizens to move away from electricity guzzling incandescent bulbs to greener alternatives like LED. Incandescent bulbs are, in fact, banned in a number of countries. According to an estimate, the ban on the use of incandescent bulbs has helped Europe save as much as 40 TWh of electricity each year, not to mention reduction of CO2 emissions by as much as 15 million tons.

But the switch to LED is not going to be easy, at least in poor and developing countries. Despite the dramatic fall in prices of LED bulbs over the past several years, they are still five to ten times more expensive than incandescent bulbs. That is not to say that LED bulbs are not a better alternative. Studies show that LED bulbs can have a lifespan of over 50,000 hours. To give this some perspective, the corresponding figure for an incandescent bulb is just 1,200 hours. In other words, if you were to run a bulb for twelve hours every day, an incandescent bulb would last for just 100 days. In comparison, the LED bulb could last well over 11 years.

These studies however may not make much sense to the average daily wage worker who might be more concerned about the higher capital investments required to install an LED bulb. To such a consumer, the per-unit costs matter more than the lifespan.

Government subsidies could thus help these consumers hop on the LED bandwagon without having to worry about the higher per-unit cost. In 2015, the government of India announced a scheme to offer free and subsidized LED bulbs to consumers across the country. The UJALA scheme is expected to replace 200 million incandescent light bulbs across the country with LED bulbs, saving 35 million kWh of electricity. In monetary terms, that’s a saving of over $2 billion dollars.

The game plan here is to force an increase in demand for LED bulbs through subsidies and incentives. This helps manufacturers scale up production volume, which will subsequently bring down prices.

This way, when the consumer is in the market for new bulbs, the retail price of lighting equipment will be low enough for them to afford it without the need for any subsidy.

So how well are these incentives working economically? In the case of India, the production of LED bulbs shot up from one million units a month in 2014 to 40 million in 2016. Subsequently, the price of these products has fallen from INR 310 (roughly $4.75) in 2014 to just over a dollar at present day prices. The price has been brought down even further to less than 50 cents for consumers taking advantage of the government subsidy.

There are over 250 million households in India and over 270 million LED bulbs have been distributed by the government so far. Assuming a mean price of $2.5 per bulb over the three year period, this is expected to have cost the government about $675 million. At $2 billion dollars, the correspon-
ding savings in electricity are several times over this figure.

LED lighting, like solar panels, has proved to be an economically viable replacement for legacy technologies. It is high time that countries came together in pushing forward the adoption of these green technologies. This is the only way to push higher demand that will help bring down the cost for such technologies.

Anand Srinivasan is an independent technology consultant based out of Bangalore, India.
First published: The energy collective.
Kenya has become the leading PAYG market in Africa. All big players are present in Kenya. But all of them are international companies: the mother company in Europe, India, China or US makes the strategic decisions and gets funding, while the local branch is responsible for the last mile distribution. Kenya is entirely occupied by the international PAYG companies.

Well, not entirely... One local company still is not a branch of an international company, but majority owned by a Kenyan entrepreneur: Sun-Transfer Kenya Ltd., founded in 2009 by Gathu Kirubi.

The company is selling Solar-Home-Systems with PAYG finance and has build one of the strongest sales network through rural Solar-Centers. Each Solar-Center is driven by technicians, sales people and credit specialists. The main products are Solar-TV, Solar-Home-Systems and solar water pumps.

But how can a local company survive in between all these international companies who are raising millions of Dollars as grants and loans to build their businesses?

Kirubi’s answer is very clear: “There are two key factors: First and most important is to focus on distribution only without the burden of also being a manufacturer. This gives us much more flexibility in product selection and also we don’t have to raise lot of money for expensive product development. We also can react on customers demands much faster: We just look for the top-quality products available in the market and then include it into our portfolio for last mile distribution."

Another advantage for us as a local company is that decisions are made from our local management team and not outside Kenya. In consequence the decision making process is fast and very close to the customers needs.”

And what is the other key?

“Second is to diversify your business. All the other companies are pure PAYG companies, selling PAYG mass products. This is very helpful for the market and we do the same. But we don’t want to be a PAYG company only. Therefore we limit this part of our business and add others.”

You are limiting your PAYG-business, why?

“To reduce our business risk and to make a difference from all the international PAYG companies. As a pure Kenyan company we have to find market sectors others cannot serve as well as a local company. For example customized solutions for resorts, schools etc. Also the backup-market is growing fast in Kenya due to the unreliability of the grid power. Solar water heating is another emerging market we shall tap into.”

Diversification in distribution as the key factor for success?

“Yes! SunTransfer Kenya has a strong network of rural Solar-Centers with experienced staff and also a big customer database of households with credit history: why not sell other products and...”
services than just SHS or PAYG-products? We can offer manufacturers a reliable last-mile-distribution network - not only for solar products."

You mentioned the advantages of being a local company, but what are the disadvantages?

"We don't have the same big budget and manpower for corporate branding and marketing like the international companies. This limits our visibility for manufacturers and investors. But to solve this disadvantage the solar entrepreneur network "Sendea" has been extremely helpful: Sendea gave us not only access to investors and manufacturers, but also brings local entrepreneurs in East Africa together. To share our experience with entrepreneurs in Uganda and even Asia helped us a lot to improve our business and find the right way in our Kenyan market."

Last question: What shall the brand SunTransfer stand for in your vision?

"SunTransfer should be the Kenyan brand with the best after-sales-service. Our customer should know: If you buy a product from SunTransfer, you are on the safe side and your customer experience will be quite high: first the product is selected carefully, second you get a professional and best after-sales-service."

Harald Schützeichel is expert for off-grid energy in developing countries; Editor of Sun-Connect News.

Gathu Kirubi PhD is CEO of SunTransfer Kenya Investments Ltd.

First published: Sun-Connect News.
Finance
In the last years, the awareness about the importance of a reliable energy supply raised as well as the number of tested distribution models or end users financing. The off-grid technology is now available in a wide variety and also able to provide a comprehensive energy supply.

The problem is evident: The off-grid industry is dominated by multinational companies

Thanks to the ongoing hype for PAYG-finance there is significant amount of capital in the market. Many international PAYG companies already feel a veritable "cash outflow pressure". In consequence we see in some countries a cutthroat competition with highly reduced profit margin. Additionally, the big international companies are significantly benefitting from grants from major international organisations.

But what about local energy access companies?

The establishment of local SME, which work independently and are majority owned by domestic entrepreneurs, is important for sustainable job creation in the off-grid industry. Small and medium enterprises are the main driver for innovation, poverty reduction, employment generation and social integration. The lack of small and medium enterprises in developing countries is a significant obstacle - commonly referred to as "the missing middle".

SMEs require little capital, have the quality to make a quick decision, work with manual labour and in low level of management expenses. While microenterprises typically stay small, SMEs are designed to grow: they start with a few employees, but with the right support they are able to scale, create sustainable jobs upwards of 200 or more and deliver reliable services to needy customers.

Where is the "Muhammad Yunus for SME"?

Why is it not possible to bring the available capital to the companies? The reason is supposedly simple: local companies in the off-grid industry are too small. They range between start-up and mid-size companies, thus below the threshold that many funds set before they even consider finding out more about a company. Normal banks avoid anyway the risk of a commitment in developing countries, microcredit organizations have not developed a concept for companies of this size, and even the new "Impact Finance Funds" or CSR-funds are tied to rigid standards. They can therefore hardly help the industry, although this is exactly what they have set out to do.

The necessary financial instruments to finance small and medium companies in the off-grid industry are still lacking. There was some time ago a similar situation with the micro enterprises in Bangladesh, where banks would not give them loans because the bureaucratic burden on small loan amounts appeared too big. This was the appropriate ground for the now globally widespread microfinance idea, whose most prominent representative is Muhammad Yunus.

The off-grid industry needs today a similarly intelligent and creative solution as the microfinance institutions developed back then. Quasi "SME Fi-
The ingredients are aligned: tested products, successful distribution models, reliable end-customer financing, and a largely subsidy-independent market.

**The question therefore is:** where is the person or creative group of entrepreneurial minded investors, that will assume, in a wise and committed way, the succession of Muhammad Yunus and that will develop an innovative financing concept for the local companies in the off-grid industry?
Developing countries are the unlikely drivers of green finance innovation and they are also leading the way in the use of fintech such as mobile payments. But collaboration is key to making green finance work at scale, said panelists at the Singapore, Green Finance and the Collaborative Challenge event last week.

Jointly organised by Singapore Management University (SMU), the United Nations Environment Programme (UNEP), and the Singapore Institute of International Affairs (SIIA), the dialogue featured speakers from the finance sector and national and international regulatory bodies sharing their views on how collaboration can make money work for the public good.

Green finance, or investments that contribute towards a sustainable, low-carbon and climate-resilient economy, has been touted by experts as a way to drive carbon reduction strategies and achieve sustainable development goals.

Simon Zadek, co-director, UNEP Inquiry into the Design of a Sustainable Financial System – which engages, informs and guides policy makers, financial market actors and other stakeholders in the transition of the global economy to a low carbon, green economy – told the 100-strong audience that much of the innovation in green finance is not coming from where the major capital pools are, but from developing nations such as Mongolia, Kenya, Bangladesh, Chile, Peru and Colombia.

Fellow panellist Nuru Mugambi, director of communications and public affairs at the Kenya Bankers Association likewise said there had been a change in the way emerging markets are being viewed by the developed world.

"When you look at the amount of innovation taking place, especially in the financial technology (fintech) space on the back of mobile technology, you realise there’s a lot of opportunity for the developed world to learn from the developing world," she said.

In developing countries, the lack of infrastructure has led to technological leapfrogging in how people use the Internet. Rather than desktop or laptop computers, mobile phones have become the favoured devices to communicate, search for information and perform financial transactions.

This is especially the case in Kenya, where 82 per cent of the adult population owns a mobile phone – either a feature phone or a smart phone – and mobile phone-based funds transfer service M-Pesa is a daily way of life.

M-Pesa was originally a payment platform for microfinance owners with no access to banks, and transactions for 2015 on this platform totalled US$28 billion or the equivalent of 44 per cent of Kenya’s GDP for the same year, making M-Pesa the world’s leading mobile money service provider.

Banking institutions viewed M-Pesa as a threat at the beginning, Mugambi noted. But the sector began to embrace the platform as adoption increased, eventually integrating M-Pesa into their ope-
Fintech solutions are helping to create a financial ecosystem around it. Kenyans can now get credit, save money, make business payments, and soon even access bonds and pay bills via their mobile phones.

Panel discussion moderator Ann Florini, academic director, Master of Tri-Sector Collaboration, professor of Public Policy, School of Social Sciences, SMU, pointed out that besides solving the banking exclusion problem, M-Pesa is also addressing the issue of access to electricity in a sustainable way.

The creation of the mobile money system enabled the rise of M-Kopa, which sells household-level solar lighting systems through an installment plan that is paid for via mobile phone.

Mugambi said that collaboration tends to drive the growth of companies like M-Kopa because securing funding is an area in which fintech typically struggles. "You have a concept and it has potential, but you don't have the money to scale it, and you don't have the regulatory system in place," Mugambi noted, referring to a common problem.

Lucky for M-Kopa, its last round of fundraising attracted the interest of Al Gore-founded fund Generation Investment Management, Virgin's Richard Branson, and AOL co-founder Steve Case.

**How Ant is building a forest**

China's mobile payments platform Ant Financial Services is another example of how collaboration has enabled mobile-based fintech solutions to take off. It launched a carbon emissions calculation and offset feature within its Alipay app in August 2016.

Zadek, who is also visiting professor DSM senior fellow in Partnership and Sustainability at SMU, said the experiment, called Ant Forest, was the product of a joint effort by UNEP and Ant, and informs users of the amount of carbon emissions they have prevented through making online payments or other daily activities such as taking public transport instead of driving a car to work.

Once a user has accumulated a certain level of carbon emissions reductions, Ant's partner organisations plant a real tree in Inner Mongolia. China.org.cn, a state-backed news portal, reports that so far 520,000 trees have been planted through the scheme.

Like M-Pesa, Ant Financial Services began as a small merchant payments platform specifically for an e-commerce site.

"The difference," said Zadek, "is it has (450 million active) users. It runs 170 billion transactions a year and at its peak usage, which is in the Chinese New Year period, it runs at 83,000 transactions a second."

In a major show of leadership, Ant Financial Services is also set to become the first Chinese company to drive a global public-private partnership that will be announced at the 2017 World Economic Forum this month.

**Green finance's dirty little secret**

Collaboration is green finance's "dirty little secret", according to Zadek. An estimated US$5 to 7 trillion is needed each year to finance climate mitigation and adaptation efforts, as well as address the sustainable development challenges laid out in the United Nations' 2030 Agenda for Sustainable Development.

"It's completely inconceivable that public finance will play a major role in meeting those targets. The answer has to be private money," he said.

Although the question of how to make green finance work appears to depend mainly on policy, regulation and market innovation, "we find almost no cases where it's not about collaboration", Zadek said.

Stock exchanges have a key role to play in encouraging the business sector to get on board with green finance, stressed Mohammed Omran, executive chairman of the Egyptian Exchange, chairman of the Federation Euro-Asian Stock Exchanges and professor of finance at the Arab Academy for Science and Technology.

He added that the US$7 trillion needed to achieve sustainable development and climate action will come not only from the banking sector but from the private market too, and that the world needs stock exchanges to help shift investment flows to the green economy.

"That's why I expect that in the next three to five years, rather than a comply-or-explain scenario for environment, social and governance (ESG) guidelines, they will become compulsory," he said.

Presenting a view from the banking sector, DBS Bank CEO Piyush Gupta said two emerging trends are making green finance more compelling.

Advancements in technology, he said, has made the financing of green fintech more economical-
ly viable; the cost of generating clean energy is lower today and thus is a more attractive investment option.

Meanwhile, sustainable development has moved into the mainstream, and into the boardroom, he said.

DBS rolled out a set of comprehensive ESG policies last year for the first time, and in 2015 the Association of Banks in Singapore released guidelines to align the financial sector’s activities with social development goals.

Banks are interested in being aligned with national and international level policies as “finance doesn’t live in a vacuum”, said Gupta. “Finance and financial services work in the context of society and economies.”

When a member of the audience asked what it would take for the finance sector to dial down investment in fossil fuels, Gupta said that if a government chooses to include oil, coal or gas in the country’s energy mix for the future it is a “very hard decision” for any bank to steer clear of such large financing opportunities.

This shows the need for everyone - banks, government and the financial system itself - to be on the same page to reduce investment in unsustainable options, he said. “It’s very hard for the financial system to operate in and of itself, independent of international and national agendas.”

Hannah Koh has five years of journalistic experience in current affairs and the B2B travel industry.
First published: eco-business.
In a small village called Katiahat, West Bengal, men and women are predominantly engaged in agriculture. Sudha (name changed) and her husband are also involved in the same, working as agricultural labourers.

Sudha wakes up at 5 am to do her daily chores – finishes her ablutions and religious rituals to leave the house by 6:30am with her husband. In a nearby field, they plough, sow, and till the land in the same fashion, devoting an equal number of hours. But at the end of the day, Sudha ends up earning Rs 30 less than her husband.

“That’s the standard rate, and everyone pays the same,” says Sudha.

She, like the rest of women in the village, knows this disparity, but they are so used to it that no one questions the authority; money is money after all, even if it is Rs 30 less.

On average, women in the labour market still earn 24% less than men. While this standard rate essentially pulls the women’s share in equality down, the women are generally put on the forefront when it comes to taking loans from micro-finance organisations.

Micro-finance and women’s empowerment

With the advent of neo-liberal ideas, the free market has grown by leaps and bounds, and so has the economy of developing countries. The ones that were staggering started growing by giving small credits and consolidating the informal sector.

Small credits or micro-credits are given in rural areas primarily to women. What started as a revolution in Bangladesh during the 1970s with the inception of Grameen Bank slowly started spreading across developing countries.

Women were inducted into the programme, they were given small loans to start their own businesses, to make them self-reliant and provide employment. The insinuation behind this gender-driven initiative was the tenacity and responsiveness that women were able to show, when it came to handling money for their own households.

It was noticed and feared that men would bounce on their loans and spend it on themselves rather than utilising it for building assets. Women were the safer bet; from a business point of view, female clients register higher repayment rates. It was portrayed as a scheme that would consolidate economic independence and gender equality within the rural masses.

For this purpose, small credit groups are created and women and given loans based on their needs.

But the lacuna to this grand plan was this: women’s participation in building assets was far less than it was thought to be. In different reports and studies, it was found that most women were not the direct beneficiaries of the small credits. Instead, women acted as a channel for the male members of the family to get the loan.

Aminul Islam from the Varendra University,
Bangladesh, says: “Most rural women in Bangladesh used the money to pay the dowry for their daughters; it did not particularly lead to any women’s upliftment, nor was it utilised to build business enterprises. In fact, in some cases, women’s positions were relegated.”

The situation in West Bengal
A similar situation was noticed in different parts of West Bengal, where women readily agreed that although the loan was taken by them, it was in fact utilised in agriculture by their husbands. Sahiba Khatun (name changed) says: “I never falter to pay the interest on time, but the money goes into my husband’s pocket, he knows where he spends, at the end of every week, he gives me the amount and I pay it back in the branch. I have no idea what is profit or loss. We are dependent on them (micro-financing units) because banks wouldn’t give loan to my husband. They need collateral.”

Although in most cases women were more than happy to get small loans, which the family was utilising for different purposes, there seemed to be no direct relation between micro-credits and women’s empowerment. In fact, child marriage and illiteracy were rampant among women and girls in West Bengal.

Rupa, from Falakata, West Bengal, has been taking loans for years from MFIs. She says: “I will get my daughter married by next year, that’s why we pulled her out of school. She now needs to learn household work. We are planning to take a loan for my son’s education.”

Experiences from the ground
Millenials who have worked in different parts of the country with various micro-finance organisations shared their experiences with this author.

Ritika Puri, 26, who has worked as a fellow in rural Odisha, says: “Gender disparity is widespread. Women are barely part of the economic decision-making. Though the MFIs put up a show of giving out loans only to women members of the family, in a high percentage of cases, the money is used for/by the businesses run by the male members of the family.”

Shrutanwita, who works with an MFI, says: “The first thing about micro-finance is, it gives you an idea that it is a social development tool rather than a business model. However, that’s not true at all. Women’s empowerment is just a misconception attached to micro-finance. Women in rural India who take these micro loans, don’t even use the money themselves; they are just being used to get the loans by their husbands. They are mostly illiterate, and do not even understand how much interest they are paying. Whenever I have visited the rural areas for my work, I have seen the wife, running a handloom, has taken a loan to fix the loom, but given away the loan money to the husband. When asked about the use of the money, they would say it was used for their husbands’ businesses, but had no clue how their husbands used it.”

In most rural areas, the idea of growing up is associated with marriage for girls. Parents get their daughters married before they can even reach the legal age, and education loans are mostly used for teaching male children, not female.

No tangible impact
According to a research study by the World Economic Forum, in 2015, in Bosnia and Herzegovina, Ethiopia, India, Mexico, Mongolia, Morocco, and the Philippines, “access to micro-credit also did not appear to have tangible impacts on borrowers’ well-being or the well-being of others in their households. For instance, three of four studies found no effect on female decision-making power and independence. In Mexico, where the micro-finance institutions emphasised empowerment, women did enjoy a small but significant increase in decision-making power. In six studies, micro-credit access did not increase children’s schooling.”

Although they are a business, most small-scale MFIs register themselves as non-profit organisations, charging as high as 26% of interest for business loans.

Ritika says: “Borrowers have to pay an enormous interest rate for every small amount of money they are lent out. The interest rate cap by RBI has been fixed to 26%. And most MFIs charge this upper limit rate on the micro loans given out for business purposes. Loans for other purposes like education or solar/energy loans, i.e. non-income generating loans, have slightly lower interest rates, but never less than 18%.”

Additional note: While most of the developing countries perceive micro-credit as a tool to eradicate poverty, on the ground, it only enhances people’s ‘freedom of choice’ in how they decide to
spend the money, which does not necessarily mean it would be used for asset building.

Some MFIs try and incorporate financial training to their women borrowers, which in turn can lead to financial independence. However, the financial status of women should not be a bar to measure social development index.

Deepanwita De is a free journalist in India.
First published: CatchNews.
What if the institution that financed your business could also light up your house? Microfinance institutions (MFIs) have mostly stayed out of the pay-as-you-go solar (PAYGo) space, but that may be changing — creating both new opportunities and challenges for financial inclusion, as it brings MFIs into consumer financing.

In recent years, we have seen non-traditional lenders such as M-Kopa and Fenix International emerge in the PAYGo space, installing more than 800,000 solar home systems and offering follow-on loans to many of those customers. Traditionally, PAYGo providers have strived to be vertically integrated companies that do hardware and software design, sales, distribution, service and financing all under one roof. While many of these companies have excelled at three or even four of these competencies, offering one- to three-year financing has created obstacles to growth. PAYGo companies are not financial intermediaries, so their portfolios are typically funded with hard currency loans. Since customers pay for solar over several years in local currency (Kenyan shillings, Ghanaian cedis, etc.), PAYGo companies can find themselves with significant working capital shortages and foreign exchange risk (the Ugandan shilling fell 30 percent against the dollar in 2015 alone).

MFIs are arguably better positioned than PAYGo companies to finance pay-as-you-go solar. As deposit-taking institutions, they have more local currency and less foreign exchange risk. They also have an existing customer base and loan distribution network along with the ability to offer a wider variety of follow-on products to good-paying customers, such as unsecured loans, savings and insurance. For years, PAYGo companies adhered to the vertical integration model, excluding financial intermediaries. But now a diverse set of companies, including solar manufacturers, local distributors and financial intermediaries, is disaggregating the value chain by forming synergistic partnerships. Companies like Angaza, for example, are providing PAYGo hardware and portfolio management software to potential financiers. Angaza’s VP of Global Strategy, Victoria Arch, is committed to the idea of disaggregation within the PAYGo sector: “We believe that specialization across the value chain will be critical as energy access market matures. Capitalizing on partnerships keeps cost structures low and allows companies to focus their time, resources, and energy on what they do best.”

These partnerships have the potential to deliver PAYGo to customers at greater scale and lower cost, and more MFIs are now coming to view PAYGo as a secure means of reaching new, poorer customers with a variety of products. Some notable examples include:

- **MicroCred.** In Senegal, Madagascar, Ivory Coast and Mali, MicroCred has created a distinct subsidiary, called Baobab Plus, that uses the MicroCred network to sell life-changing products (tablets, water filters, and solar units) on credit, financed by MicroCred. Until recently, these pro-
ducts had been aimed at existing clients, with 35,000 solar units sold in 2016 alone. More recently, Baobab Plus has also begun offering PAYGo solar home systems to new customers in rural areas. The products are sold by dedicated Baobab+ agents who use the Angaza smartphone application to record activation and initial payments. The lockout technology provides security for MicroCred, which enables it to lend to poorer, largely unknown clients, with the goal of establishing a long-term financial relationship. MicroCred could also use the historical data payments for the loan scoring analysis. Per Alexandre Coster, the director of Baobab Plus: “if we want to reach non-MicroCred clients in rural areas, pay-as-you-go is the only solution to provide solar products but also for financial inclusion.”

**FINCA International.** FINCA International has done something similar in Uganda with Bright Life, creating a product called Flexipay that provides low-income households with solar electricity or clean cookstoves on credit. Customers pay using mobile money, which is more widely adopted in Uganda than in Senegal (where users pay over the counter), and they have the choice of paying over four to six months. FINCA is also working with customers to create savings and build wealth. The loan is deliberately over-long in tenor, creating a borrow-to-save experience where the customer receives some of his or her solar payments back as savings at the end of the loan. Follow-on loans are offered and approved digitally based on repayment behavior.

Each of these financial institutions is using off-the-shelf components and sophisticated management software to move rapidly into a new type of lending. They are also learning from PAYGo operators, incorporating digital payments and other digital financial services to lower their operational costs. Several of these players are building out their own distribution and servicing capacity, undermining some of the efficiency gains. In the future they could partner with existing distributors to handle sales and service, and the value chain could become even more disaggregated.

We have long known that there are potential synergies between energy and finance at the bottom of the pyramid. In Bangladesh alone, government-supported financing led to more than 4 million solar home systems being sold in 10 years. MFIs do have real advantages over pure PAYGo players, as discussed above, but there are also potential stumbling blocks. What is happening now is reminiscent of an era in microfinance (MF+) when MFIs moved out of their core competency, an experiment that did not always yield optimal results.

PAYGo loans may end up mobilizing long-term household savings, but these loans are not income-generating, meaning they bring microfinance into consumer financing. Becoming a financier of household products could change the MFIs relationship with the borrower and bring the potential to create credit bubbles. PAYGo technology mitigates this risk by giving the lender a unique form of leverage, but it can only increase borrowers’ willingness to repay, not their ability. In short, PAYGo’s potential to create new opportunities to reach customers is exciting, but MFIs must be cautious in their adoption and implement proportional safeguards for this new growth area.

Daniel Waldron is a consultant for CGAP heading up the energy component of Digital Finance Plus. First published: CGAP.
Alexander Sotiriou

Are PAYGo solar companies a new type of microfinance institution?

Pay-as-you-go (PAYGo) solar companies have been lauded, by CGAP and others, for their ability to provide low-income rural households with clean, affordable energy. Yet there are many unanswered questions about their business models that may limit the speed and scope of their growth. Much of the confusion stems from the fact that the leading companies in the space are engaged in a wide variety of activities, from design and manufacturing to consumer financing. Given the diversity of PAYGo companies’ activities, it is fair to ask: Are they energy service companies, durable goods retailers or microfinance institutions (MFIs)? There is probably not a simple answer, and different companies may pursue different paths, but acknowledging PAYGo companies’ similarities to MFIs could help this emerging sector learn from MFIs’ experiences and overcome some key challenges.

A shift in perspective: PAYGo solar as micro-leasing

The leading PAYGo solar companies set out to solve an energy access problem, but because of the relatively low incomes of their customers and the relatively high cost of their products, their business models require a solution with an embedded financial product. And embedding a financial product has required these companies to build out activities that are similar to what MFIs have been doing for years.

“We see ourselves as an energy service company, but we understand the importance of having a strong credit department. That’s why we’re increasing our investments into credit scoring and understanding customer finances — for example, how crop cycles affect cash flows and how our offerings should take those cash flows into account.” - Paul Warnars, Consumer and Market Intelligence Manager, Off Grid Electric.

We could even take this logic one step further and say that some companies could develop the financial institution side of their business as a core competency. A PAYGo solar company with a strong credit department could use the knowledge of its customer’s risk profile, payment behavior, and desires to build a suite of leasing and other financial products.

Even if most PAYGo companies never get this far, the financial inclusion implications of the financial products they already offer are exciting. We have anecdotal evidence that more than half of new PAYGo customers do not have a relationship with a financial institution, which means that PAYGo companies have created a business model that provides financing to rural, low-income customers that even traditional MFIs have been unable to reach.

Lessons from the microfinance sector: A robust funding ecosystem

Each PAYGo company will have to decide how
much to focus on its financial activities, but all of them share at least some similarities with MFIs in terms of target customers, the sizes of the loans they are making to customers, balance sheet management, and their potential for development impact. Given these similarities, PAYGo companies, investors, and development professionals can look to the more mature MFI market for lessons to apply to the rapidly evolving PAYGo solar market.

One important set of lessons relates to the ecosystem of players that has evolved to help support the growth and sustainability of the microfinance sector. The MFI ecosystem includes a variety of actors, from core banking system providers (e.g., Oradian) to data aggregators (e.g., MIX Market), to customer protection standard setters (e.g., Smart Campaign), each of which could add value to the PAYGo solar space. In some cases, the same players will be able to adapt their services to meet the needs of both the PAYGo solar and MFI sectors. In other cases, new, more specialized players will need to emerge, but they can build off of the business models that are already established in the MFI space, rather than starting from scratch. Here we focus on players that address what has long been a critical challenge for the MFI sector — particularly during its early stages — and is now challenging PAYGo companies: attracting and managing funding.

Debt funders

If you have been paying attention to the PAYGo sector, you have probably come across the recent series of articles posted on Next Billion — by Ceniarth, Persistent Energy, GOGLA, and IFC — that discuss the level of investment flows into the sector. A related issue is the type of investment flows. We have said in the past that an integrated approach is best, and that massive amounts of wholesale debt will be required to finance the working capital of the sector. As noted, managing that debt is an activity that MFIs have been doing for decades and that PAYGo companies will need to master.

"The treasury department of a PAYGo company needs to have the same skills as one in a financial institution. It has to match the asset and liability sides of the balance sheet in terms of duration and [foreign exchange]. It has to consider its liabilities [debt] when designing assets [loans, leases, solar home systems] and vice versa." - Chad Larson, Founder/Finance Director, MKOPA.

Finding debt providers has also been a challenge, which was also true in the early days of microfinance. Over time, microfinance investment vehicles (MIVs) developed an expertise in the unique business of providing wholesale debt to MFIs in the developing world, and it would not be a departure for them to do the same for PAYGo solar companies. MIVs collectively manage over $10 billion of funds dedicated mainly to microfinance investments and, as they look for new opportunities, many have become interested in the PAYGo solar market.

"We have built strong renewable energy capabilities, which led us to raise our Energy Access Fund two years ago, and we’re excited about the opportunities we see in this sector. However, some PAYGo solar companies have similar characteristics as asset-backed financing companies, and those investments could fit into our MFI portfolios as well." - Martin Heimes, Head of Financial Institution Debt Financing, ResponsAbility.

Foreign exchange hedging services

Most international investors have hard currency funds, but taking a loan in a hard currency when your customers are earning in a local currency creates a mismatch that can put companies and their borrowers at risk of default. Here, too, the MFI ecosystem has already achieved some scale in providing solutions. Players like TCX and MFX have been providing currency hedging solutions to development finance institutions and MIVs for the past 10 years. And new entrants like Frontera Capital are looking to provide similar solutions. The products they provide should be easy to replicate in the PAYGo solar space, particularly for shorter tenor transactions.

"We have engaged with several of our current and potential clients about currency risk hedging in the PAYGo sector and see this as a promising area of growth for our business. That and the broader off-grid and clean energy space." - Luz Leyva, MFX Solutions, Senior Trader.

What’s next?

PAYGo solar companies can represent different things to different people. They have received a lot of attention from the donors, investors, and deve-
Development actors focused on energy access, and with good reason. Their impact on energy access has been impressive. As the companies evolve, however, the financial sector activities they are involved in have taken on a larger role in their business models. Consequently, these companies now show significant potential to drive financial inclusion. At CGAP, we are continuing to work on untangling the value chains the companies are involved in and are asking the question: What comes next?

Alexander Sotiriou leads CGAP’s work on Digital Finance Plus (DF+), which aims to understand how digital finance can support innovative solutions to some of the most pressing challenges in development.

First published: CGAP.
Pay-as-you-go (PAYGo or PAYG) is emerging as a solution that addresses both end-customer affordability and provides sufficient margins to fuel operational models that can scale the deployment of off-grid solar solutions to the 1.2 billion people in the world who do not have access to electricity.

Under a PAYGo model, a low-income household can take home a high-quality home solar energy system by paying a deposit – typically 10-20 percent of the total cost of ownership – and committing to a certain number of ongoing payments by signing a solar lease with a PAYGo operator. The end customer makes payments in daily, weekly or monthly increments through a mobile money account, with each payment typically paying down a portion of the principal. Proprietary hardware in the solar device regulates usage, disabling the energy services when the customer’s prepaid usage is used up or expires. Under most PAYGo models, the device permanently unlocks at the end of the lease period and ownership is transferred to the end customer. With over 1 million units installed in the past four years and over 40,000 units installed each month, the PAYGo technology and financing model is already responsible for unlocking significant growth for the off-grid solar industry.

PAYGo operators are flush with data generated daily through products, mobile payment transactions and customer touch points that are increasingly captured by a commission-based agent equipped with a smartphone. At FIBR, a project by global consulting firm BFA, in partnership with Mastercard Foundation, we see significant opportunities to improve how PAYGo operators leverage these data sets to make better point-of-sale decisions, customize the product offerings, engage and retain agent networks, inform future follow-on product and financial services offered, and ultimately build linkages with banks and other local financial service providers.
FIBR brings together fintechs and banks to partner on using networks of small businesses to deliver digital financial services to low-income customers. Small and medium enterprises such as PAYGo solar operators can act as an “indirect” channel for financial inclusion. Through the solar lease and agent touch points, low-income consumers can access a high-value asset without prior access to formal finance. Predictive analytics and machine learning enable PAYGo operators to customize the product offerings to fit market segments with unpredictable income and expenditure patterns. PAYGo solar also provides a tangible reason for low-income consumers to sign up for and use mobile money services. By generating payment and credit histories, this data can be leveraged to provide additional services in the form of product upgrades, financing appliances and other livelihood-improving devices and even financial products.

But the PAYGo solar sector also faces formidable challenges. There is a growing tension between the current rates of sales growth and portfolio quality, particularly in markets where competition is forcing operators to lower the financial hurdles to become a new PAYGo customer. As PAYGo operators scale, figuring out the right agent engagement and compensation model becomes critical to drive sustainable growth and customer satisfaction, while lowering high agent network churn and management costs.

Many PAYGo operators are also finding that a large portion of the off-grid solar market is new to mobile money in general and bill pay options in
particular, forcing companies to play an active role in reducing frictions in the customer payment experience to minimize payment delays and customer churn. The PAYGo model is inherently capital intensive, requiring financing at a scale that will necessitate new approaches to unlock capital from local financial institutions.

A new FIBR Briefing Note, "PAYGo Solar: Lighting the way for flexible financing and services" examines four key industry challenges from a financial inclusion perspective that serve as the foundation for FIBR’s PAYGo solar learning agenda: 1) unlocking local capital; 2) building data-driven financial operations; 3) tackling customer payment frictions; and 4) driving smarter agent network management. FIBR expects to conduct research and make project investments aligned with these four industry challenges in the sector. FIBR is currently working with CGAP to explore how PAYGo solar fits into the financial lives of low-income consumers across Africa, and next week will publish, through NextBillion, a case study on Lendable, an alternative lending platform that is pioneering asset-backed lending for PAYGo solar and other leasing companies in Africa.

Jacob Winiecki, a senior associate at BFA, is an off-grid energy and digital finance specialist.

First published: Nextbillion.
Jim Kaddaras

The rise of a new asset class: Can ‘PAYGo finance’ connect investors to low-income customers?

Alternative lenders in East Africa are connecting underbanked consumers with affordable, asset-backed financing that allows them to own productive assets, access credit and link to a range of pay-as-you-go services (PAYGo or PAYG), including energy. Notably, U.S.-based Lendable Inc. has pioneered a marketplace lending platform that connects these alternative lenders in East Africa (non-financial operating companies that use digital payment systems) with impact and institutional debt investors.

Lendable helps alternative lenders scale up their operations through access to technology-enabled structured financing deal services, including deal origination, due diligence, standardized documentation, payments administration and post-deal reporting. The company also facilitates customized deal pricing around principal, yield, duration and currency for alternative lenders and investors. So far, Lendable has structured financing for solar panel (click here for a related post) and motorcycle leasing companies in East Africa, where it estimates that, by 2020, the alternative lender market will reach USD $15 billion.

The potential market for solar energy

Structured asset-backed financing has strong potential to bring clean energy to residents of developing countries. According to recent estimates, 1.2 billion people – about one-sixth of the world’s population – live outside their country’s electrical grids. Currently, approximately 1 million people benefit from off-grid solar power – that’s less than 0.1 percent of those living off-grid. The potential of this untapped market is considerable. When households access solar energy and move from candlelight to electric lighting, or from polluting wood- and coal-burning stoves to electric stoves, their quality of life is greatly enhanced. Access to off-grid solar power may also prompt them to acquire refrigerators, radios and televisions. The potential of these improvements and the associated reductions in climate-affecting pollutants could provide significant benefits to low-income individuals, their communities and their countries.

A marketplace lending platform to connect lenders and investors

The Lendable approach to data analytics builds predictive models on the probability of repayment...
of the receivables it finances on leased assets, such as solar panels and motorcycles. The platform approach offers several innovative vehicles for lenders and investors:

A forex (FX) buffer. Since Lendable investors finance in U.S. dollars while the underlying loan portfolios are in local currency, the company offers lenders the opportunity to set a foreign currency depreciation buffer that absorbs FX risk on each deal, before that risk affects repayment of foreign debt financing. To limit FX risk, lenders pay a higher interest rate on their financing.

Flexible terms for lenders. Three pricing options are designed to optimize the interest rate offered as a function of the advance rate, i.e., the amount of funding advanced on the receivables financed. The greater the advance rate, the higher the interest rate lenders pay - and vice-versa.

Real-time loan-level MIS for investors. Real-time management information system (MIS) reports provide loan-level granularity. Lendable links its risk engine to client management information systems, and through a trusted third-party local service provider like a telecom, payment aggregator or payment gateway, tracks assigned receivables payments in real time.

Risk engine for analysis and pricing. Lendable has developed strong predictive capabilities on the likelihood of repayment of individual receivables. Through its sophisticated risk engine, receivables are cherry-picked and assigned to their investment vehicles as collateral for debt financing repayment. Results are highly encouraging so far. As of March 2017, Lendable has run its risk engine on 300,000 loans created by seven lenders and all results have fallen within the model’s confidence band. The average error at nine months of transaction performance was just 1 percent.

Rise of a new asset class: PAYG finance

Providing alternative lenders with structured debt financing could potentially give rise to a new asset class of PAYGo receivables. To constitute an asset class, PAYGo receivables would need to:

- Be recognized as a distinct asset class
- Give rise to a market of sufficient size
- Offer asset diversification
- Produce consistently high portfolio quality
- Offer investors risk-correlated returns

If successful in raising funds from investors at scale, the Lendable approach could bring financing for low-income individuals full circle. A predictive, risk-based approach would allow for low-touch methods with customers that financial services providers can use to originate and manage portfolios. To scale the platform, Lendable would need to ensure robust performance in its underlying receivables portfolios and operate in countries where an enabling environment would attract investors.

The latest FIBR Briefing Note “Lendable: Case Study of a Marketplace Lending Platform in East Africa” elaborates further on the new platform and PAYGo financing as a new asset class. In the past months, we have been working with Lendable through FIBR, a project by global consulting firm BFA, in partnership with Mastercard Foundation. FIBR brings together fintechs and banks to partner on using networks of small businesses to deliver digital financial services to low-income customers. The PAYGo sector and the data generated could advance fintech solutions for low-income customers using the FIBR approach. Thus, we will continue to explore PAYGo finance in the coming months.

Jim Kaddaras is an international lawyer and consultant (including for BFA) in the development finance field.

First published: Nextbillion.
Near the century-old Don Bosco Cathedral, Anita runs a flower stall. Her red roses, lilac orchids, pink hibiscus and orange bougainvillea burst in glory, beckoning the dazzled passersby. She has been selling flowers to the churchgoers since 2001. That's roughly when George, who now runs Specialist Florists, began his business on the street adjacent to Equal Shopping Mall. While Anita continues to operate from the same place with the same scale, in the past 15 years George has managed to buy 11 franchise stores in the city. While one may argue that a multitude of factors play a role in the growth of a business, Anita’s flowers could have enabled an even rosier future – in the absence of gender inequality.

Entrepreneurs can be segmented along several dimensions such as education, experience, income and geographic location. While these characteristics are certainly important, one key, often-overlooked characteristic is gender. While enterprises play a crucial role in economic development, the financial (and other) needs of those enterprises are all too frequently ignored. And this is particularly true for women-owned enterprises.

Characteristics of women entrepreneurs
Societal change has played a significant role in the emergence of women entrepreneurs. Over half of women entrepreneurs in developing countries start businesses out of necessity. They do it to survive, as they cannot find a job. Many women in rural and semi-urban areas lack specific skills needed to be employable in regular jobs, so they build micro enterprises. Other reasons why women choose to start a business include traumatic events, such as divorce or the death of a spouse; workplace discrimination due to pregnancy; sickness in the family; or economic reasons such as a layoff.

The motivations for a woman to become an entrepreneur are different from those that drive a man. Women often become entrepreneurs to be able to make their own decisions, become independent, and to establish identity and social status. Men, on the other hand, are motivated by the prospect of profits or are driven by their initiative and willingness to take risks.

Female entrepreneurs often engage in trades traditionally considered the domain of women, such as the manufacturing of apparel, beauty salons, home-based livestock rearing, food products and beverages; their male counterparts usually engage in "men's work" such as carpentry, metal work and transportation.

Women entrepreneurs often start businesses using less capital than men due to limitations in income and reserves as well as lack of knowledge about the availability of institutional funding. They are less likely to use bank loans to fund the commencement of operations and more likely to borrow from family and friends and use non-traditional/non-institutional lenders. This mani-
fests in the relatively smaller sizes of the businesses that they run. In addition, a significant proportion of such businesses operate informally in the market due to the perceived hassles of the registration procedure and lack of awareness of and access to the documents required to register.

**Ways women entrepreneurs limit their own access to finance**

Most women entrepreneurs rely on their own funds or borrow from friends and family for seed, as well as working, capital. The reasons for lack of access to financing for this segment include:

- Limited awareness/understanding of the formal financial sector’s products/services;
- Informal nature of the business and relatively smaller sizes in terms of turnover and equity;
- Lack of ownership of property or land title to pledge as collateral; and
- Inadequate documentation in terms of business and accounting records to reliably determine borrowing capacity.

**Limits financial institutions place on women entrepreneurs’ access to finance**

On the supply side, reasons that formal financial institutions often limit the finance provided to women entrepreneurs include:

- Most banks employ more men than women, and most female employees are assigned desk jobs. As a result, financial institutions miss the opportunity to empathize with, and fully understand, women entrepreneurs.
- Bankers’ perceptions that women-led enterprises present higher risks as they are usually smaller businesses with limited/no collateral.
- Comparatively, larger numbers of women entrepreneurs struggle to understand complex processes due to lack of familiarity with banking and financial systems, compounded by some bankers’ demands for signatures/approval from a male member of the household.
- Lack of access points in areas where many women entrepreneurs operate.

**Business case and opportunities for financial institutions to expand access to finance for women entrepreneurs**

Financial institutions can achieve significant first-mover advantage if they differentiate and develop a structured approach to focus on women entrepreneurs. This will ensure that the financial institution is able to attract and retain many unserved and underserved, but responsible, loyal and profitable clients. For the financial institutions, extending finance to women-owned businesses presents a great business case as:

- Women entrepreneurs are a segment that is presently not being served at scale by formal financial institutions. IFC determined that 70 percent of women entrepreneurs are un(der)served and face a USD $300 billion annual credit deficit.
- Female customers have a higher propensity to save both as business and personal customers. Also, it has been observed that deposits from female customers typically grow at a higher rate and stay with the financial institution longer.
- The financial needs of women entrepreneurs differ from that of their male counterparts on account of their different life cycles. Products and services to meet their financial needs enable women entrepreneurs to increase their assets while also meeting their life cycle needs. Financial institutions have an opportunity to customize products to the needs of women entrepreneurs such as relaxing collateral and documentation requirements; bundling savings, loans and insurance; providing loyalty bonuses; and creating differentiated marketing campaigns that open doors for higher and faster portfolio growth.
- Women entrepreneurs are reliable repayers of credit as demonstrated by the experience of banks in developing economies.
- Women end up being roughly twice as profitable for banks as men, because once they connect with a bank, they tend to access a range of financial products from the same source and do not keep their involvement limited to just credit. Hence, women enterprises present a higher potential for cross sales as compared with their male counterparts.

**How can financial institutions leverage this opportunity?**

Considering the business opportunity, financial institutions can tap into this market by:

- Developing appropriate products and services that cater to women entrepreneurs. Customized offerings for women entrepreneurs will require deep understanding of the market,
necessitating research and documentation of their needs for financial and support services.

- Reworking processes for approval and delivery of loans to women entrepreneurs in order to respond to socio-religious factors that prevent women from interacting with men (in certain regions), their tight time schedule between family and work, and need for swift approvals with limited paper formalities. Some of these changes might require appropriate changes in the institution’s policies.

- Development of alternative delivery channels to address bankers’ complaints that there are often significant delays in loan disbursement to women who are unable or unwilling to come to the branch to complete documentation. Innovative doorstep delivery systems and greater use of branchless banking channels may allow financial institutions to address these challenges without incurring significantly increased costs.

- Information systems that allow the tracking and analysis of sub-segments and the performance of the new products customised for women.

- Training staff on how to engage with women entrepreneurs. Financial institutions may consider hiring and training more female relationship managers to target women entrepreneurs. This could increase access to (and for) new customers and enhance their comfort in dealing with the institution.

- Delivery of nonfinancial services to complement the bank’s core financial services. A bank with a variety of need-based non-financial services will encourage women to access its credit services and is more likely to retain its clients. IFC reports that while banks do not profit directly from these nonfinancial services, they benefit indirectly as they are able to: differentiate themselves from the competition; experience improved client retention resulting in portfolio growth; and mitigate credit risks as small and medium enterprises improve their businesses and hence their ability to repay their bank loans.

- Investment in generating increased awareness of women-focused products and services. This might include a toll-free advisory service to allow women entrepreneurs to access advice, support and information on the financial institution’s services.

Overall, financial institutions that are ready to innovate and develop tailored financial and nonfinancial services/products can achieve first-mover advantage in this high-potential and profitable market. Such initiatives open up two opportunities: to increase their overall enterprise finance portfolio and to showcase their commitment to women enterprises.

Such an approach will ensure that many more Anitas grow their businesses – just as George managed to do.

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Anup Singh leads MicroSave’s inclusive finance and banking domain and is a key contributor to the research working group.

Christine Wanjiru Gachui is a manager in MicroSave’s inclusive finance and banking domain.

First published: NextBillion.
Let's see financing energy access as an opportunity, not a challenge

At the heart of efforts to slow climate change and build a more sustainable development future lies the often overlooked and shameful fact that, today, 1 billion people live without access to electricity and 3 billion without access to clean cooking. The challenge for these governments where there are significant energy gaps is a complex one: how to produce cleaner, affordable energy for far more people, far more quickly.

This is a challenge we must, and can, overcome. But if we’re to do that, we need to help countries unpack one of the key obstacles – lack of finance.

New SEforALL Energizing Finance research released during the UN General Assembly, done in partnership with the World Bank, the African Development Bank, Climate Policy Initiative, Practical Action Consulting and E3 Analytics, targets countries in Sub-Saharan Africa and Asia with the biggest gaps in access to electricity and clean cooking countries. It analyzes what countries are committing to energy access, how quickly and effectively the finance is being disbursed and financial challenges energy enterprises are facing in delivering modern energy services.

Overall investment in these countries is not nearly at the levels needed to meet key parts of UN Sustainable Development Goal (SDG) 7 – universal access to affordable, reliable and, with Paris Climate Agreement now in place, clean energy for all by 2030. Estimates indicate that $45 billion a year in investment is needed to achieve universal electrification access, but the latest data shows that finance commitments in the high-impact countries, representing 80 percent of the global electricity access gap, average only $19.4 billion a year.

A significant increase in investment is especially needed in Sub-Saharan Africa countries where roughly half a billion people are living without power, most of them in hard-to-reach rural areas. Decentralized renewable energy such as solar, offers a promising solution for these people, but precious little financing – only 1 percent of the finance we tracked – is going into services for them.

Perhaps more shocking, despite 3 billion people worldwide lacking access to clean cooking, investments in clean fuels and technologies for cooking are even lower. Finance commitments for residential clean cooking in the high-impact countries – representing 84 percent of the global clean cooking gap – averaged about $32 million during the two-year period we analyzed. Estimated annual residential clean cooking investment needs are at least $4.4 billion a year. We are orders of magnitude off the pace needed to ensure we leave no one behind.

But our research also shows myriad encouraging indicators, including modest gains in several countries that have made access to electricity and clean cooking political priorities. We’re also seeing early stage shifts in financing strategies by
governments and development finance institutions that will target energy access solutions more effectively.

Bangladesh and Kenya, in particular, are making gains in urban and rural areas with more integrated electrification strategies that include centralized electric grid infrastructure and decentralized solar services, which are already powering millions of rural households. They’re also enacting policies to spur diverse types of public and private finance for centralized and decentralized energy access projects and companies – such as the Infrastructure Development Co. (IDCOL) in Bangladesh, which is helping renewable developers gain access to local debt, and the rise of pay-as-you-go solar businesses like Mobisol and M-KOPA Solar in Kenya. It’s no coincidence that Kenya and Bangladesh were among the top scorers of these 20 countries on energy access in the 2017 Regulatory Indicators for Sustainable Energy (RISE) report.

Still, scattered, incremental successes will never deliver the global results that are needed on energy access. More than ever, we need bolder, refined strategies that will catalyze larger and smarter investment in electricity and clean cooking access.

Government leaders, financiers and other key influencers need to work together with greater urgency toward targeted, integrated electrification strategies that emphasize both large grid-scale projects and decentralized energy. Encouraging decentralized, renewable energy investments offers a cheaper, quicker, way to reach a critical segment of people whose economic potential – their productive capacity – is lost to the broader economy by not having reliable, affordable energy services. We need to be focused on the economic dividend that comes from speeding up energy access – from better health and education outcomes and the new income derived from the business.

We must also acknowledge, as confirmed by the woeful finance commitments, that it is time to have a frank dialogue on how to spur access to clean cooking, shifting the focus to how we create market-based strategies to deploy a range of clean fuels - as opposed to dirty, high-polluting fuels like charcoal - far more rapidly and at scale.

This research provides a first-ever picture to examine existing, generous, development finance flows to ensure they are having maximum impact, and to ask serious questions of governments about their own investment strategies using domestic resources. In addition, as we build markets to serve such large numbers, it also points to room for patient capital from new sources – the faith communities, philanthropy and mission related investment, that can complement existing flows.

But look back to where we started. The commitments governments made in adopting the SDGs and in joining the Paris Climate Agreement mean that we need to extend energy services to people who we have never reached before, and do so while decarbonizing.

The good news is that if we work together, we can still achieve universal energy access. The innovation and examples of success at small and medium scale across the world help show a pathway. Yet we’re risking this future if we don’t meet the global challenge of attracting exponentially more finance that is used with much more discipline and urgency. If we do that, we will see the results we all want so much.

Rachel Kyte is CEO and Special Representative of the UN Secretary General for Sustainable Energy for All (SEforALL).

First published: Thomson Reuters Foundation.
Using Fintech to feed the world: Four innovative approaches in smallholder finance

As aspiring homeowners in the United States use online services like Rocket Mortgage to "make getting a home loan easy," an ocean away in places like Kenya and Zambia, rural smallholder farmers are using similar digital technologies to access the finance they need to improve their farms and businesses.

These farmers – who typically farm fewer than 5 acres of land, roughly the size of five football fields – play a critical role in feeding the world's growing population (set to hit 9 billion people by 2050). But with a whopping US $200 billion gap in smallholder financing, many cannot access the financing they need to invest in things like seeds, fertilizers and irrigation technologies to increase production and improve their livelihoods.

There's good news though: Across the world, innovative fintechs – companies using technology to enable financial services like virtual currency and mobile banking – are making it easier for farmers to access finance. Take East Africa, for instance, where fintechs are booming. If scaled, these companies could play an important role in empowering smallholders to improve their livelihoods while delivering a food secure future.

From our experience at the Rural and Agricultural Finance Learning Lab, a research firm that advises agricultural fintechs to better serve farmers, we're seeing several innovative fintech companies starting to address some of the most challenging barriers to financing smallholders:

First Access and FarmDrive are using alternative data to help banks lend to rural and smallholder clients: In the U.S., banks and other lenders use credit histories and FICO scores to assess creditworthiness when people apply for car loans, home mortgages and more. In countries like Ghana and Rwanda, however, most smallholders use cash only, have no bank accounts and don't own property - leaving them without a credit history for banks to use in evaluating risk and justifying loans.

First Access is addressing this challenge by developing a technology platform and algorithm through which banks can create credit profiles for smallholders. By combining First Access' own customer data with "hidden" points – such as consumers' prepaid mobile money history or utility bills – financial institutions can assess smallholders' creditworthiness and extend loans to individuals previously unreached.

FarmDrive takes a different approach, allowing farmers to upload information about their expenses, revenues and yields through a mobile app on their phone. FarmDrive combines this information with data from other sources like social media, weather stations and market prices to build personal credit scores and enable farmers to request loans via mobile phone.

Musoni is making traditional banking more accessible to rural customers: Most of us could walk
or drive a short distance to a local bank if we wanted to set up a new account. But in many rural communities in Africa, banks don’t have branches outside major cities and ATM networks are scarce. As a result, many farmers are not familiar with how banks work and therefore don’t benefit from traditional banking services such as savings accounts or loans.

Musoni is addressing this challenge by bringing the bank to the farmer. It sends field officers with tablets to register new farmers and educate them about the process. Then, with Musoni’s digital platform, farmers use mobile phones to manage their accounts, receive loan disbursements and make payments.

**Tulaa**, the mobile agent banking arm of Esoko, is connecting banks and suppliers/buyers to smallholders for information sharing: Many of us are used to having information at our fingertips – if we want to know how to grow rosemary in our backyard, for example, we can watch a YouTube video or ask Siri. However, in countries such as Kenya, Ghana and Rwanda, most farmers don’t yet have high-speed data or smartphones. As a result, farmers cannot access critical information needed to manage their farms, including good farming practices, weather patterns and market prices for their products.

Tulaa connects farmers with organizations such as financial institutions, agribusiness buyers, input suppliers and NGOs, all through mobile phone technologies such as SMS texting. Its communications platform delivers critical information – like tailored agriculture and market advice – to improve farmers’ production and businesses. And now, Esoko also helps fintechs develop new products that benefit farmers and enable them to borrow cash for discounted farming supplies.

Fintech solutions are unlocking new ways to reach the farmers who will play a critical role in feeding the world’s 9 billion people. Although you’re unlikely to hear about a Silicon Valley-type IPO from fintechs across countries in Africa – these innovations are ripe and have significant potential to scale and make impact if they receive the necessary investments.

Ultimately, closing the gap in smallholder financing to help address food security is a daunting task. Even with the proper access to finance, ongoing droughts and famines (such as those in Nigeria, South Sudan, Somalia, and Yemen) remind us of the challenges farmers face on a daily basis. But we believe a food secure world is within our reach, and fintech solutions for farmers are an important step in the right direction.

Mikael L. Clason Höök is the manager and Malia Bachesta is communications lead of the RAF Learning Lab.

First published: Nextbillion.
The 2016 Climatescope report—which focuses on the state of cleantech markets within 58 developing nations in Africa, Asia, Latin America, & the Middle East—renewable energy investment in developing countries are more attractive than the developed counterparts. Thus, affirming that emerging markets offer excellent opportunities for solar energy investment, which should make investors very happy.

The report adds that emerging markets had more investment in 2015 than its Organisation for Economic Co-Operation (OECD) & developed counterparts (USD 154 billion vs. USD 153 billion) and renewable energy capacity (69.8 GW vs. 59.2 GW).

And this is just the tipping point.

Recently, the Asian Development Bank (ADB) invested heavily in Sri-Lankan solar power, confirming why emerging markets are a hot destination for solar investment. According to CNBC.com, the ADB had approved $50 million in loans to advance Sri-Lankan solar power generation.

Energy specialist at the ADB Mukhtor Khamudkhanov said to CNBC that Sri-Lanka has made gains in adding electricity within the country over the past 20 years, and believes its essential to make the nation’s energy more environmentally sustainable. “But there is a need to diversify the country’s energy mix toward more renewable and sustainable sources,” he said.

The ADB sees the possibilities in solar energy investment within developing nations. Here is why emerging markets offer abundant opportunities for solar investment.

**Reason 1: Falling Prices**

A 2016 Quartz article pinpoints the critical driver why solar is becoming a more attractive investment option. The article points to a World Economic Forum report which said wind and solar are now cost competitive with fossil fuels.

According to the analysis, solar is expected to be half of the electricity price of natural gas within 10-20 years.

However, that may come sooner than expected, as SolarPack bid to provide solar electricity in parts of Chile at 58% lower than natural gas (€29.1/MWh). ClimateScope also projects solar bids are becoming cheaper against their fossil fuel competition.

Falling prices will no doubt sweeten the pot for investors if they are on the fence on investing in solar energy within these regions.

**Reason 2: Developing nations are beginning to compete with developed nations on innovation**

Mainland China was ranked 27th in a recent World Economic Forum study on competitiveness while being level or better than many developed nations on innovation. Chief representative of the World Economic Forum’s China outlet David Aikman told China Daily its prowess as an innovator has been the most critical development for them within the past ten years.

The proof is visible with the nation’s solar industry.

China topped globally in total solar capacity in 2016 with 78GW, according to the International
Energy Agency Photovoltaic Power System Programme (IEA-PVPS).
If China is any indication, and with billions of middle-class customers coming from emerging markets, expect innovation to explode, and entice more solar development.

Reason 3: Paris Climate Agreement will open up the floodgates for solar investment
In 2015, the Paris Climate Accord brought over 190 countries to bring global warming to well below 2C of pre-industrial levels, while targeting 1.5C. This opens a wealth of opportunity for solar in developing nations.
The International Finance Corporation, a World Bank group, predicts climate investment for emerging markets will reach USD 23 trillion by 2030. Latin America is primed to grow their solar markets, with USD 3.8 billion invested in 2015. Wind energy was tops in the region with USD 10.7 billion.
With extreme weather events expected to increase from a warming planet and effect those areas most vulnerable, including emerging market countries, will find solar investment as a mitigation tool in trying to avoid the worst effects of climate change.

Reason 4: Leapfrogging past fossil fuel infrastructure
At a social level, there is another reason than for emerging market countries to entirely build a new clean infrastructure from scratch, rather than copy what developed nations went through using fossil fuels to grow their economies.
Former French President Francois Hollande told the Organisation for Economic Co-Operation and Development 2015 Annual meeting, developing nations have a chance to kill two birds with one stone in developing their economies, while supporting low carbon energy systems.
Hollande said leapfrogging in emerging markets past fossil fuel use to clean energy is the equivalent of when mobile phones penetrated the African market, thanks to falling costs. Traditional landline infrastructure became irrelevant.
"The digital revolution and the energy revolution will go hand in hand as in a sense we are talking about the same revolution," Hollande said to The Guardian.
Whether its falling prices, the rise of innovation, leveraging climate investments or leapfrogging past old infrastructure, developing nations will offer golden opportunities for solar investment.
Social enterprises are unique additions to our economic landscape. While they employ business principles to earn revenue and offset costs, their primary mission is to create positive social and/or environmental benefits. They often work in challenging business environments where the need for balancing social objectives with financial sustainability is paramount.

However, the capital they depend on expects a lot from them: On the one hand, they should be more efficient than governments, and on the other hand, more sustainable than the nonprofit sector, while simultaneously being more socially conscious and even as profitable as traditional business.

The truth is that the impact investing story has not been told from the social enterprises’ perspective and so the field remains blissfully unaware – or intentionally ignorant – of the social enterprises’ experience as they seek and gain impact investments, which often involves accepting financial terms and/or partners that can distract from their social mission.

For the field to evolve, we need to start telling – and hearing – their stories. To that end, we offer the financing story of the two-decade-old social energy enterprise, SELCO India. Since 1995, SELCO has delivered solar-based energy solutions to low-income communities in a financially and socially sustainable manner. SELCO’s is a deeply client-centered approach.

From SELCO’s 2015 article, “Bridging Gaps: Impact Investors and Social Energy Enterprises”

For example, it adopted the role of systems integrator, which means it does not manufacture components itself, but rather establishes partnerships with local suppliers for component parts like panels, batteries and electronics. By leveraging this portfolio of partners, it is able to tailor energy solutions specifically to the needs of each particular client. Understanding the mobility constraints of rural clients, SELCO has achieved its reach through 52 energy service centers across five states in India and employs over 375 local sales and service staff to support its customers. It has also built partnerships with local financial institutions to provide user-centric financing via a cash flow lending approach.

SELCO understood how grant dependency could threaten its financial sustainability and, as such, rather than registering as nonprofit, it registered as an Indian private limited company in 1994.
Early expansion was funded by a conditional loan from USAID and equity from E+CO and SELCO USA. After seven years, SELCO broke even, and after 11 years, it had peak profits of $88,380 USD. In 2003, further expansion was supported by a low-interest IFC loan.

The trouble started in 2006, when demand in the German solar market spiked and Indian panel manufacturers began mass production and export of high wattage panels, neglecting production of smaller panels. This led to an inventory crunch for the types of smaller panels SELCO sold to its low-income clients and significantly increased their costs. As a result, SELCO came under significant pressure from primary investors at SELCO USA to cut back on workforce and focus on larger system orders to bolster profits. This was in direct conflict with the philosophy of the organization and would have spelled doom in the future, both from a business and social impact standpoint. SELCO believed maintaining its intellectual capital was vital and focusing on larger systems was unsustainable for fulfilling its social mission.

SELCO was able to access the social finance field outside of India and, thus, able to attract capital that understood the importance of maintaining the clean and affordable energy network that SELCO had built. With the help of the IFC and E+CO, SELCO refinanced the business, which included taking out SELCO USA and replacing it with long-term social investors, including E+CO, Lemelson Foundation and Good Energies Foundation in 2007. In its fundraising pitch, SELCO focused on its measurable social returns and projected only modest financial returns. These were investments not grants yet the primary performance criteria were social with a focus on financial sustainability. This gave flexibility to SELCO’s management team to make strategic decisions that were optimal from a social standpoint but could have been seen as too costly or time-consuming if profit maximization was the primary measure of success.

For example, rather than focusing exclusively on sales growth, SELCO took pains to cultivate a financial network that would allow its clients to access appropriate financing. SELCO understood that its target clients would be unable to afford outright purchase of solar systems but with the right type of financing would make excellent borrowers. However, SELCO did not want to become a lender itself. Instead, it set about improving the ecosystem through partnerships with local financing institutions with deep rural reach, persuading them to offer cash-flow based lending. This required educating banks on the benefits of financing clean energy systems for low-resource households, a technology and client base that was still new to many. SELCO raised some grant funds to provide partial guarantees to banks to de-risk their entry into the space of energy financing for people living in poverty. This extra effort took time away from its core activity of selling energy systems but was seen as an important aspect for the sector to be built in a pro-poor manner. Despite this “impact first” orientation (or perhaps because of it), SELCO has grown to over US $6 million in revenue with 375 employees earning a self-sustaining 2 percent return.

SELCO’s experience is emblematic of so many other social enterprises that prioritize social returns within fragmented enabling environments. Its experience points to several improvements that the impact investing field should consider:

- **Fund Zebras not Unicorns:** “Unicorns” are the typical high-growth VC target companies that grow exponentially and carry the returns for an entire VC portfolio. An alternative concept that has been offered recently is “zebras” - normal growth businesses that “balance profit and purpose, champion democracy, and put a premium on sharing power and resources.” SELCO knew it was a zebra and that this limited the pool of possible financial partners. Managers steered clear of investors who they felt could lead the firm to “mission drift,” wherein the values upon which the social enterprise was founded become negotiable. Even with mission-aligned investors (or perhaps thanks to them), SELCO has built mission protection safeguards such as staff incentives for those going the extra mile to achieve impact, and checks and balances in its governance practices to avoid decisions that would move SELCO from its original vision and mission.

- **Set the right notions on internal rate of return:** Zebras will not achieve unicorn-status –like IRRs. Zebra firms reinvest not exclusively in their businesses but also in the communities around them. For SELCO, responsibly selling decentralized renewable energy systems among poor communities and households has required considerable
financial and human resources to build a functioning system with appropriate financial products, market linkages, robust after-sales service and new products co-developed with people living in poverty. This extra effort has resulted in IRRs and profits in the single digits, however, this is not by accident as much as by design. While SELCO's investors have received less than they could have from many traditional investments – and far less than from unicorn funds, which according to the Kauffman foundation often fail to exceed returns available from the public markets – this intentionality around impact has meant that the community has received considerably more.

- **Dig beneath the surface**: Common metrics of success focus on growth. In the absence of strong oversight, mission-supporting safeguards and transparency, this can result in a dangerous tendency to pursue large volumes over developing responsible processes. We know this from the history of microfinance where, in certain circumstances, the social mission was subjugated to the pursuit of sales targets. At SELCO, a branch that outperforms its peers in terms of revenue growth may not be succeeding in delivering its impact goals, since selling just a few solar systems to large institutional buyers can lead to high revenues, while selling smaller systems in more remote regions is considerably more time-consuming. SELCO rewards its staff accordingly by aligning performance incentives and recognition around impact achieved – for instance, when a staff member figured out that Indian dairy farmers would directly benefit if more dairy co-ops had access to reliable energy. The staff member understood the problem that many dairy farmers faced, i.e., that they would waste time traveling to their co-ops only to find that, because they had no electricity, the co-op was unable to weigh and price the milk. The solution was a market-based one: to work with dairy co-ops to solarize their systems.

In impact investing, we have the opportunity to rethink the rules, incentives and structures of money lending that have defined traditional finance. Investors in this space and the funds in which they invest should act in service of the greater goals they are collectively looking to achieve: poverty alleviation, gender justice, energy access, etc. Hence, the rules, mechanisms and structures, not to mention attitudes and behaviors of impact investors, should adapt to be first in service of those goals, and second, in service of the enterprises and stakeholders who will help achieve those goals. The first step is to listen.

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Mara Bolis is a senior advisor at Oxfam, where she leads work on shareholder advocacy, as well as influencing work on impact investing.

Sarah Alexander is a senior advisor at SELCO, which seeks to develop enabling conditions for the replication and scale-up of energy access solutions for the poor.

First published: NextBillion.
Taking stock after 15 years working on off-grid solutions to energy access, we are hugely encouraged by the progress that has been made. We are seeing scalable solutions emerging and growing commitments from governments and funders to do what is necessary to deliver universal access to energy.

At the same time, with only 13 years to go before 2030, we see limited analysis on how much this is likely to cost. In recent discussions with our off-grid energy partners, DFID and USAID, we agreed that more clarity on this would be helpful for the sector.

This summer, Shell Foundation and Catalyst Off Grid Advisers set about trying to get a realistic idea of the quantum and type of capital needed to reach the off-grid component of Sustainable Development Goal 7 (SDG 7) in sub-Saharan Africa (SSA), defined as all households with at least a large portable system or a solar home system.

Our key findings
1. Over 125 million households in Africa still lack access to modern energy services. Mini-grids and solar home systems have, to date, reached around 1.8 million households (HH). We estimate that with business as usual, we will miss the SDG targets in Africa by about 100 million HH.

At the current pace, SDG 7 will be missed by more than 100 million households.
2. Projections for the expansion capacity of the grid and mini-grids suggest that their share of 2030 coverage will be in the following ranges, depending on different investment scenarios: 52%-62% grid and 0.4%-2.5% mini-grid. This leaves off-grid solar (OGS) delivering 13% of 2030 coverage in the business-as-usual scenario and 41% in the high investment scenario. The high end of these ranges for grid and mini-grid, result from extreme stretch assumptions: for the grids, projections that are more aggressive than the IEA’s "African Century" investment projections, for mini-grids: from 3,000 (today) to 42,000 mini-grids (2030), plus significant progress around cost, modularity and policy reform. OGS is the balancing number, with the model assuming that the 10 market leaders (currently operating at scale in at least one country) would capture 75% market share in the "active" markets of Kenya, Tanzania, Uganda, and Rwanda, and 40% market share of the remaining 46 "latent" markets that do not have more than one company operating at scale. The remaining market share would need to be filled by a projected ~278 new deployments by 2nd and 3rd generation OGS companies, with each deployment serving quarter of a million customers. 41% for OGS is a very significant share and implies a step change in growth to reach the 100m HH shortfall.

3. A word on mini-grids. Even at 2.5%, we see mini-grids as a vital part of the mix, given how they trigger very significant economic growth, including productive use and SME development, and enable wider impacts to be achieved. The 42,000 figure above is a high vote of confidence for mini-grids.

4. To calculate how much capital is needed, we took actuals from known companies, assumed the typical company funding journey: early stage grant funding, debt, equity and facilitation funding for incentivising leaders into new markets. We segmented the countries into groups (active, big three and frontier) to at least start to reflect the market archetypes. We did a top-down, market demand analysis and a bottom-up, supply side costing which showed that by 2030 we have: 7.5 million (top down)/7.5 million (bottom up) HH served by mini-grid connections, 103 million (top down)/126 million (bottom up) HH served by connections from OGS. This requires $31/33 billion commercial capital ($7 billion of which is mini-grids), including $1 billion catalytic grant/blended capital, plus funding for a $4 billion affordability gap for the poorest who cannot afford entry level systems (N.B. we see it as totally legitimate and non-market-distorting to fund this $4 billion gap, given grids are commonly subsidised – we cannot ignore it). From a methodology perspective, it was reassuring to see that two completely different, top down/bottom up analyses came to broadly similar results.

SF experience shows that establishing and scaling a SHS off-grid deployment in one country takes years and millions of USD.
There is a mismatch with currently available finance
1. Quantum: The $1 billion catalytic grant/blended capital does not exist, so we will not generate the pipeline without finding more of this. The late stage commercial capital is probably there for de-risked opportunities. Capital finds good opportunities.

2. Type: There is a clear financing type gap between early stage (mainly grant, convertibles) and late stage (commercial) capital, which is proving to be a critical blocker to sector growth. We are calling this the "growth stage" funding gap, defining growth stage as being companies with a typical profile of: ~$2-15 million revenue, $5-100 million in assets, already with a blended funding stack, with a validated product, not yet EBITDA +ve but with a clear path to breakeven, and a strong management team in place. Growth stage companies generally find that funds are structured more to meet investor needs than theirs and often come with terms that are inaccessible or highly risk averse. This accounts for our experience working with growth stage enterprises over the last 10 years, where we see CEOs spending a big proportion of their time fundraising. So, as per the grant component, without more growth stage funding, we will not achieve the sector growth needed.

It is unrealistic to change the way DFIs do business, but we can reorganise the way different types of capital are used
1. For early stage companies, we need more patient grant, repayable grant, convertibles, to build the pipeline for the 278 deployments. This capital is increasingly scarce and is likely to require some form of syndication between foundations, strategic corporates, commercial investors, impact investors and DFIs to reach the quantum required.

2. For growth stage companies, we need to build financing instruments which provide a better bridge from grant to commercial capital. Let’s call these "bridge vehicles". A bridge vehicle will typically: a) offer more than one type of capital to the client (e.g. mezzanine debt, early stage equity, guarantees, revenue based finance) so enterprises can get what they need as they grow, and on terms which are affordable; b) be return seeking but tolerate more flexible terms and take higher risk than traditional debt/equity; and c) be funded by blending capital from investors of different risk return expectations. The advantage of such vehicles is that they provide finance to companies which is flexible, affordable and accessible. Enterprises can graduate to more commercial types of capital as they achieve metrics of financial performance. They have a more predictable fundraising journey, knowing what metrics they have to achieve to be considered for more commercial funding. They allow for reduced transaction costs, standardised due diligence and much improved visibility of the emerging pipeline for later stage investors. There are already examples of bridge vehicles that have worked very well (e.g. EU/Proparco), but they are a minor category and we believe they need to proliferate if SDG 7 is to be reached. Rather than promoting the idea of setting up a single, huge, bridging vehicle, we believe it will be more realistic to promote the adoption of bridging vehicles as a generic model, with different financing agencies constructing variants that suit their own internal requirements.

3. We would argue that the only way to provide enough growth stage capital to reach SDG7 is that bridge vehicles are funded by later stage investors, who have an interest in building pipeline. Whilst we do not expect later stage financiers to change their core investment principles, it is feasible that DFIs and impact investors can identify pools of grant/bridge capital, either internally or from partners, and establish formal linkages where grant/bridge capital graduates to commercial capital.

4. Taking this idea further, if we could find a way for the sector to allocate $1 to early stage funding (of which, say, 30% grant and 70% bridge finance) to invest in seed to Series B stage companies, for every $10 of commercial finance to invest in later stage companies, we could begin to see the acceleration we need to reach that 100m HH.

5. A bold start would be for a group of funders to construct a facility of around US$250 million early stage funding, which would catalyse $2 billion of later stage investment.
We need public sector involvement, especially in frontier markets

1. Public sector will need to be involved to realise the full potential of the sector. This is already demonstrated in the “active” markets. The study suggests that the strong interaction already taking place in these countries will need to deepen further, as the business-as-usual scenario shows some of these markets still falling short of universal access.

2. There are a number of markets which are either too small or too fragile to attract private sector without incentives. Nevertheless, they play an important part in achieving SDG7. In these markets, we believe it is inevitable that closer partnerships between government and private sector will be needed. The private sector will need to be reassured that this does not necessarily mean market intervention or distortion. There are a wide variety of measures possible, and would only be needed where private sector wasn’t stepping up unassisted. There are clearly differences between the markets categorised as “latent” in the study, so different tools (see below) will need to be applied in different contexts to ensure the public funding ends up with those that need it most.

3. Bidding for participation in markets can be attractive for the private sector, if there is confidence that rules of engagement and regulatory arrangements are clear and will be respected. For off-grid energy, bidding for market participation could not only attract the new generation of off-grid companies into frontier markets, but also established service companies (e.g. utilities) partnering with off-grid companies.

4. Clearly, any arrangements curated by government need to avoid the disadvantages of traditional concession approaches which have had a mixed history. Each country is best placed to select the measures most suited to its needs. Licensing, tenders, results based payments, smart subsidies and tax exemptions are all models which have worked in different industries. Whilst district-level concessions are usually applied in on grid settings, there is potential to design variants tailored to off-grid services, especially in areas where there is an interface with the grid. Well administered, such schemes can also attract longer term, more competitively priced infrastructure finance. Our view is that one of the pre-conditions for success will be dedicated local capacity, with a mandate to provide neutral (i.e. working equally in sup-
port of private sector, government and consumers) institutional support to building a functioning market in each country. If based on a detailed understanding of local context, and of the needs of private sector, it is more likely that arrangements between government and private sector are kept as light touch, targeted and practical as possible. Ideally, such arrangements would not be needed; however without them, it is quite possible that, in some frontier markets, off-grid energy companies may not enter at all.

5. Government capacity is often limited in this area, and for those countries which do decide to explore these approaches, there would be a clear need for capacity development through exposure to other countries with a more developed off-grid energy private sector.

We see the entry of larger companies into off-grid energy as positive

The sector needs to see the entry of more established companies into the market, not just from the power sector, but also from related sectors (e.g. information, telcom, logistics); it is good to see this starting. We see this as greatly assisting both off-grid enterprises and SDG 7. Off grid companies have deep knowledge of customers and how to serve them. Established infrastructure and service companies have access to lower cost capital, market reach, expertise and R&D capability. That’s a great combination. We anticipate a gradual fading out of the terms “off-grid” and “on grid” as modern energy companies increasingly make efforts to serve both.

Funding is only one ingredient

This analysis in no way intends to imply that it is just about the funding. It is well documented that finance must go hand in hand with business support to growing companies and a supportive market environment. There is also a lot of work needed to improve margins, so many more companies can reach profitability. Shell Foundation has documented its learning in this regard from over 15 years working with social enterprises.

How Shell Foundation is responding

As we finalise our 2018-22 Shell Foundation strategy, alongside our core work building enterprises, we intend to allocate resources to help create the financing tools needed to reach SDG 7. We are strengthening our team in finance. Setting up bridging vehicles will be a priority and we aim to launch our first one in partnership with FMO and DFID in the next quarter (Energy Entrepreneurs Fund). We are also looking to establish a bridge facility and explore using a portion of our endowment to anchor it, in partnership with a number of other funders.

We will continue to work with our strategic partners DFID and USAID, through our TIME and SEAM agreements respectively, and through the Scaling Off-Grid Energy Partnership that we have co-founded, to overcome market constraints, align investments and provide the patient capital that is so plainly needed to unlock further financing for energy access.

Through these actions, and by forging new partnerships with others, we continue our commitment to making the goal of universal access to energy a reality.

Sam Parker is Director of Shell Foundation.
First published: Shell Foundation.
Technology
offer this as a working draft to the sector. I would very much welcome any feedback or comment on it, and hope that it may in some way be useful to others in developing their own thinking on these issues. With thanks, and none of any blame for any mistakes or oversights, to those who have commented on earlier drafts including Simon Kenny, Clare Boland-Ross, Randall (ESRES), Andrew Tipping, Bozhil Kondev, Jeff Felten, Phil Outram and Vivian Vendeirinho.

Mini-Grids powered by renewable energy or hybrids are increasingly recognised as having important potential to provide least-cost electricity supply to unserved settlements which are not viable for main grid connection, but densely enough packed to give Mini-Grids an advantage over a series of household solar systems. While such delivery is possible technically and innovation is moving globally, the roll out to date in developing countries has been slow. A key reason for this is that mini-grids are often considered in policy and practice as "similar to the main grid". What this has meant in practice is that a series of grid policy frameworks and preconceptions, planning and interface issues have to some extent overlapped with the emerging mini-grids sector — with the net result of deterring of investment and slowing roll-out.

While in some respects grid frameworks are appropriate, in other dimensions the mini-grids sector can be considered more similar to the household solar sector or informal diesel networks in its off-grid character. It is proposed in this paper that the mini-grids sector cannot afford to let 1000 flowers bloom and hope that a scalable model will emerge from the market. It proposes instead that a scalable model will inherently be a public-private model, and so a more active engagement is needed in the definition of this model from both the public and the private sides. It goes further and proposes a framework for such a model, drawing on evidence for what has been working to date in a range of countries and companies, and proposes where the balance of evidence lies in terms of the approach to a range of the issues and uncertainties which have undermined progress to date.

Defining a Mini-Grid

The members of the SE4ALL Clean Energy Mini-Grids High Impact Opportunity have defined mini-grids as village, town or district scale electrical distribution networks either unconnected to, or able to operate autonomously from, the main electrical grid. This is recognised as being an inclusive definition which simply differentiates mini-grids from stand-alone household systems and main grid-extension approaches. Such a mini-grid must by definition serve multiple customers with some ground-based infrastructure linking these, unlike a household solar system. Such a mini-grid offers a service either physically isolated from the grid, or able to operate in the absence of grid power — thereby clearly being an operational entity in its own right, not only a branch of the grid.

Although the mini-grids HIO does not set any
limits on the sizes of mini-grids beyond the definition above, experience indicates that there is value in a rough typology of mini-grids according to scale and other associated characteristics, given the extent of these differences, and also the policy and regulatory implications of the different types:

For a Type 1 mini-grid[2] it is highly likely that all relevant grid standards, service levels and regulations would have to be met. The service levels which customers should be receiving on such a grid should be as good as, or even better than, the main grid — since there is the possibility of autonomous generation if the grid goes down. Although all efforts should be made to ensure costs are kept down with low cost electrification approaches — grid norms (voltage, frequency, safety standards etc) should be implemented. In this respect there is no reason why the delivery cost will be any less than a grid extension project, and a similar level of subsidy on connection costs likely to be required if a regulated tariff is to be maintained.

By contrast Type 3 mini-grids[3] should be more lightly regulated in terms of service level and tariffs in particular. What is typically happening in these systems is that a power service quality at a lower Tier in the SE4ALL Multi-Tier Framework is being delivered,[4] reaching consumers with essential energy services in a place where the grid will not reach in the near future because of low population densities and/or distance from the grid. Customers are often, but not always, charged on a Pay-as-you-Go for service (not by kWh) type basis, sometimes via mobile money, at prices below that of kerosene, phone charging or diesel generators, similar to that provided by household solar systems. Those firms who do want to innovate and deliver such services should be allowed to do so, and clear future grid planning can help guide them to the most useful areas. In the pursuit of affordable delivery costs to consumers such grids are often not, and should not be forced to be, main grid compatible — although some are and this is also welcome. However, it is relatively difficult to justify from a public interest perspective that such installations, especially if not established on a competitive and contractual basis, should receive protection or significant compensation if the grid arrives, and actually does offer consumers a better service at lower cost.

Type 2 Mini-Grids[5] can potentially have some of the characteristics of both, but there is more of a premium on future grid compatibility than Type 3. By definition a mini-grid of over 100kW, if it is not on an island, is serving a reasonable load cluster which over time may well
be connected to the grid. In this context, regulation which anticipates the requirement for grid connection would make sense (i.e. grid compatible wiring and standards). For such mini-grids the payment of a subsidy can be seen as a public contribution to the mini-grid against the wires and poles—which on connection could revert to public/utility ownership depending on the exit/continuation approach taken.[6]

Planning and siting of mini-grids
There have long been calls for transparent and long term electrification plans to enable mini-grid planning, which would be extremely helpful to developers and communities alike. However, in practice these are often either very difficult to provide politically and/or inaccurate since electrification rates and budgets are not necessarily linear. A scalable model for mini-grid scale up cannot therefore entirely rely on such plans, and in any case orientation towards planning and siting should likely also vary with mini-grid type:

Type 1 Mini-Grids should have similar planning requirements to an IPP/SPP project. This is because Mini-Grids are likely to be sited in close proximity to the generating resources such as hydropower or biomass, and as such their site characteristics and ownership of the resource may be specific. Such developers will typically be considering the IPP project as the bigger part of their revenues, and since the households are likely in any case to be paying the grid tariff (see tariffs), there is a relatively reduced consumer protection consideration. In this context "sole-source" proposals are not necessarily problematic, if subsidy, service levels and pricing to consumers is grid standard.

Type 2 Mini-Grids require more consideration in planning since they will establish what could be monopolies at rates and service levels which could diverge from grid standard. Given the scale of the investment required and capital to be raised, developers and lenders will need a reasonable degree of certainty of revenues. This points to a more structured public-private approach for this type of mini-grid, where a survey is conducted identifying such towns and villages, bundling them into lots and then running an auction for 10 year concessions to supply to those places.[7] This would likely have subsidy integrated, however the auction process should reveal the best use of that subsidy, and the lowest tariff feasible for the community (or the tariff top-up required — similar to GetFIT — to bring the tariff down to grid levels if that is the policy position).

Type 3 mini-grids should generally be less regulated, and so also would expect less protection from grid planning. Realistic and transparent grid-electrification planning will definitely help guide their efforts to the places which make most sense. Investors in such firms are less interested in the site by site economics, but more in the overall revenues and growth in connections. In this respect payback times may be shorter and with more flexibility to move operating assets if needed. If concession/auction systems at the 100kW-1MW level work well and uncertainty still holds back Type 3, there could be an argument for subsequent rounds clustering Type 3 villages, but in the short run leaving delivery of such systems open to the market appears the most pragmatic approach. However, this does not mean Type 3 mini-grids should be entirely unregulated, and a proportionate interpretation of relevant regulations (eg on safety) may well be appropriate.[8]

Licensing
All mini-grid operators need to be able to demonstrate to their investors a clear license to operate, although the terms of these will likely vary between the three types:

For Type 1 Mini-Grids, firms need a license to sell power to the grid, as per an IPP, as well as a license to distribute electricity to consumers. These should be relatively straightforward and aligned with national policy and regulatory norms for such roles. In countries without the potential to offer a license to distribute, the mini-grids sector in Type 1 and Type 2 is very unlikely to emerge at all, while Type 3 will be heavily constrained.

For Type 2 Mini-Grids, the terms of the license should be linked to the Auction/Concession. This would have a clear (10 year is proposed) timeframe allowing the developer to raise financing and project revenues over a known period — with clear compensation or other clauses in the event this period is not honoured. Licenses would involve the meeting of some grid standards (eg on wiring and safety) however service level may be a potential variable, or tariff — depending on the availability of subsidy/incentive.
For Type 3 Mini-Grids, the license should generally be issued at the level of the developer, not site by site. Although developers should register sites as delivered, they should have a license to operate at the level of the firm, to do as many sites as they are able. The key point here is that although such developers have a substantial degree of regulatory freedom to operate, they should be clearly licensed at the firm level, and not in a regulatory vacuum as often currently the case, undermining investment. Environmental approvals etc should be provided also at the firm level for the mini-grid installation type, not required for each site (provided that the systems are standardised and considered low environmental risk).

**Tariffs and subsidy/incentive approach**

The overarching principle of relevance to tariffs is that to be sustainable, they need to recognise the full costs of delivery, and either reflect these costs directly in the tariff over an agreed period, or have a portion of those costs met through other means i.e. subsidies or incentives. There are important principles around equity of access to energy, meanwhile there are countervailing considerations in terms of the practical costs of delivery to remote and dispersed populations. Generally subsidies should act in as progressive a manner as possible in terms of benefitting poorer consumers, while also being efficient in terms of achieving public good objectives and leveraging private investment. As far as possible subsidies should have the character of “incentives”, i.e. to leverage private sector action and the more results at agreed quality levels are achieved, the more incentives are claimable.

Type 1 Mini-Grids should generally be expected to charge grid tariffs, which will imply a similar subsidy as other rural electrification. The fact that there is a grid link makes it very difficult to argue that a higher cost-reflective tariff should be applied. Further to do so would create a monopoly situation outside of any concession or auction process (unless the IPP/SPP site itself is tendered). On the assumption that delivery costs would otherwise imply a high tariff, it would be expected that the general rural electrification subsidy or incentive would be applied to bring the tariff down to the grid level. If the grid tariff itself is substantially below delivery cost and not topped up from wider taxation, cross-subsidy or other sources, then this is in any case an unsustainable situation likely to undermine energy sector development more widely.

Type 2 Mini-Grids, isolated from the grid, would have the tariff — and any necessary viability gap subsidy/incentive — set in the concession/auction process. Given the circumstances, it would not be unexpected for a cost-reflective tariff to be higher than the main grid. If a policy decision is made that the tariff is to be the grid tariff, then the competition would be to identify the lowest level of subsidy needed to close the viability gap. If a higher tariff is allowed, then it can be expected that any available subsidy will stretch to more villages.

Either way, an auction can reassure authorities that the lowest achievable cost is being charged (and/or the best use of subsidy made), while a 10 year concession (potentially coupled with low cost loan financing and guarantees [9]) keeps loan costs and risk premiums down (which also reflects through into tariffs). Where public services such as schools and clinics are part of the mini-grid, there can be a strong sustainability advantage to payments (e.g. a “unitary charge”) being made for services throughout the lifetime of the scheme as an “anchor customer”, rather than up front. This helps incentivise ongoing delivery and maintenance of the service over time.

Type 3 Mini-Grids may be charging on a payment-for-service basis, and in this case should not be held to any particular kWh tariff. As noted above, the basis for sale should be “willing buyer, willing seller” i.e. set on a market basis, with developers making a value proposition which has to beat existing kerosene, diesel generators and household solar etc. This does not mean that no subsidy or incentive is appropriate, since typically the costs of reaching these smaller villages is even higher per household than for Type 2 mini-grids, given volumes are smaller and distances often larger.

Typically incentives should be provided at the level of the firm, in terms of the numbers of households reached with a given service level, ideally considering the ongoing provision of the service over time, not only up-front. Even if the system is not future grid compatible, there may still be an argument for subsidy effectively reflec-
ting the opportunity cost of the years of electrification offered to the consumers in advance of grid arrival.\[10\]

**Grid Interconnection**

The approach to Grid interconnection is very specific to each type of mini-grid:

**For Type 1 Mini-Grids** the grid is already essentially connected to the system, so there should be no issues around grid arrival. The only exception to this could be if a utility extended an additional line to the community and tried to bypass the mini-utility. This eventuality should be covered and avoided in the rural electrification distribution license of the firm.

**For Type 2 Mini-Grids** the conditions around grid interconnection should be very clearly stated in the terms of the concession license. Since the duration of that concession is central to the ability of the developer to finance the project and price the power etc., and the public through the concession contract and any subsidy has a stake in the project, the terms around this should be very clear. Any change (e.g., the grid arriving earlier than expected, or the mini-grid operator not providing the agreed service level) should trigger compensation terms. While there are a number of “possible” outcomes which can be considered “when the big grid connects to the little grid”\[11\], the outcome should be clear and agreed in advance. Since the initial subsidy can be considered to cover the wires and poles, there should not be a complaint over these assets being turned over to the utility if needed, while generation assets can be relocated and then any remaining compensation paid at agreed rates based on years of interrupted operation.

**For Type 3 Mini-Grids which have not been developed under a concession, the argument for protection from grid arrival is less clear.** Since no licenses specific to a site are held and on the assumption that when the grid arrives it will be charging consumers a much lower price per kWh if customers can afford to connect, then there is a limited moral case for holding off the grid or compensating the firm. This is particularly true if a subsidy or incentive to the firm has helped pay for some years of electrification, the infrastructure is not grid compatible and there was no competition for service to that village. In general, as the regulatory and licensing approach for Type 3 strengthens (e.g., introducing auctions), so should the protections to the developer — and vice versa.

**Customer Protections**

It is important to bear in mind that consumer protections may not always be implemented in a given country, and that in fact the grid as it stands in many developing countries does not meet “grid standards”. However, it is important to consider the implications of a range of regulatory approaches to consumer protections, and ensure that these are just as, or more, robust as those prevailing today:

**For Type 1 mini-grids customer protections should be as for main grid consumers and set out in distribution licenses, including recourse to a complaints and dispute resolution service etc.** Customers should not to a large extent be able to tell the difference between the supplier being a mini-grid firm or not, although firms should be aspiring to increasingly excellent customer service. Given the ability to operate the mini-grid autonomously of the main grid if that goes down, the mini-grid should seek to offer a service better than a main grid if that is unreliable.

**For Type 2 mini-grids customer protections should be incorporated into the concession licenses.** These should include all relevant terms around the service levels expected etc, with any penalties, compensation and dispute resolution mechanisms etc included.

**For Type 3 mini-grids customer protections could be included in codes of practice agreed by firms in their general license, and a complaints mechanism to the regulator.** In a willing-buyer, willing-seller scenario there is more flexibility in the range of service levels offered, since there is also limited protection for the provider of services they should be considered alongside other potential providers of household solar systems, kerosene and diesel generators. That said, it is important to retain some kind of recourse for consumers, and for good practices to be pursued by Type 3 operators, particularly when receiving public incentives.

**Conclusion**

Although remaining flexible to interpretation in many aspects of the details — the core of the proposal here is that the approach to mini-grids needs to be split between three broad types of
Mini-Grid, each meeting a different market need and having different characteristics. If such an approach is followed in a public-private partnership framework then this could provide clarity on some of the key barriers and uncertainties which have stalled progress to date for developers and investors. This clarity could lay the foundations for a more rapid scale-up of the contribution of mini-grids to rural electrification, efficient use of rural electrification funds in a context where it is clearer what is being “bought”, and provide appropriate protection to both investors as well as rural consumers.

The following table summarises the proposed framework which it is hoped could offer the basis for a Scalable Model for accelerated mini-grid electrification, alongside and complementary to grid expansion and household solar system delivery.

**Summary Framework Model Proposal for Mini-Grids Scale-up**

<table>
<thead>
<tr>
<th>TYPE 1 Mini-Grid (PP &gt; 1MW)</th>
<th>TYPE 2 Isolated Mini-Grid (100kW-1MW)</th>
<th>TYPE 3 Micro-Grid (&lt;100kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation</td>
<td>As grid</td>
<td>Future grid-compatible</td>
</tr>
<tr>
<td>Planning</td>
<td>As grid if planning</td>
<td>Bundled concession based on auction</td>
</tr>
<tr>
<td>Licensing</td>
<td>As independent power retailer</td>
<td>Formal licence per site/bundle, based on concession</td>
</tr>
<tr>
<td>Tariffs and Subsidy/Incentive</td>
<td>As grid if electrification</td>
<td>Sell by auction, public buying, wires and poles</td>
</tr>
<tr>
<td>Grid Interconnection</td>
<td>Not applicable, grid already present</td>
<td>Terms within 10yr concession licence</td>
</tr>
<tr>
<td>Customer Protections</td>
<td>As grid</td>
<td>As contained in the concession licence agreement</td>
</tr>
</tbody>
</table>

[1] Notably From the Bottom Up: How Small Power Producers and Mini-Grids Can Deliver Electrification and Renewable Energy in Africa (Tenenbaum, Greacen, Siyambalapitiya, and Knuckles) and the EUEI PDF Mini-Grids Policy Toolkit. This paper was also strongly informed by the series of discussions at the World Bank ESMAP-organised Mini-Grids Action Learning Event in Nairobi in May 2016.

[2] The 4MW Mwenga Hydro in Tanzania run by Rift Valley Energy would be an example here

[3] Devergy, SteamaCo, Meshpower and Mera Gau would be examples of Type 3 mini-grids


[5] Inensus-Jumeme or the Titimane Mozambique project by JFS-EDM-EDP-UNEP would be an example of a Type 2 Mini-Grid

[6] This proposal draws on the Inensus Micropower Economy framework

[7] GIZ in Nigeria have been running a process similar to this which should be watched with interest. The Scaling Solar Auction in Zambia also provides important lessons.

[8] It has been noted in feedback on drafts of this paper that in India for example practically all of the mini-grids opportunities are expected to be in the Type 3 <100kW range. It is unlikely that a completely unregulated approach to mini-grids will be the right approach for consumers, or developers and investors, if the sector is to scale. In cases such as this the threshold between Type 1 and 2 may be substantially below 100kW.

[9] For example as provided by IFC in Scaling-Solar’s auction package on grid.

[10] See forthcoming Power for All paper on the Opportunity Cost of lack of energy access


Steven Hunt is Energy Innovation Advisor at DFID. First published: Medium.
The cost of solar equipment is declining at ever-steeper rates, threatening a meltdown in Utility companies share prices and catalysing new projects and driving growth in developing countries.

That’s among the key findings from this year’s Climatescope, an analysis of 58 emerging markets in Africa, Asia, Latin America and the Caribbean. Conducted by the Multilateral Investment Fund of the Inter-American Development Bank and Bloomberg New Energy Finance, it reports investment in utility-scale solar in the Climatescope nations spiked 43 per cent to $71.8bn in 2015. The countries covered include China, India, Egypt, Pakistan, Brazil, Chile, Mexico, Kenya, Tanzania and South Africa. The report stresses that the 58 countries “are not waiting to get started on adding renewable capacity – between them, they added 69.8 GW of new wind, solar, geothermal, and other renewable power generating capacity in 2015 – the same as total installed capacity in Australia today”.

China accounted for the majority of activity in Climatescope countries, but smaller nations also played important roles. By comparison, wealthier OECD countries built 59.2 GW last year. Climatescope also found that cheap solar, innovative business models and a new breed of entrepreneurs are revolutionizing how energy access issues are addressed in least developed nations.

“New players focused on off-grid or mini-grid solutions are challenging the assumption that only an expanded hub-and-spoke power grid can meet the needs of the world’s 1.2bn with inadequate access to power. A slew of these start-ups are privately-funded and between them had raised over $450m cumulatively through year-2015.”

And the report highlights how private investors, lenders, and development finance institutions in OECD countries accounted for nearly half of all capital to the Climatescope countries, with the exception of China, where virtually all capital was provided locally.

This is up from the roughly one third of capital provided in 2012. But the report also notes that some Climatescope countries with the highest rates of clean energy penetration are beginning to encounter integration challenges. “Some have seen projects completed before sufficient transmission could be built. Others have not prioritized clean electrons from wind or solar projects in their grids over those from coal-fired plants.”

But the writing is on the wall for fossil fuel companies (and share prices) – with the report noting that “tenders held for power-delivery contracts have highlighted that photovoltaics can now compete against and beat fossil-fuelled projects on price in some nations”.

Off-Grid reports on the people, technologies, events and influences throughout the global off-grid community. The webpage exists in English and German language. Founder Nick Rosen also published NETZAUSSTIEG (german language)

First published: offgrid.net.
Microgrids -- distributed systems of localised generation, distribution network and load -- are being increasingly deployed particularly in rural areas of emerging and under-developed countries to achieve energy access. India has been a pioneer in rural microgrids since the 1990s, however there is significant progress to be made despite rapid advancements in technologies like solar PV, energy storage and affordable LED lighting solutions. India Energy Storage Alliance (IESA) estimates that India has installed over 2,000 AC microgrids of over 5 kW by 2016 and over 10,000 DC microgrids with the majority sized at less than 1 kW.

Funding in this sector at the initial stage were made by the national and state governments in form of subsidies and also in form of grants by international organizations such Asian Development Bank (ADB), the World Bank, USAID and others. This funding encouraged many entrepreneurial individuals to implement their unique ideas for electrification through various off grid technologies. Following the grants, several institutions and foundations such as Rockefeller Foundation introduced soft loans in this sector at affordable lending rates. It is not reported though, but not every asset is providing expected returns and these assets are not breaking even in a period of 10 years.

The enthusiasm of entrepreneurs and local government agencies working as project developers has yet not conquered the challenges in the fields and hence funding the in form of grants and soft loans has rarely scaled in the form of private investments. Ever more funding in form of soft loans, private capital and equity is required to plug the funding gap. Over US$49 billion a year till 2030 would be needed to achieve energy access across the world. Out of this, ADB has quoted that only US$9 billion of funds are available globally. Well, the business risks here can be easily classified as financial collection risks and asset performance risks. However, the challenges around the performance of assets will be more difficult to address at this point of time.

Growth restraints include poor visibility of performance

There are many challenges which have restrained growth of this sector including numerous financial, technical and social limitations. Different funding agencies have mentioned that most of the technical challenges are not yet known to them. Project operators at several occasions do not have clear answers themselves to recognise why microgrids are prematurely failing or operating at lower efficiencies. Interestingly, funding agencies, investors and equipment suppliers are often surprised by sudden news of failure of assets or technical audit reports which undermine the poor functionality of minigrids or microgrids.

As could be guessed, these microgrids are re-
motely monitored with manual reporting or not monitored at all. And hence, inaccessibility of data in this case has led to lack of analysis and knowledge generation.

In many of the cases, project owners and operators are not to be blamed as poor telecom connectivity and the high cost of remote monitoring at remote locations has plagued data acquisition and analysis. The international Micro-grid Initiative for Campus and Rural Opportunities (MICRO) is working with different remote monitoring hardware suppliers to bring down the costs by simply bringing economies of scale and developing cheaper products for rural microgrids and for areas with limited telecom signal accessibility.

In this regard IESA has collaborated with the European Space Agency (ESA) to bring satellite communication technology as an alternative solution. ESA is now launching a new invitation to support feasibility studies which identify and explore business opportunities for deploying services based on satellite communications, earth observation data, and/or other space assets to support the decentralised management of microgrids in India and other developing countries. The study is expected to culminate into a funded microgrid pilot project demonstrating the potential of the above services.

**An IoT for a fragmented and unorganised sector**

The other challenge is that the sector is fragmented and unorganised, which is leading to its inefficacy. This in turn is causing roadblocks for social and technological innovation at the very bottom of the social pyramid, leading to microgrids and related off-grid solutions becoming an expensive affair.

In this context, a need for a platform to bring transparency and innovation to the system has been recognized. Customized Energy Solutions, a leading energy services company, has developed an initiative under the India Energy Storage Alliance that looks to provide the rural consumer with affordable and reliable power. The Microgrid Initiative for Campus and Rural Opportunities (MICRO) has set a goal of reducing cost of electricity in rural microgrids by 30.0% within the next 3 years through innovation and collaboration across stakeholders.

At the heart of MICRO lies an IOT (Internet of Things) based portal which incorporates a remote monitoring platform with supply, demand and funding aggregation capabilities. The portal is a unique multi-stakeholder platform which allows the industry to work as a bazaar where different stakeholders like project developers (or ESCOs), funding agencies and equipment suppliers can communicate with each other, realise future business opportunities and validate the performance of current assets. MICRO is looking to involve a variety of stakeholders, namely technology providers, regulators, microgrid developers, end users through local not-for-profit organisations and funding agencies in its effort to make microgrids techno-commercially sustainable and link electricity to economic development.

**Looking beyond the microgrid as a solar generation plant**

The operation of a microgrid has evolved as a multifaceted task that involves the dedicated upkeep of various components. The activities here revolve around maintenance of the generation plant, network planning and expansion, customer acquisition, billing and recovery. Early stage expansion has red-flagged many issues in these grids such as voltage drop, inability of serving high inductive loads and reliable power output. The stakeholders in this industry would need to think beyond the microgrid as just a solar generation plant and provide a complete set of diagnostic and analytical tools to microgrid developers and operators in order to achieve the target of achieving energy access in India through over a hundred thousand microgrids in India.

Harsh Thacker is a senior analyst at Customized Energy Solutions and the India Energy Storage Alliance.

Advances in off-grid solar power make it possible to power homes and businesses without connecting to public utilities, making solar arrays vital to those seeking to live more sustainable, independent lives. The process isn't easy and requires a significant investment of time and money, but the results are well worth the effort.

**Why Do You Want to Live Off-Grid?**

Before we delve into the intricacies of going off-grid with solar power, it's important to understand why you want to go off-grid in the first place. Public utilities are, after all, good deals for their monthly fees and, despite blackouts and rolling brownouts, pretty reliable.

So why switch to off-grid? Possible answers to this question include:

- Your home or business is geographically far-removed from the grid
- You want to live a more sustainable, greener life
- You want to eliminate your vulnerability to power outages
- You prefer to take personal responsibility for your own power
- You want to remain connected to the grid but reduce your reliance on it.

More than one of these answers may apply to your situation, or you may have your own reasons not listed here. For the moment, however, let's consider the last answer on our list.

**Going Off-Grid Without Going Off-Grid**

People interested in solar power aren't always planning on going completely off-grid. In many cases, they're looking for a renewable energy source to offset their utility bills.

Using solar power in combination with energy from the grid makes sense for many businesses and residents. Solar power is used to cut utility costs. The Majority of states offer some type of net metering system so you can transfer excess power from your solar system into the grid for credits on your bill, allowing you to save money when solar power output drops.

Grid-tied solar systems aren’t for everyone. Most such systems don’t have built-in batteries, so don’t provide protection during blackouts. They do, however, offer less cost, are easier to install, and have lower maintenance requirements and higher system lives than completely off-grid systems.

Battery-based grid-tied systems are perhaps ideal, as your system offers both renewable energy and stored power for during outages. Many businesses use such systems to protect mission-critical equipment from power interruptions.

**Going Off-Grid**

If grid-tied systems are not feasible—or if you want complete energy independence on principle—you’re going to want to take advantage of off-grid solar power and other renewable energy sources.

There’s a romance attached to going off-grid...
because of the independence such systems offer. Do not let idealized notions cloud your judgement. Going off-grid successfully means being realistic about the amount of energy your system produces and the energy you use. System costs, maintenance, and time constraints are also important considerations, but let’s start with load analysis.

Load Analysis
Understanding how much energy you use is vital information for anyone wanting to design an off-grid power system. Your energy load (the amount of energy your home or business uses) is measured in kilowatt-hours, or kWh. You’re going to need an accurate measurement of your month-to-month energy load before designing your system.

If you’re on the grid, measuring your energy load is as easy as reviewing your last twelve months of electric bills—your kWh consumption for the month is listed on each bill. It’s important to note how energy loads change over the year; a solar system capable of handling the energy load of a North Dakota dwelling in July might not be able to provide enough power in mid-January.

If you’re already living off-grid, you’ll need to measure the wattage and daily kWH use of every load in the building. Commercial meters such as Kill A Watt are helpful for measuring 120 VAC loads, while 240 VAC loads can be measured with kWh meters designed for utility use.

Reducing Energy Load
If your energy load is higher than an off-grid solar system can handle, you need to find ways to reduce the load. Common sense energy efficiency tips can reduce the average household’s energy load by up to twenty percent, although with a dedicated approach to energy consumption it’s possible to cut load as much as fifty percent. Possible strategies include:

Choosing Energy Star high-efficiency appliances
Controlling phantom loads by prewiring switched outlets to cut power completely when not in use.
Using compact florescent and LED lightbulbs
• Choosing front-loading clothes washers which use less power than vertical-loading models
• Go solar for clothes drying (Grandma called it a clothesline!)
• Use laptops instead of CPUs
• Wood stoves
• Passive solar water heaters
• Use portable generators with solar panels to recharge and use small appliances.

Measuring Sunlight
The effectiveness of any off-grid solar system, from small portable generators to large systems, depends on how much sunlight your location receives. Online data should provide you with your regional average, but this may not accurately affect the microenvironment in which your system will operate. Shade analysis tools, such as Solar Pathfinder, help measure how much energy you can expect to capture with your system.

Don’t neglect other types of renewable energy. Backup Lithium batteries can capture power from wind turbines as well as solar arrays, and you may be able to incorporate hydropower if local streams provide the right conditions.

System Components
The two main components for your system will be your solar array and your storage battery (or batteries). Solar arrays are long-lasting: you can expect anywhere from thirty to fifty years use from them. Batteries will not last as long, although the technology behind solar storage is increasing all the time.

Misusing a battery will seriously compromise its life, sometimes to as little as a few years. For this reason, consider starting with less costly batteries and upgrading as you learn proper battery maintenance.

Your system will also require some form of generator, for times when solar power proved insufficient for your needs. Portable generators are fine for small tasks, but a larger fuel-based generator may be needed as a backup for large solar systems.

Installation Options
Off-grid life tends to attract individuals who value independence, so you may be tempted to build and install your solar system yourself. This is possible, but unless you’re willing to commit to some intensive training and education (plus the possibili-
ty of costly errors) you might be better off hiring a contractor for installation.

Be aware that most solar contractors are familiar with grid-tied systems with no battery component. You may have to search to find one with completely off-grid experience. The extra effort is well worth the time.

Unlike grid-tied systems, once you’re off-grid your energy production is entirely in your hands. Some find this challenge refreshing, while other people find the commitment too much to handle. If you’re truly committed to independent, sustainable living however, off-grid solar helps you meet your goals.
How the world defines microgrids and why you are confused

Microgrid, mini-grid, picogrid... All this tiny terminology can add up to some big confusion. Even the industry itself defines microgrids in different ways.

Microgrids, mini-grids and picogrids have some things in common: they are all locally generated, locally distributed sources of clean energy.

Is it all just a matter of to-MAY-to, to-MAH-to, then? Well, it depends on whom you ask – and where they live. Here are some of the different ways microgrids are defined worldwide.

**India’s mini-grids and microgrids**

In fast emerging microgrid markets like Africa and India, what North America calls a 'microgrid' would likely be considered a 'mini-grid.'

In India, a mini-grid is defined as renewable-based distribution – usually solar – with a capacity of 10 kW and above (typically 10-200 kW). A mini-grid can connect to the central grid to exchange power or operate independently. In a country where a quarter of the population – more than 300 million people – lacks access to electricity, the latter is more often the case.

Mini-grids provide power for a range of purposes including residential electrification and power for commercial uses: businesses, medical centers, public buildings, streetlights and the like. Take, for example, this project in rural South Africa, which powers irrigation equipment and a pack house for local farmers. Or, Africa’s largest self-sufficient solar microgrid (5 MW) off Equatorial Guinea. You guessed it: mini-grid.

So then what’s a microgrid? India’s Ministry of New and Renewable Energy defines a microgrid as a smaller system, with capacity of under 10 kW.

By contrast, a ‘microgrid’ in the U.S. and other OECD countries has a capacity in the hundreds of kilowatts and megawatt range.

A picogrid is even smaller. Think of a cluster of homes connected to a single solar panel, or these battery-charging energy kiosks in the Congo. The picogrid provides enough power to keep the lights on and charge cell phones. Picogrids fill in where people don’t have access to a mini-grid or cannot afford connection fees.

**Better power vs. basic power**

A microgrid (U.S.) or mini-grid’s relationship to the central grid is another distinction to keep in mind. In OECD countries like the U.S., microgrids are often defined in terms of a means to improve the efficiency of the central grid or make it more resilient to outages and emergencies like a severe storm.

Consider these microgrid definitions: a report by the International Renewable Energy Agency (IRENA) says that microgrids (by OECD standards) are installed “…to achieve exceptionally high levels of reliability for industrial applications, such as data farms or industrial processes for which a power outage could prove extremely costly.”
The U.S. Office of Electricity and Energy Reliability defines microgrids as "...localized grids that can disconnect from the traditional grid to operate autonomously and help mitigate grid disturbances to strengthen grid resilience." Likewise, the Department of Energy includes mitigating grid disturbances and strengthening grid resilience as part of its microgrid definition.

But in non-OECD countries, mini-grids play a different role. Mini-grids are often the primary source of electricity access for people in poor, rural communities where central grid access is either woefully unreliable or nonexistent.

Africa has 13 percent of the world’s population but accounts for only four percent of the world’s energy demand. That’s some 600 million people with no access to electricity.

In India, a quarter of the population lacks access.

In these contexts, the mini-grid isn’t there in case of a storm: it’s the primary source of power.

Microgrids come in many flavors and go by many names. While OECD countries like the United States define a microgrid as an installation with hundreds of kilowatts and megawatts of capacity, in the African and Indian markets, that’s considered a ‘mini-grid.’

However the world defines microgrids, local clean-energy generation and distribution, by any other name, still improves lives.

Cara Goman is Associate Director of Microgrid Knowledge.

First published: Microgrid Knowledge.
Two carefully-watched microgrids took big steps forward April 6, 2017. The Schneider Electric microgrid was unveiled in Massachusetts, and Duke Energy won regulatory approval for its unusual Mount Sterling project in North Carolina.

The success of these projects brings good news to the young microgrid industry. But it is still not clear whether microgrids have leapt ‘the chasm’—a pivotal step in a disruptive technology’s market evolution, as described in Geoffrey Moore’s book, “Crossing the Chasm.”

Mark Feasel, a Schneider Electric vice president, said that the industry has advanced beyond the pioneer stage and is now accepted by early adopters. But it has yet to cross the chasm to broad market acceptance—although others believe it’s on the brink, as more conservative funds begin investing.

Regulatory and technology obstructions are part of what holds microgrids back from the all-important market leap, according to Feasel.

On the technology side, Schneider is working on making microgrids more modular and scalable.

“You’ve got to remove complexity,” Feasel said in a meeting with analysts. “You can’t have 14 inverters and 15 disconnect panels and weird wires running everywhere.”

To that end, Schneider has designed a new Energy Control Center, which connects the facility’s distributed energy resources to the microgrid and provides advanced control.

Located at Schneider’s Boston One Campus, its North American headquarters, the microgrid also features the company’s newly released EcoStruxure Microgrid Advisor, which leverages connected hardware, software and cloud-based analytics to help the campus procure, manage and consume energy more efficiently.

The combination of advanced controls and demand side software allows the microgrid to leverage weather forecast data and other operational site data to optimize energy performance across onsite solar, energy storage, electric vehicle charging, building HVAC and natural gas generation assets.

“It’s the kind of thing that will allow us to make microgrids a little more transactional,” he said.

On the regulatory end, Feasel pointed to work Schneider and others are doing with Advanced Energy Economy on a template for utility rate design. Wide adoption of distributed energy presents utilities with another round of stranded costs—as
occurred two decades ago when competition was introduced to the electric industry. But this time, resolving the stranded cost problem is more daunting. Distributed generation adds a new level of regulatory and financial complexity, according to Feasel.

“The investment is not going on the grid, where it used to. It’s going behind the meter. So you have this challenge where we have a rate structure that isn’t always incentivizing the right thing,” he said.

Despite these issues, the market is moving ahead. While Schneider’s customers once installed microgrids largely for resiliency, they now increasingly see them as a way to better manage their energy.

Inside the Schneider Electric microgrid
Located in Andover, Mass., Schneider Electric’s microgrid includes a solar array built and operated by REC Solar. Duke Energy Renewables, which owns a majority interest in REC Solar, owns the microgrid system and solar array and is selling the power to Schneider Electric through a long-term power purchase agreement. By using the microgrid-as-a-service business model, the company was able to build the microgrid without any upfront capital cost.

“The integration of an advanced microgrid at the Schneider Electric campus reduces its energy costs, incorporates more sustainable energy and delivers demand-side efficiency, while also offering resiliency to the facility in the event of a loss of power from the grid,” said Chris Fallon, vice president of Duke Energy Renewables and Commercial Portfolio. “Additionally, in partnership with Schneider, we can research and develop new microgrid technologies, solutions and applications in a real-world environment.”

The microgrid is expected to generate more than 520,000 kWh of electricity per year. It includes a 354-kW (AC) solar array with 1,379 solar modules that power the system. The microgrid also incorporates a natural gas generator as an anchor resource, allowing the solar panels to operate during grid outages to maintain critical operations.

The project was built as part of non-exclusive partnership between Schneider and Duke. The partners also are building microgrids for the Public Safety Headquarters and Correctional Facility in Montgomery, Maryland. Duke Energy Renewables will own the two Montgomery County microgrids, which will consist of a 2 MW solar project and two combined heat and power (CHP) units.

The Boston and Maryland microgrids are underway via a partnership between Schneider and Duke Energy’s unregulated arm, which is pursuing microgrid development nationally. Separately, Schneider also is working with Duke’s regulated utility, which is building microgrids within its service territory.

An energy project that preserves the view
Among Duke’s regulated projects is the unusual Mt. Sterling microgrid, which the North Carolina Utilities Commission recently approved.

The Mount Sterling microgrid includes a 10-kW solar installation and a 95-kWh zinc-air battery storage unit. Built as a non-wires alternative, the small microgrid promises to rid Great Smoky Mountains of four miles of distribution wire and return about 13 acres of wilderness to its natural state.

So rather than obstructing a scenic vista, as so many energy projects do, it’s improving the view.

Duke said it plans to begin project construction in a month.

Elisa Wood is the chief editor of Microgrid Knowledge.com.

First published: Microgrid Knowledge.
For a growing number of Australians, the idea of cutting ties with your electricity network and taking your power supply "off-grid" is becoming increasingly attractive. And, as solar and battery storage costs continue to fall, it is far from just a romantic notion.

But for some in remote Australian communities who have had little choice in the matter, the reality of living off-grid is sometimes not all it's cracked up to be - not environmentally, and not economically.

In Queensland's far north Daintree Rainforest region, the community is divided.

Cut off from the Ergon network, but surrounded by grid-connected communities on all sides, the Heritage Listed area is the centre of a protracted and contentious campaign to bring the Daintree onto a network - most likely its own, in the form of a microgrid.

The 30-year campaign, led by the Daintree Rainforest Power Committee, seeks an alternative to the current status-quo, which sees most residents and businesses reliant on their own inefficient, costly and high polluting diesel fuel generators coupled with battery storage - usually lead-acid.

Original land buyers in the late 80's were promised grid connection by developers, but this appears to have been a marketing ploy. Many early buyers have never forgotten that promise.

The latest installment in this saga came two weeks ago, when federal energy minister Josh Frydenberg met with the committee and took with him some representatives of the Australian Renewable Energy Agency (ARENA), whom he has tasked with finding solutions to the problem, and to "treat this as a priority."

Just what they will come up with - particularly considering neither the Queensland government, nor its state-owned power company Ergon Energy, are on board - is unclear. A separate advisory group will first write up a report on the best electrification options for the area, upon which ARENA will act.

Still, the members of the Committee are taking Frydenberg's show of support as a win for team grid-connect.

Meanwhile, other residents of the rainforest, like one-time One Step Off The Grid contributor Dr Hugh Spencer, the answer is not in grid-connection, but in staying power independent,
using modern distributed solar and battery storage technology.

In his article, last August, detailing his own experience of living off-grid in the Daintree, Spencer said that a large percentage of Daintree residents had put off-grid renewable energy power systems (RAPS) in the “too hard basket.”

This distrust of solar, he said, was partly a hangover from the mid-90’s Daintree Rescue Package, which installed subsidised solar and battery systems at a time when knowledge of solar – and especially of the local climatic and environmental impact on it – was in its infancy.

As Spencer pointed out, a lot has changed since then, and – he claims – a well designed solar RAPS in the Daintree can supply most households’ needs easily, even in the wet.

But others – and in particular, Daintree businesses – disagree.

“If (solar) would work in this area of course we would be doing it already,” said Daintree B&B owner Rob Lapaer, in an interview with One Step on Wednesday.

“Rainforests tend to have a lot of rain,” he added. “It’s happened where I haven’t seen the sun for months.”

According to Lapaer, most of the Daintree residents who have installed, and are happy with, solar power, live on large cleared blocks, where shading from trees is not an issue. In his case – as the name of his “Rainforest Hideaway” B&B suggests – solar is not a viable option.

“We’ve had a couple of surveys over the years, and every business wants (grid connection) and a majority of residents … want the power,” he said.

According to Russell O’Doherty, who heads up the Committee, the number of people who don’t what the grid connection numbers a “mere 3 per cent,” while the need for reliable power has increased over the years. (Spencer says this statistic is “very arguable”, and notes that a community attitude survey is currently being conducted.)

“A lot of people who are against any form of a grid here ...don’t actually live here,” argues Lapaer.

“And they have never had to come up with $20,000 to replace batteries.

“We don’t like to pay for these costs, but also we don’t like to pollute – we’re an eco-resort.”

Lapaer’s frustrations are compounded by the fact that his community is “surrounded” by the Ergon network.

“We’re surrounded by grid,” Lapaer said. “It goes behind the mountain and a lot further up the coast, but it does a loop around us.

“There is a cable across the Daintree River that feeds 13 houses on the south side. But ... even the neighbours to those (grid connected houses) have to run a generator.”

Lapaer notes that this is not new territory for Ergon, or the Queensland government.

“There are 34 remote power stations around Queensland that all have their own generator.

“It’s always good to have renewable energy,” he added, “but if they would start by putting in one central generator with a grid, that would already be an improvement to the current situation.

“Once you start a stand-alone system generator there’s enough power there to feed a whole street. It’s extremely inefficient.

“With a remote power station, once you’ve got that basic infrastructure, you can keep improving on it,” including by adding solar, he said.
A map of the Daintree development precincts (circled in red), supplied by Dr Hugh Spencer. Spencer says: "This map does not show the buy-back blocks and substantially less than 1/3rd of the blocks marked are actually occupied, so it is very misleading to think that this represents an quasi-urban environment. The southern area (Forest Creek) has the highest settlement density - and could be supplied with grid power."

Lapaer even argues that installing underground wires and other grid infrastructure in the World Heritage listed area would have less environmental impact than taking the community off-grid with solar and storage - which, he argues, would require more clearing of trees to avoid shading of solar panels.

Spencer, himself, agrees that the solar off-grid solution is not necessarily the easy solution, and without the right advice and guidance "it can be a source of immense frustration."

"Shading of any part of a panel (even though the rest is in full sun) can drastically reduce its output, a fact that needs to be borne in mind when choosing a location for your array," he notes in his story.

"As it is wise to have a clearing of at least 50 meters around a dwelling (for cyclone protection and air movement - and maybe a garden) this should allow a rooftop array to get maximum solar exposure.

Whatever the right solution, the current state of play is considered unsustainable, if only for the amount of diesel fuel that is burnt in the rainforest to keep homes and businesses in power - 3 million litres a year by businesses alone, according to a survey cited by Lapaer.

For Spencer, the frustration lies in the divisiveness of the issue, which he argues is getting in the way of all options being properly and carefully considered.

The realities, he wrote in an email to One Step, remain that there is no existing grid wiring; that all wiring would have to be underground and over a massive area; and not everybody wants be grid connected - and those people feel excluded from community discussions.

"It seems that many of the main pushers are businesses who are not prepared to reduce their energy use, won't install even notional solar ...and several want grid power so they can sell up and move out," he said.

"The costs of installation of supply lines ...will probably greatly exceed generation costs, (and) the market is not assured," Spencer adds.

"The upfront connection costs will be probably more than anyone are prepared to pay."

But finally, it's also an emotional decision, says Spencer: "Lots of residents take pride in being energy independent."

Sophie Vorrath is a clean energy journalist and Deputy Editor of "One Step Off The Grid".

First published: "One Step Off The Grid".
The fervent discussions around the role of large scale battery storage in averting the potential for an energy crisis in Australia is finally starting to settle. While there have been many conversations around utility scale storage for energy security, you might hold on to that notion that larger storage capacities would save the day but in reality, its smarter storage and not more storage on the grid that saves the day.

At the Energy Storage Parliamentary Briefing organised with the support of the Energy Storage Council (Australian Solar Council), a small part of the discussion went towards residential energy storage while parliamentarians were enamoured by a discussion on utility scale storage. It seemed like the perfect panacea for our energy crisis and just what their constituents need. As an afterthought, what we could have positioned as an industry, is how smart residential storage is the solution we have right now.

Smart storage is what needs to be the centre stage in our debate around energy security. Capitalising on the wave of interest in energy storage, many manufacturers are simply jumping on the bandwagon to build and sell storage that is affordable. Yet in the industry’s push to meet market demands, the commoditisation of storage with dumb storage flooding the market is undermining the real value of what a distributed intelligent residential storage network can do for Australia’s energy grid.

Many homeowners who currently own energy storage don’t realise that they have purchased dumb storage that is just connected with some analytical software addons. This software might provide an overview on how much energy generated has been stored, used or what is remaining in their batteries. But not many other insights beyond this.

However, when we combine storage with software, we get smart storage that has the ability to smooth out demand on the grid. For example, setting batteries to discharge when grid electricity rates is at its peak in the evening and to recharge batteries at night on off-peak rates.

If manufacturers continue to focus on pricing storage as a commodity, there will be no incentives for companies to invest in building software that delivers more integrated storage solutions that have a wider benefit electricity grids around the world.

What we need now as an industry is to continue to increase our investment in designing software that can help batteries deliver dispatchable energy on demand to stabilise the network. We have already seen some momentum in Australia with trading capabilities playing into that space — but what if households were happy to sacrifice meagre feed in tariff payouts from utilities for a reduction in their utility charges if their batteries had software capabilities that could dispatch unused energy generated to the grid when it is most needed?

Instead of merely focusing on price cutting to shift storage, energy storage manufacturers need to make a good business case for homeowners to pay a premium for smarter software. This is where we can shift the debate from looking at solving utility scale energy problems by looking at what we have in our garages and rooftops and making storage smarter.

Nathan Dunn, Managing Director, Asia Pacific, Enphase Energy.

First published: "One step off the grid".
The US electric grid is having its smart phone moment. Will the federal government get in the way? That’s the worry of clean energy groups that are arming themselves with research on grid modernization.

The groups are responding to an April 14 memo where U.S. Energy Secretary Rick Perry questions policy that encourages renewable and distributed energy. He suggests that a decline in use of ‘baseload’ coal-fired plants could lead to electric grid instability. The Department of Energy is preparing a report on the issue with release expected shortly.

While federal agencies typically seek industry comment when contemplating big shifts in energy policy, Perry did not, saying that the DOE is “uniquely qualified for the task.”

Concerned about the lack of outside input, the Advanced Energy Economy (AEE), the American Wind Energy Association (AWEA) and the Natural Resources Defense Council (NRDC) recently commissioned a response from two often-cited energy research firms, the Brattle Group and Analysis Group. The reports look at the role baseload plants — nuclear and coal — play on the new grid.

The bottom line? Renewables are not jeopardizing reliability and the very idea of ‘baseload’ — power plants that run almost all the time — may be antiquated, given today’s mix of flexible, software-driven power resources.

The debate goes beyond the old battle line between renewable energy and fossil fuels and highlights the value of nimble power sources, like microgrids and distributed energy resources.

Flexibility is the key on the new grid, according to the report, “Advancing Past ‘Baseload’ to a Flexible Grid,” prepared by the Brattle Group and issued by NRDC.

It’s expensive to turn most big coal-fired and nuclear plants on and off, so they cannot be responsive to minute-by-minute changes in price and conditions on the grid, as newer technologies can.

There was a time when bigger was better on the grid, when large nuclear and coal-fired plants offered economies of scale, says the NRDC report. But several factors have changed grid economics,
among them the falling price of both natural gas and renewable energy (fuels that are often used in microgrids), environmental rules and declining use of electricity in the U.S.

**Grid modernization makes ‘baseload’ a dated concept**

These factors are leading to the retirement of older coal and nuclear plants, based on their economic performance. Those still operating are experiencing steep revenue losses in some parts of the country during times of day when power prices drop, says the report. They are unable to compete against other resources, particularly solar and natural gas.

The NRDC cites the “2016 State of the Market” report by PJM, the largest grid operator in North America, as showing that “new entrant natural gas-fired combined cycle plants, combustion turbine plants, and solar are economical, but that new coal and nuclear plants are not.”

The environmental organization does not advocate doing away with centralized resources, but does suggest that it’s outdated to describe them as ‘baseload’ – the underlying platform that ensures the flow of electricity. Instead, grid modernization is creating a carefully managed mix of various resources – each best during different times – that makes for reliable and low-cost electric supply.

Software intelligence manages these complex electric systems for maximum efficiency and reliability. For example, NRDC notes that a 2017 study by the ISO/RTO Council found benefit in use of monitoring equipment and data analysis.

“This is particularly important when customers own or use distributed generation that traditionally are not visible to wholesale market administrators. The report indicates that technologies that improve situational awareness at all levels of the bulk power system, and those that collect data on distributed resources will be more valuable going forward,” says NRDC.

Meanwhile, the AEE/AWEA report, prepared by Analysis Group, notes that today’s diversification of resources is leading to lower wholesale market costs for electricity. And lower costs are leading to disruption.

**Reliability again?**

It’s not unusual for industries at the losing end of such trends to claim that change may jeopardize electric reliability, says AEE/AWEA’s report, “Electricity Markets, Reliability and the Evolving U.S. Power System.” The report cited similar reliability scares evoked when the industry restructured two decades ago to allow for retail competition, as well when various emissions rules were put in place over the years for sulfur dioxide, mercury and cross-state pollution. Now it’s distributed energy and renewables.

In truth, the North American Electric Reliability Corporation – the agency charged by the federal government with monitoring grid reliability - has found that today’s changing mix of resources is not degrading the grid, says the report.

“Not only have there been no serious reliability effects to date, but also numerous studies on renewable integration and coal retirements have concluded that regions within the U.S. can continue to add larger percentages of generation coming from natural gas and renewable resources without anticipated reliability concerns,” says the AEE/AWEA report. “In fact, in regions and/or at times when natural gas supply is constrained, renewable generation plays a significant positive reliability role by reducing the amount of gas needed to meet demand, making additional gas supplies available.”

New technology will inevitably usurp some of today’s generation resources. That appears to be what’s happening with coal as North American pursues grid modernization.

New England may offer an example of what’s to come. Following the retirement of several coal-fired plants, the six-state region now uses coal for only two percent of its generation. How has that impacted electric reliability? Apparently not at all, according to a quote by Gordon van Welie included in the AEE/AWEA report. “...coal is now largely irrelevant in New England...and everyone else says we need coal to maintain resilience? That just doesn’t compute for me.”

Elisa Wood is the chief editor of MicrogridKnowledge.com.

First published: Microgrid Knowledge.
A new report from the US highlights how the concept of “baseload” is really just an artefact of an old industry, and points out that baseload should not be confused with reliability. The two do not go hand in hand, and hanging on to the term is getting in the way of planning for the future.

“Baseload power”, however, is a line encouraged by the fossil fuel industry, happy that “baseload” has become a marketing tool, in the same way that it has exploited the idea of “clean coal” and “energy poverty” to pursue their interests.

The Brattle Group report was commissioned by the NRDC, a US-based NGO, just as the Trump administration prepares its own battle over the future of “baseload” in a rapidly changing energy market. It prompted this series of tweets.

As in Australia, conservatives in the US are fighting back against renewables – and variable sources like wind and solar in particular – on the basis that baseload power should be protected at all costs.

It was the central theme of former prime minister and back-bench rabble-rouser Tony Abbott’s latest salvo into Coalition party politics, and his desire for the government to build a new coal-fired power station, under the fantasy that this will somehow reduce costs.(It will do the opposite).

He was followed by George Christensen, the Queensland MP wanting a baseload coal generator in the north of the state, to give people “power that they can rely on” and not have it derailed by “sacrifices to the climate gods”.

Christensen clearly did not read the Finkel Review, or the latest BNEF analysis, because he thinks coal is half the price of solar.

And it’s the line pushed by the Trump administration and its energy secretary Rick Perry. It’s a coal industry marketing point. But it’s a lousy argument that makes no sense in a world full of technology alternatives.

Increasingly, more energy regulators, such as the head of the UK’s National Grid, and other energy experts are accepting this point. Perry’s comments were slapped down almost immediately by one of the country’s senior energy regulator. “It is absolutely not true,” she said on Perry’s false claims on wind and solar.

And energy users are starting to come to this idea too. The best example is Nectar Farms, who were ready to abandon the building of the country’s biggest glasshouse for vegetable growing, and build it overseas, instead of western Victoria, before discovering that wind energy and battery storage could deliver the same reliability at a fraction of the cost of grid power and gas.

"Why would we do it any other way," says the CEO Stephen Sasse. Extraordinary, this tale of a half a billion dollar investment, 1,300 jobs and 100 per cent renewables was completely ignored by the mainstream media. You’d think it would be a great story for prime minister Jobson Grothe.
And that explains the battle over baseload. The media runs with the coal industry talking point, it is infused in their discussions. How else could we deliver reliable energy, they ask.

Well, by using smarter, cleaner, faster and more reliable technology for one thing, would be the answer from the likes of AEMO boss Audrey Zibelman.

The new demand management recommendations coming from ARENA and the Institute of Sustainable Futures shows how these concepts like demand management can deliver the flexibility that the modern energy system needs, and save heaps on the cost of poles and wires.

The key point is that it is important to have enough power to meet demand at all times - but there are smarter ways of doing this than simply relying on large, inflexible generators - that just happen to be dirtier and more expensive than the alternatives.

The Brattle Report, like a similar analysis by the Climate Policy Initiative, and so many others before it, tries to puncture some of the myth-making around baseload. Just because a coal generator is big, and can go for 24 hours uninterrupted, does not make it reliable.

To start with, they can and do have unplanned outages, and the need for maintenance means that system planners have had to build in significant system upgrades, back-up and transmission infrastructure to spread generation over a larger region.

The planners also had to provide “contingency” management processes to avoid blackouts when one or more of these large power plants experienced unexpected outages. All the redundancy that critics say have to be built for wind and solar, have already been built for coal and gas.

Brattle points out events in Texas in 2011 when an unexpected cold snap forced 7GW of coal and gas-fired generation offline as equipment froze. Some 3GW of wind power was uninterrupted and helped keep the lights on.

Similarly, during the 2014 “Polar Vortex,” many coal and gas plants had difficulties generating power, as equipment froze and coal deliveries were stopped. Wind resources in the Midwest consistently produced power that helped to save electricity customers more than $US1 billion in two days.

In Australia, heat waves are having similar impacts. Reports into the various outages, load shedding and price spikes in Australia this past summer almost always point to the loss of capacity at coal and gas plants due to heat stress as the heart of the problem.

But still, to many people, the basic premise of the traditional utility planning processes developed over the last few decades remains unchanged today, despite the fact that wind and solar are killing coal on costs, and battery storage and other smart software has emerged to provide faster and more efficient controls, and do things that big coal-fired power stations could never do.

Brattle argues that system reliability is achieved through a mix of resources, not by any single unit. “There is no special need for continuous power supply to come from a single unit (when available and not on outage) rather than a mix of resources,” it notes.

“It is a misconception that “baseload” plants (or any plants, for that matter) are 100% reliable,” it says. “Coal and nuclear plants periodically go on outage, and when they do, their outages tend to be long. “No generating plants operate 100% reliably in all hours of the year. All generators are prone to occasional unexpected outages and must regularly go offline for maintenance outages.

The report from CPI reached the same conclusion, affirming that baseload is an outdated term and that “reliability is a technology-neutral concept.”

“Electricity systems have always been managed ‘flexibly,’” it notes. “Weather, work patterns, industry, or even sports schedules create predictable or unexpected drops or spikes in demand. “Sudden system failures, such as power station or transmission outages, mean that backup generation has always been required to keep the lights on.”
If renewable generation and battery storage prices continue to fall in line with forecasts, meeting demand in each hour of a year with 80 per cent of electricity coming from wind and solar could cost as little as $US70/MWh – even when accounting for required short-term reserves, flexibility and backup generation.

In Australia, with even greater wind and solar resources, this is expected to be around the same price, but in Australian dollars. Either way, it is cheaper than what we have got now.

And the US modelling was done with cheap gas prices. Australia’s Finkel Review came up with a much higher number because it assumed that gas would be needed to replace coal, a highly contentious assumption that seems to perpetuate the “baseload” myth.

The CPI looked at grids and energy mixes in the US, India, Europe and Scandinavia.

“A lack of flexible capacity is often cited as a constraint on the amount of variable renewable energy we can add to the grid. But in our report, we found that most systems already have enough latent flexibility to meet over 30 per cent of their electricity demand from solar and wind.”

That is exactly the conclusion of the CSIRO, which points out that in Australia there is so much back-up already built into the grid, that anything less than 50 per cent wind and solar might be considered “trivial” in some areas.

And they both agree on the second point: “Moreover, technologies that exist today could support much higher shares of wind and solar; 80% or more.” That means little if any “baseload”. Reliability is they key. Nectar Farms now understands this, it is time for politicians and mainstream media to move on.

Giles Parkinson is a journalist of 30 years experience, a former Business Editor and Deputy Editor of the Financial Review, a columnist for The Bulletin magazine and The Australian, and the former editor of Climate Spectator.

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etting electricity and clean water to remote villages and off-grid locations can make a huge difference in the lives of those who live there, but running power and water lines from a central location can cost far more than bringing an electricity generation and water filtration system directly to the location, and one Italian startup has a $15,000 all-in-one modular solution to do just that.

The OffGridBox container can supply 16 kilo-watt-hours of clean solar energy each day, plus 24,000 liters of filtered and sterilized drinking water, to remote locations, which is said to be enough to provide for a village of about 300 people. It’s fully self-contained in a 6-foot cube, and includes an inverter, a 5.5 kWh LiFePO battery bank, a 4 kW solar array, water collection and 1500 liter storage system, and a water filtration system that uses filters and UV sterilization to produce up to 1000 liters per hour. The units are designed for use as a rural electrification system, for disaster relief, for off-grid living, or as a backup or alternative system for grid-tied properties, and are said to be able to be “installed and maintained by untrained workers with a basic set of tools.”

The units are modular, so capacity can be ramped up by adding more units to the installation, and additional options are available, including a larger solar array, a bigger battery bank, WiFi capability, a desalination unit, a drip irrigation unit, a ‘pay as you go’ battery swap feature, a wind turbine, remote monitoring, and an integrated heat pump.

According to an article in Fast Company, OffGridBox has sold and installed about 28 of the units so far, and has a forthcoming pilot project in Rwanda that will see 18 units installed, but scaling up the business has been challenging.
“In places where no one has access to sustainable, reliable electricity and safe water, OffGridBox can make it happen! In a few hours using a small crane and a pickup truck, we can deliver and start the unit. We also provide basic training to local maintenance operators—no matter their education level. It’s a great opportunity to empower women while solving this crucial issue.” – OffGridBox

The company has been chosen as one of the startups in the 2017 Boston Mass Challenge accelerator, which could help shift the OffGridBox business plan away from trying to sell units to NGOs and toward providing power and water through ‘pay as you go’ systems selling direct to the end users.

“We saw that one unit, managed by a local women co-op in a Rwandese village, impacts 1500 people providing Tier 1 electricity and sterilized water with a 20c$/d per family on a Pay-As-You-Go basis (half the current rate).” – OffGridBox

Derek Markham lives in southwestern New Mexico and digs bicycles, simple living, organic gardening, sustainable lifestyle design, slacklining, bouldering, and permaculture.

First published: Greentechnica.
In 2009, the first unit of a hydro-powered mini-grid was installed in the Ludewa District of Tanzania. Today, this community-owned and -managed system serves over 1,600 customers in 10 villages, and the electricity it supplies has brought welcome benefits to citizens. In Mawengi, barbers, butchers and restaurant operators with electric lighting can extend business hours. New enterprises have sprung up; villagers who exported sunflower seeds and imported sunflower oil in the past now press sunflower seeds into sunflower oil locally. Retention rates of medical staff have improved, and village health centers can now use refrigerators to store medical supplies.

Off-grid electrification will be critical to reach Sustainable Development Goal 7, modern energy for all, by 2030. Energy leaders across the region can look to the experience of Tanzania, which has doubled the number and capacity of its mini-grids since 2008, for important lessons.

What are mini-grids?
Mini-grids—electrical generation systems of less than 10MW that serve customers through local distribution networks—are emerging as promising complements to the traditional central grid. They can help countries meet electricity access targets faster and, in some cases, more cost-effectively. By generating electricity close to where it’s needed, and with the advantage of flexibility and scale, mini-grids can become the standard choice for the millions of rural Africans who live far from the central grid and who would otherwise have to wait several years, or even decades, for an electric connection. By 2040, an estimated 140 million rural Africans could get electricity from mini-grids, requiring more than 100,000 additional units to be built.

Mini-grids in Tanzania
Rural electrification is a key component of the government’s plan to make Tanzania a middle-income country by 2025. Tanzania estimates that about half its rural population may be served more cost-effectively by decentralized options than by centralized grid expansion.

In 2008, Tanzania adopted a groundbreaking
Small Power Producer framework to encourage investment in the sector. Since then, the number of mini-grids in the country has doubled. Today, the national utility (TANESCO), private businesses, faith-based organizations and local communities own and operate over 100 mini-grid systems with a total installed capacity of 157.7MW, serving over 180,000 customers. By comparison, Tanzania’s central grid has installed generation capacity of approximately 1,500MW, with mostly hydro and natural gas.

What can we learn from Tanzania?

A new report from Tanzania Traditional Energy Development Organization (TaTEDO) and WRI examines Tanzania’s mini-grid experience and proposes five key action areas that energy practitioners across the continent can focus on to accelerate the deployment of this electrification option in their countries.

Build up knowledge and make information about mini-grids available and accessible.

There is a dearth of knowledge about mini-grids, even in countries where they have been used. Understanding how these systems have fared in the past and the reasons for their success and failures is essential for successful future deployments. Likewise, maintaining an active database of existing mini-grids—their technical characteristics, funding sources and tariffs, as well as their quality-of-service metrics—could be valuable to stakeholders involved in mini-grid implementation.

Create an adaptive policy and regulatory framework.

Having a policy and regulatory framework that can be easily adapted to changing circumstances can ensure that lessons learned along the way are integrated into future regulatory and policy improvements. In 2015, Tanzania revised its 2008 Small Power Producer framework to account for price differentials in implementing different mini-grid technologies. The 2008 framework set technology-neutral feed-in tariffs, which failed to encourage solar and wind mini-grid development due to their higher costs; the 2015 framework instituted technology-specific tariffs to address this barrier. In 2017, Tanzania launched a third generation mini-grid framework that introduces guidance on grid integration and simplified licensing and registration requirements.

Streamline licensing and permitting procedures outside the electricity sector.

Mini-grid developers must acquire several licenses, permits and clearances to build a mini-grid. Many of these—for land rights, water rights, environmental clearances and others—involve institutions outside the energy sector. Despite the utility regulator (EWURA)’s, streamlined regulatory process, procuring such documents can be time-consuming and result in significant implementation delays. It is important that governments focus on coordinating the activities of all the different licensing/permitting agencies, creating a one-stop-shop where developers can obtain the clearances and licenses they need.

Build the capacity of mini-grid developers, especially local ones.

As our report shows, local mini-grid developers face several capacity issues in accessing financing, developing effective business models and managing mini-grid systems. Investments in building the capacity of local entrepreneurs to develop
bankable proposals and effective business models will be key to sustainable mini-grid development over time.

**Build a robust understanding of the impacts of mini-grids on development.**

Mini-grids can support local development efforts by enabling income-generating activities and promoting agriculture, health and education. These sectors will also create sustained demand for mini-grid electricity, ensuring the financial viability of the systems over time.

Given the critical linkages between mini-grids and development, governments and developers must invest resources into systematic qualitative and quantitative studies that can inform rural development programs and energy access strategies.

Advancements in technology, falling prices of renewable technologies and emerging innovative business and delivery models are aligning to make mini-grids a transformative solution in sub-Saharan Africa. With useful lessons provided by countries like Tanzania, energy practitioners in the region can now learn from others’ experience and act.

Lily Odarno leads World Resource Institute’s energy access work in Africa.

First published: World Resource Institute.
Everyone is talking about blockchain, so why all the hype?

When 10,000 government delegates met at COP23 to tackle climate change, the UNFCC and other sponsors brought 100 blockchain developers to Bonn with one purpose – to code for climate. From November 12-17th, developers and industry experts met at COP’s first Hackathon, Hack4Climate. During the competition, I along with developers from all over the world, formed teams with industry experts to build blockchain-based apps & startups. The idea was to have developers and experts team up to innovate and create blockchain solutions that can start slowing down climate change now.

Blockchain, the world’s most secure digital ledger, interested the UN because it has the capability to transform and automate agreements and transactions. Blockchain’s ledger functionality can help governments, organisations, and businesses automate, record and securitize transactions and processes. With blockchain, you can track emissions sensors from all over the world, trace a product from the beginning to the end of its supply chain or even amplify the transparency of business agreements.

But first, what is blockchain?

While the bulk of blockchain news concentrates on cryptocurrency and bitcoin, the real reason why blockchain is exciting is that its structure can be used for other sectors, including sustainability.

Blockchain at its core, is a new online system of structuring and securing information, whether it be for digital currency or solar production rates. The system, consists of nodes, also known as computers. Each computer tracks details about the process being recorded. For instance, a detailed account of every energy transaction a user makes, the date and the user that makes that transaction. Then, all the computers or nodes are connected to one ledger, that records the entire systems’ information. As each node is updated with the same information, it leaves a permanent record or ledger of the process. Simple at its heart, blockchain is a secure digital ledger that tracks items from many different sources at the same time, all while showing that ledger to the many parties involved.

How Blockchain is Influencing Sustainability Projects

This simple, yet innovative technology is being used to influence every corner of the environmental field.

At Hack4Climate, international developers focused on the five main ways blockchain is influencing the environmental field: identification & tracking of emissions, carbon pricing, sustainable land use, sustainable transport, and distributed energy. Over the competition, we discussed current blockchain solutions and worked together to create new ideas of how blockchain can transform each of the five fields.

Identification & Tracking of Emissions:

Provenance, a platform based in the UK, is already allowing suppliers, auditors and shoppers to track items through the supply chain. However,
more organisations are using blockchain within their companies to track their merchandise. At Hack4Climate, Everledger, a global start-up focused on tracking provenance of diamonds and other metals, asks developers to help them trace emissions from the diamond industry. During the competition, Everledger worked with developers to create an application that can trace diamonds, using a unique ID, from the beginning to the end of its supply chain. The end application allows users to download an Everledger app to track their diamonds carbon footprint.

**Carbon Pricing**

Carbon pricing is another sustainability issue that blockchainers have dug into. At the competition, Clean Coin, worked with developers to help reduce the amount of carbon produced by blockchain mining. As cited by the Cologne Centre for Economic Service, if 50% of the world uses cryptocurrency by 2030, the demand would exceed today’s entire energy supply. Clean Coin pitched a solution to this issue, using a platform that encourages miners to reduce their footprint. Since renewable energy is only available in certain areas and at certain times, it would allow miners to make more informed decisions by telling them when and where to mine. Users can then mine responsibly, in areas with more renewable energy and at times when it can be provided.

**Sustainable Land Use**

Sustainable land use is not what people usually think of when they think about blockchain. However, two groups at the competition, GainForest and Plant Life, provided solutions to reduce deforestation. GainForest focused on financially incentivizing caretakers to reduce Amazonian deforestation. During the 24-hour competition, they used blockchain to allow donators to pay small-scale farmers, satellite data to verify if small-scale farmers have reduced deforestation, and machine learning to predict the areas of the Amazon that are the most at risk to deforestation.

Plant Life approached deforestation by gamifying tree planting and reforestation verification. This start-up believes that we can mitigate deforestation, by focusing on saving trees that are still acting as carbon sinks. Pitching their product as the plant version of Pokemon Go, gamers can verify trees and their growth rate on the blockchain by taking pictures of the tree at different time periods. The pictures are put together to give organisations a better idea of the growth rate of individual trees, allowing them to make more informed forest management decisions.

**Sustainable Transport**

Swiss Federal Railways (SBB CFF FFS), one of the sponsors at Hack4Climate, asked developers to help them build a blockchain-supported transport solution. Developers from the group Autonomi argued that in order to foster a car-lite society, we need to encourage users to opt into public transport. Pitching their solution as anti-Uber, their end-to-end platform negotiates and authenticates payment seamlessly between public and private transport. Mobile users will be able to pre-pay for their trips and use their phones to access cars, buses, and trains. Moreover, the platform incentivises users to go green by charging fees for the carbon they emit during their trip.

**Distributed Energy**

Now, how is blockchain revamping the energy sector? Multiple start-ups are already focusing on democratizing and decentralising energy production by incorporating blockchain into community-level peer-to-peer energy transfers. LO3 Energy, is an organisation most known for the Brooklyn Microgrid, already allows for peer-to-peer energy transfers in community micro grids. The microgrid allows members to trade and sell the energy they produce from their own solar systems and store energy within home battery units.

At Hack4Climate, I worked with two energy start-ups, Net+ Block and Energy Islands, which worked off of peer-to-peer transferring systems, to provide grid-level balancing in areas that already have grid access or have no grid at all. Net+ Block, a grid load-balancing solution, partners with energy providers to transform the grid to reach 100% renewable energy. Energy exchanges are automated between the provider and energy user and billing cost is reduced by using blockchain to verify consumption.

Energy Islands, a no-grid solution targets areas that can’t access electricity. With nothing more than solar PV units, PV & islanding inverters, a mounting system, and battery, Energy Islands crea-
tes a nano-grid, furthering and democratizing energy access.

**Time for businesses to take action**

The World Economic Forum announced that, “by 2027 10% of global GDP will be stored in blockchain” and that it will be highly incorporated into taxes and other contractual agreements. Fin-tech, banks, and tech firms have bet on this rate of blockchain uptake and are using its framework to transform technological systems all around the world. While the blockchain hype began with digital currency, there is space for the sustainability to use blockchain for good.

To fight climate change, more environmental companies should work with developers to create blockchain-supported climate solutions. Organisations can grab on to this new technology and realise its potential by partnering with blockchain groups and developers and incorporating it into their current frameworks, helping accelerate our journey to carbon neutrality.

Alex Todorovic-Jones is a Data Scientist at Carbon Smart.
First published: edie.net.
Countries
Our feet in length, of aggressive disposition, and deadly poisonous: you don’t want to stand on a Russell’s viper in the dark. Especially if there’s no antivenom for miles around. Yet that’s the daily predicament facing millions of villagers in Myanmar, where snakebites cause about 500 deaths every year.

In Yin Ma Chaung, a rural settlement about nine hours by car from Yangon, villagers can rest easier knowing there are doses of antivenom chilling securely in a new refrigerator in the village’s community centre, powered by solar.

“Antivenom can now be supplied quickly if people in neighbouring villages need it,” says Kono- suke Kawahara from Japanese electronics giant Panasonic, which recently installed a 2.82kW photovoltaic (PV) system for the off-grid village.

The example is just one of thousands of off-grid projects being rolled out across Myanmar as part of a huge government-led scheme, which involves private companies too, to bring electricity to the entire country by 2030.

As of 2014, only 16% of rural households had an electricity connection.

Myanmar Eco Solutions, a for-profit renewable energy firm, is part of a burgeoning industry looking to contribute to the development of off-grid solutions. It recently set up a solar-powered irrigation system for rice farmers near Pathein, a remote agricultural region in the Ayeyarwady delta in southern Myanmar. The submersible pump is mounted on a raft, meaning it can travel up and down the river supporting multiple villages.

Sunlabob, a Laos-based solar developer, has just installed solar mini-grids in 11 villages in the remote provinces of Shan and Chin. The PV-based systems enable householders to power low-voltage electrical items such as lights, mobile phones and small televisions.

**Can off-grid make profits?**

At present, almost all Myanmar’s off-grid projects are either government-funded or donor-backed. Panasonic’s fridge-powering power system is financed through charity money from Mitsui & Co; Myanmar Eco Solutions’ raft is seed-funded by the non-profit World View International; and Sunlabob has a grant from the Japanese government for its mini-grid project.

Poverty levels are the most immediate hurdle to off-grid commercialisation. Despite enviable growth rates over recent years, Myanmar is starting from a very low base. It still ranks 148th of 188 countries on the UN’s benchmark development index, with the highest levels of poverty concentrated in rural areas.

"Our original idea was to supply solar home systems because they are relatively affordable,” says Ben Frederick, head of operations for Myanmar Eco Solutions. “But it quickly became apparent that this business model wouldn’t work ... Even though the systems we were selling were about
$100 (£80), they were still far too expensive for a single farmer to buy."

Myanmar Eco Solutions's strategy has been twofold. In the case of the raft project, it operates a revolving fund, with participating farmers making small payments on a seasonal basis. The capital costs of the raft, around $6,000 (£4,800), should be paid back after two years or so, enabling the company to set up a similar project elsewhere.

**Commercial Opportunities**

Myanmar’s lack of electrification presents a puzzling dilemma for commercial operators. With so many of the rural population having no electricity at all, it is difficult to judge future demand patterns, feasible price points and the reliability of billing systems.

"It’s tricky from a commercial perspective because you can’t go to a lender or a financier and say, 'Yes, we can prove this is the level of demand and this is the price point people are able to meet,'" says Philip Napier-Moore, programme director for solar power in Asia Pacific for the engineering consultancy Mott MacDonald.

The real money for Myanmar’s solar firms lies in providing PV-systems for factories, hotels and other large-scale industrial users in urban areas. Myanmar Eco Solutions, for example, is about to integrate a 1MW solar plant into an existing diesel power station on an island in the country’s Tanintharyi region. Sunlabob, meanwhile, is installing a 117kW solar system in Junction City, a mall and office complex in Yangon. The project is set to be the first grid-connected solar project in Myanmar.

"Businesses and larger energy users are beginning to see the benefit of investing in solar-based electricity given the rising prices of grid-based electricity paired with the high cost of back-up diesel generators," says Evan Scandling, Sunlabob’s managing director in Myanmar.

Given the demand hurdles, Napier-Moore anticipates Myanmar’s off-grid solar roll-out remaining largely government-led over the coming years. But a commercial model may provide a better guarantee of it working in the long-term, for example with a corresponding growth in a support network of suppliers and engineers.

"Ideally, government-backed initiatives could harness private-sector models so that it helps to demonstrate to financiers that these models are viable rather than being just purely grant-funded," he adds.

First published: Vuphong Asia.
Every evening, the sun drops behind the horizon and darkness falls. And, every evening, although 6 billion people reach out and switch on the lights, over 1.2 billion remain off-grid [1]. For over 100 years, since Thomas Edison’s coal-fired power station first lit up homes and offices in downtown Manhattan, the power for that light has—for the vast majority—been delivered by the electricity grid. But the grid as it is today cannot meet the challenge of delivering power to the 1 billion people who remain without it. Delivering power to the final billion will require the grid of the future—combining governments, the private sector, and the technological innovations that are revolutionizing the energy industry as we know it.

The challenge
The challenge is best illustrated by the 650 million Africans who don’t have access to electricity, and living mainly in remote, rural areas. At the moment, the economics of electrifying those communities are non-viable for three main reasons. The first two are:

1. Cost: Cost per connection and ongoing operating expenses are incredibly high due to the remoteness and low population density.

2. Poverty: Most people in these rural communities cannot support the revenues required to cover those costs.

These two factors mean that rural customers cannot pay what it would cost to connect them. This gap is not unique to Africa. It’s generic to the history of rural electrification in every single country, going right back to the United States, the first country to distribute power through electricity grids. The challenges listed in this 1926 Congressional research report [2] could almost have been lifted from a World Bank report on current efforts in Africa:

Widespread rural electrification has been held back to date by the financial obstacles to profitable distribution of power in the farming areas...Chief among the financial obstacles are the farmer’s small cash income, coupled with the large unit investment required in distribution systems to serve only a few farms per mile of line.

President Franklin Roosevelt addressed this gap in 1935 by establishing the Rural Electrification Administration (REA). In its first 5 years, the REA provided over $227 million in government subsidized loans ($3.6 billion in today’s dollars) to connect rural farmers through laying distribution lines, wiring homes, and even building local diesel generation plants.[3]

This principle of subsidizing main grid connections is common to every country that has achieved universal electrification. So why hasn’t it worked for sub-Saharan Africa?

Because rural Africans face one additional, crucial, barrier, that rural Americans in the 1930s did not:

3. They live in countries whose governments are not wealthy.

McKinsey forecasts that in 2040, 500 million Africans will still lack access to the main grid.[4] Historically, it has taken countries an average of 25
years to move from an electrification rate of 20 percent to 80 percent.[5] South Africa is a good example: It made that 20-80 transition over 27 years. Key to this was a huge push in the late 1990s when the government subsidized 100 percent of the capital cost of every single connection.[6] However, for countries at the beginning of that transition, like Tanzania, for example, even 27 years looks optimistic. Tanzania’s GDP per capita is seven times smaller than South Africa’s was at the same moment in their electrification efforts.[7] If rural Tanzanians wait for the government to fully fund universal access, they will be waiting for a long time.

The solution: Technological innovation and the private sector

All three barriers can be addressed by building the grid of the future, today. This move integrates existing government involvement with two new developments.

The first development is the rise of four technological trends that are reshaping the energy industry as we know it:
1. Solar and batteries—becoming ever cheaper and better.
2. Internet of Things (IoTs)—the rise of remote monitoring and servicing.
3. Mobile money—frictionless payment systems for the unbanked.
4. Energy efficient appliances—LEDs, TVs, fridges delivering the same service for less energy.

These four mega-trends are radically transforming the economics of delivering energy to remote rural customers.

To bring the magnitude of this transformation alive, it’s worth going back to late 19th century New York. By the end of 1890, if you were a resident of Manhattan below 59th street, you could join the Edison Electric Illuminating Company’s 1,698 other customers and enjoy electricity for the price of “one cent, per 16 c. p. lamp hour.”[8] equivalent to 20 cents per kilowatt-hour ($0.20/kWh). How does that compare with today? Adjusted for inflation, this is equivalent to around $5/kWh, which is about the same as the levelized price of energy that a solar home system can deliver to a rural customer in Africa.

Do not underestimate how extraordinary this is. It is now possible to deliver energy to a remote rural community in Africa, with a standalone system that fits in a cardboard box, at the same price per kWh as Edison’s coal-fired power station could in one of largest and most densely populated cities in the world.

The second development is the emergence of private sector rural energy companies. Solar home systems (SHS) companies such M-KOPA Solar and Mobisol have had huge success in providing energy services by selling 8W to 200W kits with lights, phone charging, and TVs. More recently, private sector companies such as PowerGen Renewable Energy have taken advantage of the four technological mega-trends to build and operate small versions of the main electricity grid—mini-grids—that can serve rural customers both more economically and many years before the main grid arrives.

It typically costs Tanzania’s national utility TANESCO $2,300 to extend the main grid to a rural off-grid household[9] due to the high cost of running high voltage lines out to remote areas (over $30,000/km for >66kV lines[10]). The new promise of mini-grids is that the same household could instead be connected to a mini-grid for $500 – $1,000 (through cheaper solar and batteries and cutting out high voltage lines), provided with a high-level of ongoing energy services at a lower cost (through the IoTs, mobile money, and energy efficient appliances), and supported up the energy ladder to use energy for refrigeration, milling, and irrigation by the private companies’ relentless focus on the customer.

Private capital is the final piece of the solution to the three barriers to rural electrification. Bringing private capital to bear will reduce the burden on the national governments. Long-term government support is still vital, but is far reduced. For a government accustomed to subsidizing 100 percent of a $1,000 – 2,000 per connection, subsidizing 50 percent of $500 – $1,000 mini-grid connection is a far better allocation of scarce resources.

Grid of the future

But—why should governments support mini-grids? Aren’t they just a stopgap, an investment that becomes a sunk cost when the main grid arrives?

Sam Slaughter, CEO and Founder of PowerGen disagrees "No—mini-grids are the main grid, just built more cheaply, with smarter technology, and
years ahead of schedule. When the main grid does reach these communities, there’s a functioning distribution network and customer base for it to plug into." The localized generation and storage then continues to provide additional power, and reliability. Slaughter argues that mini-grids enable countries to effectively "build the grid of the future from the outside in," allowing poorer and more remote people to be connected faster and cheaper than has previously been possible.

What needs to be done?

What needs to be done to make this happen? Fortunately, there's nothing new about mini-grids, subsidized rural electrification, or private sector involvement, so we can look to recent examples to draw lessons.

Three things need to happen:

1. Mini-grid economics must become too compelling to ignore. Mini-grids need to become the answer to politicians' promises of universal energy access. They need to deliver the most connections, at the same level of energy service, for the least amount of government funding. African governments are already familiar with mini-grids: Kenya's national utility KPLC runs 19 largely diesel-based mini-grids. However, their economics are not compelling. The government of Kenya funded 100 percent of the grids' capital costs, and the cost of fuel used in power generation is fully transferred to all KPLC customers. Instead, private sector mini-grids must become an "offer that's too good to refuse." — cheaper and better.

2. Private and public capital must be brought into the sector to show it works at scale. Governments need evidence of how mini-grids can combine innovation in the hands of the private sector, with blended private and public funding, to deliver electrification at scale. Again, this is not new to Africa. Mali's spontaneous bottom-up mini-grid concessions have succeeded in providing electricity to 78,000 rural households since the program began in 2003. More than 250 such mini-grids are operating in the country, run by 68 private entities. AMADER (Mali's rural electrification agency) established a rural electrification fund, which provided mini-grid operators an average of 75 percent of the capital investment costs, the remainder coming from local private financiers.

For other countries considering subsidizing mini-grids, the burden is also less than expected. For example, a recent report calculated the additional levy required to support mini-grid expansion in Kenya is $0.0006/kWh, less than a 1 percent increase on the average tariff[11].

3. Government policy and regulation must support innovation. Finally, government policy and regulation needs to support the development of the grid of the future, which will be an integrated mesh of large-scale generation, consumers, and local distributed generation and storage, allowing consumers to both receive and send power. Nigeria has recently taken the lead in building mini-grids into its future energy planning by passing some of the clearest regulation on the continent, setting out how mini-grid integrates into the main grid when it arrives.

Conclusion

These three changes will help deliver the grid of the future, today. And that grid of the future is what's needed to deliver on the ambition of universal energy access, championed by governments across Africa today and first articulated by the Edison Electric Illuminating Company 124 years ago:

*With the natural increase of business, the relative cost of generating current should steadily decrease, and the time should come, and at no distant day, when it will be practicable to reduce the price of current for illumination as well as for other purposes, and make electricity not merely a luxury in private residences, and a convenience and economy in manufacturing establishments, but the general servant of the community.*[12]

Note: This piece reflects the views of the author only and not those of the Africa Growth Initiative.

End notes


2015
[4] ibid


Gabriel Davies is Investment Associate - Cross-Boundary LLC.
First published: Brookings.
Kenya plans to launch a $150 million project this year to bring solar electricity to markets, schools, shops and homes in poor, off-grid areas without existing power access, officials say.

The effort, expected to receive World Bank funding in March, would bring mini-grid solar plants to areas of 14 counties categorised by Kenya’s government as marginalised, according to World Bank documents.

Such off-grid systems are the cleanest and most cost effective way to bring electrical power to poor areas, particularly those sparsely populated, Kenyan officials said.

"Solar photovoltaics and mini-grids are the most effective way of supplying power to settlements with 300-400 inhabitants, and Kenya is one of the best prepared countries in Africa in providing such solutions," said Pavel Oimeke, the director of renewable energy at Kenya’s Energy Regulatory Commission.

The country has more than 400 registered companies that can fulfil solar energy contracts, and more than 300 technicians trained and approved by the government to support the systems, Oimeke said.

Under the new project, solar mini-grids would be used to supply market centres, community facilities, and some households, according to planning documents.

In more isolated areas, households would be equipped with home solar systems. New solar power capacity also would be used to pump water to supply homes and fields.

"Evidence suggests that PV (photovoltaic) powered water pumping significantly reduces the cost of water extraction through lower operational and maintenance costs," a World Bank project document noted.

As part of the planned project, schools would get new solar-powered borehole wells while some communities would be equipped with water systems powered by solar pumps. Existing diesel-powered pumping systems would be retrofitted with hybrid solar systems, according to planning documents.

The plan also provides for technical assistance and training to help make the scheme more sustainable.

Rabia Ferroukhi, head of policy at the International Renewable Energy Agency, an intergovernmental organisation based in Abu Dhabi, said in an interview with the Thomson Reuters Foundation that she believes the time has come for a paradigm shift in how off-grid systems are deployed, focusing less on power generation and more on using them to support jobs and incomes.

That would help them make a greater contribution to achieving the Sustainable Development goals, she said.

Using solar electricity to power irrigation pumps, process harvests and create cold storage could transform rural lives by providing better crop
yields, higher incomes and a reduction in drudge work, she said.

"By linking mini-grid supply with productive uses such as agriculture, rural industries, market centres (and) schools, the socio-economic impacts can be maximised which in turn improves the ability of consumers to afford energy supply," Ferroukhi said.

Maina Waruru is a freelance contributor for the Thomson Reuters Foundation, with an interest in science and climate change issues. He is based in Nairobi.

First published: Thomson Reuters Foundation.
Politics, capitalism, and energy poverty are combining in strange ways across India. The result looks like progress - sometimes.

My exploration has revealed that firms in the business of deploying off-grid solar technologies in India are finding ways to work in or around a flawed regulatory regime. Most of the firms selling off-grid solar products are doing so in urban and peri-urban areas with grid access. In some ways, then, the market for such technologies may depend on the continued unreliability of the grid. Rural areas face more fundamental challenges that seem inadequately addressed by government policies and development assistance. I’ve learned that getting more locally embedded entrepreneurs into the game of deploying solar micro-grids is an important element of success stories. But many micro-grid companies are reluctant to invest in rural areas without having a clear sense of potentially competing national policies for building out the central electricity grid. To address this uncertainty, some states, such as Rajasthan and Uttar Pradesh, are starting to experiment with policies that clarify how micro-grids may work in tandem with the central grid system.

On financing, if the government continues to provide end-user subsidies for consumers to purchase solar technologies, then it must also accelerate financial inclusion programs that help the rural poor to open bank accounts. But another option may be to provide financing for those businesses that find innovative ways to make access to solar energy easy and reliable without subsidies. Examples include pay-as-you-go solar energy services or the ability to make mobile phone payments for however much local, micro-grid electricity consumers want to consume. Regulations could also encourage crowdfunding to support the solar entrepreneurs who are deploying the best technologies with the best financial models. At a time when incomes are rising and the cost of technology is falling, financial innovation in the deployment of solar technologies remains important because it is still unclear how poor people are making purchasing decisions.

India is angling to be a world leader in solar energy. It has indicated its commitment not only through domestic political targets, but also by introducing and leading the International Solar Alliance, launched at the November 2015 Paris climate conference. But, as the stories I heard make clear, solar technologies are being deployed across India thanks to innovative entrepreneurs who can manage working in difficult and often uncertain regulatory regimes. What these entrepreneurs need from India is not hyped political targets, but policy coherence, quality standards, better training, better access to testing facilities, access to more finance, and better support for incubation or acceleration of their ideas.

Solar energy in India is not a story of a battle between decentralized, renewable energy technologies and centralized grid distribution. Both approaches to providing energy in a nation as diverse and complex as India offer valuable lessons and opportunities. More important is India’s need to
get its people access to energy to maximize their ability to thrive in the changing climate of the future. How this energy is delivered will take many forms and, perhaps, require the assistance of many gods.

Kartikeya Singh is an IDRC Fellow at the Center for Global Development and Deputy Director and Fellow of the India States initiative at the Center for Strategic & International Studies.

First published: author.
For Inonge Imutowana, buying food for her family of six is becoming increasingly costly. On the outskirts of the capital, a 25-kilo bag of staple mealie meal that cost 65 kwacha a year ago now is selling for 140 kwacha ($14).

Across Zambia, drought that swept across the region last year, leading to widespread crop failure, has sent cereal prices soaring.

The high cost of buying food has persuaded a share of small-scale farmers to hang onto their maize, rice and cassava harvests and mill them for their own household use and for their livestock, rather than selling the grain into the market.

But a combination of higher fuel prices and unstable electrical supplies - both the result of lack of rainfall hitting hydropower - mean many small grain mills are charging higher prices for milling, or don't have sufficient capacity.

But Zambia's government hopes it has an answer: Since 2015 it has been installing hundreds of small solar-powered mills in rural areas as a way to help hold down the price of producing food.

Cheaper, closer

One of those, built last November, is now operating just seven kilometers from Imotowana's farm, which lies about 50 kilometres east of Lusaka.

"Before this, we used to take (our grain) to a diesel-operated hammer mill (about 20 kilometres away) or buy commercially produced mealie meal in smaller quantities, just as we could afford it," said the 54 year-old farmer.

Now "it is cheaper milling here," she said.

According to the Zambia Cooperation Federation (ZCF), a government agency that is installing the mills, over 250 have been set up so far out of 2,000 planned.

Patrick Mumbi, an operator of one of the plants, said the 60 solar panels that power the mill can generate 15 megawatts of electricity.

"To mill maize or rice, we need less than nine megawatts of electricity" each day to process about two tonnes of grain, he told the Thomson Reuters Foundation. That means "we have surplus electricity output".

Unfortunately, the plant does not have any means of capturing that power in batteries, to charge cellphones or provide lighting at night, he said.

The Chinese-manufactured solar mills cost about $70,000 each including installation, according to ZCF.

Lower prices?

Whether the mills will help hold the line on cereal price hikes remains to be seen, however, some analysts say.

Clement Mwiinga, a lecturer at the University of Zambia, said the problem is that many farmers are under contract to sell their grain to the government.

That grain is then sold at subsidized prices to commercial milling firms that are supposed to supply the national market with food at moderate prices.
But government officials have accused some commercial millers of holding onto government grain and selling it illegally to drought-hit neighbouring countries at higher prices.

Mwiinga said it is difficult to monitor whether commercial millers are selling government grain to food insecure countries such as Malawi, the Democratic Republic of Congo and Mozambique, largely because non-government grain can legally be sold in that way.

The Indaba Agricultural Policy Research Institute (IAPRI) also says government efforts to stabilise food prices by routing subsidised grain through commercial millers have not lowered prices for mealie meal and other staples.

To improve the situation, "we need to have a clear standard operating strategy on how to deal with shortfalls and bumper crop harvests," Chance Kabaghe, IAPRI director, said in December, at the launch of a maize outlook report.

The country is expected to receive normal to above normal rainfall this rainy season, as it begins to recover from last year’s drought, according to the Zambia Meteorological Department.

The Southern Africa Regional Climate Outlook also predicted that most parts of southern Africa should receive good rainfall between January and March.

Danstan Kaunda is Climate Change Journalist.
First published: Thomson Reuters Foundation.
According to the world energy outlook 2016 study of the International Energy Agency, only five percent of the scattered rural population in Zambia has access to electricity. A solar powered mini-grid provides an interesting approach to electrify these remote areas. Italian solar manufacturer OffgridSun, Zambian solar company Pressinnovate and the Technical University of Delft conducted a 7-month feasibility study with the aim of finding a scalable solution to electrify off-grid Zambian villages. The study was funded by the Swedish Agency for Economic and Regional Growth (Tillväxtverket).

Five remote villages in different provinces of Zambia, were targeted for the study. In each village a workshop was held which explained the idea of a solar powered mini-grid, followed by questions and feedback from the participants. Furthermore 50 questionnaires were held to collect socio-economic data and each building in the village was mapped with its location, purpose and energy need. For the village with the most favourable conditions a full design and business plan was made. This was followed by in-depth interviews with the inhabitants of the selected village over a period of three months, conducted by students of the Technical University of Delft. Meanwhile a consultant explored the government regulations and licensing requirements for power generation and distribution.

The first, and perhaps obvious, conclusion of the study was that there is a real need for electricity in the Zambian village and that the positive impact on the lives can be vast. The enthusiasm from the inhabitants was overwhelming and here I will just name some examples of the benefits the solar system can have. A solar pumping system could provide access to water for drinking, washing and irrigation of farm lands. The health centre struggled with the lack of light for child births and the refrigeration of vaccines. A grocery shop owner expressed the wish for a fridge to cool drinks and attract more customers. The barbershop can only cut a small number of people each day since it is expensive and time-consuming to charge the batteries. Lighting for a household means getting rid of the harmful and expensive kerosene lamps and increasing the night hours for studying and social gatherings. A school is giving computer lessons, to their 859 pupils, using a small and expensive generator and only five computers.

But what kind of system and how to implement it was not so straightforward as the potential benefits. In the beginning of the study the idea was to install a mini-grid for the whole village, but this turned out to be a suboptimal solution. For a mini-grid to be economically feasible, the buildings need to be relatively close together and the connected users should have a large power need on a regular basis. This was the case for the market area since the shops and businesses were close to each other, they needed the electricity, and had the income to pay for it. By also providing productive appliances on credit and training them in the use, more electricity would be needed from the mini-grid, increasing its revenues while also stimulating the local economy.
The households had varying incomes, but most of them could not afford the connection and electricity fee needed to make the mini-grid economically viable. They were also located far apart so the costs for cabling and the energy losses would be too high. For these reasons, solar home systems in multiple sizes offered with pay-as-you-go or micro-credit to accommodate for the different income levels of households, would be a more suitable solution.

The final group, the public buildings, require yet another solution. The large distance between them, their low disposable income for electricity and the relatively small power consumption, made a mini-grid not feasible. A stand alone solar system for each building would be more appropriate and cost-effective. By donating the systems for the public buildings, community goodwill would be created, benefitting the commercial mini-grid implementation and the sales of solar home systems. Moreover, the access to electricity would lead to an improved service of the school, health centre and community centre impacting a large area, even beyond the village, that is relying on these services.

If the mini-grid for the market area, the solar home systems for the households and the stand alone solar systems for the public buildings are going to be installed, a strong local management, accepted by the community, is absolutely vital. Starting a village solar shop with well trained and motivated entrepreneurs, is a must before installing the other systems. The village solar shop will have the responsibility to train the inhabitants in the use of their system, to maintain and repair the systems, to sell the solar home systems on pay-as-you-go or micro-credit to the households, to offer productive appliances on credit and to collect the fees for the mini-grid. Financial, managerial and technical support for this village solar shop should be in place. The community leaders should be involved in this shop from the beginning so that it will be accepted and supported by the community.

Bart Magura is Business developer Sub-Saharan Africa at Futura Holding LTD.

First published: Sun-Connect News.
A

n inexpensive, solar-powered ambulance that can fit down narrow laneways is set to hit the road in rural Bangladesh this year, its manufacturers say.

The three-wheeled van, as well-equipped as ambulances used in Bangladesh’s cities, runs entirely on solar power – including solar battery power at night – and can be used in rural areas with no grid electricity, according to the developers.

A Bangladeshi university, a government organisation and a local vehicle manufacturer who are collaborating on the vehicle say it should for the first time bring ambulance service to rural areas without it.

The vehicle is in the field testing stage and there are plans to launch it by the end of 2017.

In many rural areas, emergency patients are often taken to hospital in hand-pulled rickshaw vans. But the new, small three-wheeler ambulance will fit along narrow roads in rural areas where it is difficult for larger ambulances to run.

Zahidul Islam, a farmer in Saturia in Manikgonj district, said that when his first child was born his wife had a difficult delivery and was taken to the nearby clinic in a hand-pulled rickshaw – a trip that took too much time.

"If I had taken her to hospital a little earlier, she would have had fewer complications," he said. But larger vehicles could not reach his house, he said.

He believes that faster, smaller ambulances would be helpful for rural people.

Safe and comfortable

Kamal Hossain, a driver who has tested a prototype of the ambulance, said that it was safe and comfortable to drive on both smooth and rough surfaces, and went at a good speed.

A.K.M. Abdul Malek Azad, the project’s team leader and a professor at BRAC University in Dhaka, said that most rural community health clinics cannot afford conventional ambulance services, but that the new ambulance would be cheap to buy and to run.

"I thought a low-cost ambulance service would be a good idea for these rural clinics. And by using solar power we can reduce operational costs and save the environment," he said.

The ambulance is expected to cost $1,900 to $2,500, a fraction of the price of conventional ambulances, which can cost at least $30,000 in Bangladesh.

BRAC University’s Control and Applications Research Centre is running the project in association with vehicle manufacturer Beevatech. Financing comes from the World Bank through Bangladesh’s Infrastructure Development Company Limited, with seed funding from the U.S. Institute of Electrical and Electronics Engineers.

Race car inspiration

Azad said that, as far as he is aware, there is no equivalent elsewhere in the world of the solar-powered three-wheeler ambulance his team is
developing. The inspiration for it came from solar racing cars in Australia.

"I thought if researchers can develop a solar racing car, there is potential to develop a solar ambulance," he said. A vehicle that would not be reliant for power on Bangladesh’s overburned national power grid would be a bonus, he explained.

The new ambulance can accommodate three people. It has a maximum speed of 15-20 km per hour (9-12 mph), and a range of up to 50 km (30 miles).

By day it is powered by four 100-watt solar panels on the roof. At night it runs on four 12-volt batteries, which are charged from the solar panels.

"The last layer of the development includes installation of a battery charging station (at a hospital or other site close by) that is completely fuelled by a solar canopy," Azad said. "This step is taken to ensure complete independence of these electrically assisted rickshaws from the national grid."

The ambulance’s battery can recharge in three to four hours, he said.

Azad said his team has built and tested five prototypes over the past year. The new ambulances are expected to hit the roads at the end of 2017.

He expects that buyers will include community clinics across the country run by the BRAC non-governmental organisation. Azad says officials of the BRAC Health and Nutrition Programme have assured the team they will consider using the vehicles in their clinics.

Dr. Shahana Nazneen of the BRAC Health and Nutrition Population Programme said that the vehicles are cost-effective and should be affordable for rural hospitals.

Habibur Rahman Khan, an additional secretary at the Health Ministry in charge of hospitals, agreed that the low-cost ambulance would help the ministry boost health facilities in rural areas.

"We will certainly consider purchasing (them) for rural hospitals," he said.

Mushfique Wadud, Journalist and Writer for Thomson Reuters Foundation and University of Dhaka.

First published: Thomson Reuters Foundation.
Inside the courtyard of the Mawasem El Dayaa Cooperative, overlooking the small village of Deir Qanoun-Ras al-Ain in southern Lebanon, there was a palpable sense of excitement about the solar panels that had recently been installed on the roof. This relatively minor addition to the architecture will have an outsize impact for the cooperative. “Today we are celebrating a positive change to our lives and our community that will last forever,” Daad Ismail, president of the cooperative, told The Daily Star. “Electricity shortages have hurt our productivity, our working hours and our personal lives. Solar energy will not only generate more income, but it will make our production more sustainable and environmentally friendly.”

Power outages have plagued Lebanon since the Civil War. The country now has the third-highest number of monthly electricity cuts in the world, with an average of 50.5 cuts per month, according to a World Bank report published in 2016. Intermittent energy provision is a troublesome reality across the country, particularly for low-income households for whom generators are unaffordable. But alternative energy solutions are slowly taking root across the country.

The 23 women who work at the cooperative, which was founded in 1998 and produces organic local biscuits, jams and preserves, received their crowdfunded solar panels, led by a Greenpeace campaign, last week with relief. “At times, the women were only getting two to three hours of electricity a day,” said project manager Julien Jreissati from environmental NGO Greenpeace. This region, he added, experiences severe electricity cuts that have left residents heavily reliant on unaffordable and high-polluting generators.

“We had all sorts of machines that were rusting here because we couldn’t use them,” Ismail said, gesturing toward machinery acquired with funds from the United Nations Development Program and the European Union. “We had to do everything by hand. We had sore backs and we just weren’t able to produce as much.”

The installation of the solar panels cost $12,000 but will ultimately cut the cooperative’s energy bill by two-thirds, Jreissati said. “The women will never have to use the generator again.”

The result will be increased productivity and lower costs, according to Nader Hajj Shehadeh, the independent energy consultant who advised and led the installation of the solar panels.

Beyond assisting the women’s cooperative, this pilot project is intended to act as an example, promoting solar energy as a viable alternative to generators in lieu of a reliable national electrical supply.

Residents of Metn’s Burj Hammoud, like others around the country, are weary of the ongoing struggle to provide energy for their families. Jacques, who chose not to provide his last name, was
waiting for customers inside his small auto shop when The Daily Star visited and asked him about his electricity costs.

"I live in a small flat with my mother in Sin al-Fil," he said. "I pay LL30,000 ($20) per month for government electricity. But there is only electricity here for a few hours a day. So we rely, like everyone else in Lebanon, on a generator. I usually pay around LL90,000 ($60) per month. In the summer, the price doubles. Then I have to pay for LPG, LL18,000 ($12) per month."

All told, Jacques has calculated that he spends over a quarter of his income on electricity. Further up the street, Gregory, who also chose to be referred to by his first name only, gave similar figures. "It’s always been like this," Jacques added. "The price of oil has fallen, but the [energy] prices haven’t. But that’s just the way it is."

The heavily subsidized national entity Electricite du Liban has a monopoly on the provision of electricity, but deteriorating state infrastructure means the public grid is unable to reliably service the country. Lebanese households typically spend two-thirds of their total energy allowance on generators, according to a 2013 World Bank report.

Controlled by private, largely unregulated groups, generators retail for excruciatingly high prices, Professor Roland Riachi of the American University of Beirut said.

UNDP’s EU-funded CEDRO project – an initiative designed to help the Lebanese government implement a national sustainable energy strategy – is in the process of distributing solar home systems to households in rural areas, allowing low-income families to meet their basic electricity needs, according to Hassan Harajli, a project manager with CEDRO. The new systems will replace inefficient and unsustainable technologies such as kerosene lamps, candles and battery torches.

Access to energy has slightly increased since 2013, Harajli said, but there is still much to do, particularly as the Syrian refugee crisis has imposed additional pressure on Lebanon’s energy supply and infrastructure in general.

Lebanon currently hosts over 1 million Syrian refugees as well as at least 400,000 Palestinians. However, displaced people’s access to energy remains substandard, according to Nancy Hilal, who manages a UNDP project intended to improve living conditions in Palestinian communities and host communities. Hilal’s project is looking to install a large, low-maintenance photovoltaic solar panel system within a Palestinian community on the outskirts of Tyre, which would provide energy for the community’s 1,000 households. "[Solar panels] present solutions that can be used even when the refugees leave," Hilal said.

Although upfront costs remain high, solar installations can cut generator bills extensively and reduce pressure on the national grid. Currently, 18 percent of Lebanon’s total solar capacity is installed in the residential sector, according to Jil Amine, co-author of Lebanon’s first Solar PV Status Report and project manager of UNDP’s Small Decentralized Renewable Energy Power Generation Project. Although solar energy systems able to meet households’ total energy demands remain expensive and unfeasible, there are micro wind and solar applications that can help produce some energy, pushing down household expenditure on energy. "These systems are present in Lebanon and they are usually sold and sized just like private generator subscriptions," Amine said.

Energy efficient technologies at the household level are also available in Lebanon, Amine said. "What is lacking is the awareness [required] for the people to adopt them."

The organizations behind the sustainable energy pilot projects sprouting up across Lebanon are hoping to prove that individuals, neighborhoods, schools, religious institutions and businesses don’t have to pay extortionate amounts for generators while waiting for the national grid to improve.

According to CEDRO, 94 percent of energy production in Lebanon is reliant on fossil fuels. Adopting more sustainable solutions to the current energy crisis will be less detrimental to people’s wallets and the environment.

Alice Rowsome is a Freelance Reporter, currently reporting on the environmental impact of conflict and climate change on communities, specifically indigenous peoples and farmers.

First published: The Daily Star Lebanon.
For generations, residents of this farming village in central Myanmar had a set rhythm to their day - waking up with the sunrise and going to sleep after dark. Diesel generators and batteries were for the privileged few, while the candles used by most were a fire hazard for thatch and bamboo houses.

On a recent, balmy evening, however, the remote village of Nyaung Kone in Myanmar’s central Dry Zone was still abuzz long after night fell. Women sifted onions and winnowed peanuts under their stilt homes. There were queues at snack stalls and children recited their lessons. One family watched a Korean soap opera on TV.

"I used to spend about 200 kyat (€0.15) every night on candles for my sons to study, and I was always worried it would cause a fire. Now I don't spend that anymore and can work late into the night," said peanut farmer Than Than Sint, 44.

A power inverter blinked nearby on the floor of her neighbour’s home, connected to two solar panels.

Access to electricity from clean sources such as solar and small-scale hydropower is changing the centuries-old way of life in thousands of rural communities like this across Myanmar.

But experts say unsupportive policies and a lack of political will are hampering the development of a commercially viable market in renewable energy.

More than two-thirds of Myanmar’s 51 million people lack access to reliable, affordable electricity, mostly in rural areas. Yet successive governments have focused on large-scale hydropower, gas and coal, which critics say are environmentally destructive and costly.

Than Than Sint, whose husband left to work in Malaysia nine years ago, paid 63,000 kyat for her solar system in instalments over 10 months, under a project led by Pact, an international nonprofit working with businesses to bring electricity to a million people in rural Myanmar by 2020.

The solar power lights up her shrine, living room and the space beneath her house, where she works in the evenings.

Half of Nyaung Kone bought solar systems through Pact’s programme, while 16 more families later purchased them outright from the same supplier.

The project’s second phase, if Pact can find funding, would develop mini-grids - local power networks that can supply a village, unconnected to the national grid.

**Political neglect**

For over half a century, Myanmar’s military rulers neglected their citizens, leaving nearly 40,000 villages without access to the ageing grid.

But with blackouts plaguing even areas that are grid-connected in the dry season due to an over-reliance on hydropower people have taken matters into their own hands.

"With no government support whatsoever, the-
re has risen a market for household-scale solutions,” said Chris Greacen, a consultant on off-grid electrification who has advised the World Bank and Germany’s development agency GIZ in Myanmar.

According to Myanmar’s 2014 census, about 178,000 households used private water mills as a primary source of lighting, while 945,000 used solar, and 1 million used diesel generators.

Generators are expensive. Pact says one hour of diesel power in rural Myanmar costs roughly the same as 24 hours of power in Yangon, the commercial capital. But their prevalence shows villagers’ willingness to pay to get electricity, experts say.

Renewables are greener and cheaper, quicker to set up and well-positioned for off-grid needs, said Aung Myint, general secretary of the Renewable Energy Association of Myanmar (REAM).

Yet there is little political will to develop a sustainable market in renewables, or even consider their potential as the government favours a centralised system, he said.

Myanmar’s Energy Master Plan, drawn up with the Asian Development Bank (ADB), projects a significant increase in coal’s share of national electricity output by 2030, to almost 30 percent from less than 2 percent in 2015.

Meanwhile, the $5.8-billion National Electrification Plan (NEP) - which aims to bring power to all of Myanmar by 2030 and overwhelmingly favours grid extension - is starting with a $400 million loan from the World Bank, which said the money is not funding coal or hydropower projects.

Industry watchers call the universal access target ambitious. But Sunil Kumar Khosla, the World Bank’s lead energy specialist, said Vietnam, Laos and Thailand were able to increase electricity coverage from 30 percent to nearly 100 percent within two decades.

Myanmar’s Department of Rural Development, which is responsible for off-grid electrification, did not respond to requests for comment on government policy.

Uneven playing field

Greacen said renewable energy systems, especially micro-hydro and mini-grids, are viable options while people wait to be connected to the main power grid.

In Thailand, a programme for “very small power producers” allows mini-grids to sell electricity to the national grid at standardised rates.

“That programme has enabled over 3,000 megawatts of small-scale renewables to come online - that’s the same generating capacity as three large nuclear power plants,” said Greacen.

Yet in Myanmar, basic laws governing off-grid and rural electrification have not been passed. REAM’s Aung Myint said this regulatory bottleneck makes investors reluctant to step in.

In addition, most of Myanmar’s off-grid projects so far have been heavily subsidised by the government or donors.

For example, nearly 500,000 households will benefit from solar home systems and mini-grids under the NEP, with subsidies of up to 90 percent.

“How can you compete with a free or nearly free product?” asked Evan Scandling, Myanmar managing director of Sunlabob Renewable Energy Ltd, which recently built 11 solar mini-grids in remote villages with funding from the Japanese government.

But with thousands of villages unlikely to be connected to the grid for the foreseeable future, “there’s a market opportunity and a development opportunity”, he added.

The main clients for off-grid solutions in Myanmar are the 4.5 million households spending more than $200 million per year on candles, kerosene, batteries and diesel, according to the International Finance Corporation, the World Bank’s private-sector arm which is helping foster a commercial market for solar devices and kits in the country.

Farmer Myint Maung, 58, has heard rumours the main grid might reach his isolated village of Aung Thar in the Dry Zone next year - but hook-ups will cost each household 400,000 kyat.

"I'm not sure how I can afford that. I might as well stick with my solar system," he said.

Thin Lei Win is Correspondent Southeast & East Asia for Thomson Reuters Foundation.

First published: Thomson Reuters Foundation.
In 2015, Hope Dzimunya began changing the lightbulbs in her house, replacing the old bulbs with energy-efficient ones.

For her, the reasons were both environmental and financial. “There are at least nine bulbs in my house and they are all energy savers, they last long,” said the 39-year-old, who works as a waitress in the mining town of Bindura, 80km (50 miles) north of Zimbabwe’s capital, Harare.

Dzimunya decided to switch over even though she had missed a handout of low-energy lightbulbs to households a few years previously.

In 2011, struggling with a 20 year power crisis, ZESA Holdings - the state power utility and Zimbabwe’s only power supplier - rolled out a $12 million campaign to distribute millions of free energy-efficient bulbs. The company hoped the campaign would encourage users to give up the more familiar but inefficient filament bulbs and fluorescent tubes, as part of measures to conserve energy.

Now the government is trying to push all consumers to switch to more efficient lighting - by banning the older kinds of bulbs.

Cutting emissions
The switch could have a dramatic impact on Zimbabwe’s climate change goals, preventing the equivalent of 1,300 gigatonnes of carbon dioxide emissions over the next 13 years, according to the government’s plan drawn up under the Paris Agreement on climate.

Zimbabwe aims to cut emissions by 33 percent - or 17,300 gigatonnes - by 2030, mostly by increasing investment in hydro and solar power and by improving energy efficiency, the government plan said.

Nearly 40 percent of Zimbabwe’s electricity supply comes from thermal power plants, 39 percent from hydro-power - which has been hampered by drought in recent years - and the remainder is imported, says ZESA Holdings.

Power shortages
Banning energy-inefficient bulbs should help ease the country’s power crisis, says the country’s energy regulator, ZERA.

At their worst in 2015, the shortages left thousands of homes without electricity for 18 hours a day.

Power outages also cut production in the key industries of manufacturing and mining by over 55 percent between 2015 and 2016, according to a survey carried out by the Confederation of Zimbabwe Industries.

Overall, Zimbabwe needs about 2,200 megawatts of electricity at peak consumption.

"The banning of inefficient lighting systems will reduce the country’s electricity demand by 30 to 40 megawatts." Gloria Magombo, chief executive of ZERA, told the Thomson Reuters Foundation.
The ban was introduced in January, and ZERA expects the switchover to more efficient bulbs to be completed by the end of the year.

The energy saved can be used by the mining, agriculture and manufacturing sectors, Magombo said.

Retailers and wholesalers who continue to stock the old-style bulbs, or consulting engineers that recommend inefficient lighting, are liable for a fine or face six months in jail.

Hanging onto old bulbs

Conventional lighting still accounts for up to 15 percent of lighting in Zimbabwean homes, schools and businesses. And there is some resistance to switching over.

In Bindura, Hope Dzimunya says the initial cost of purchasing the energy-saving lights may be off-putting to many consumers.

"The disadvantage is that they are expensive at first, but you don't have to replace them for up to two years if you buy the right one," she said.

That is not always an easy choice, since consumers can be deceived by counterfeits. Dzimunya spent up to $5 each for her bulbs, but fakes that cost just $1.50 require replacement at least three times a month, she said.

Experts say the LED bulb's average price of $3.50 (compared to $0.50 for the obsolete filament bulbs) pales in significance when compared to its long-term energy and cost benefits.

LEDs can provide up to 50,000 hours of light – the equivalent of five-and-a-half years' continuous use, said Norbert Nziramasanga, an electronics engineer and former director of the Southern Centre for Energy and Environment in Harare.

By comparison, the filament bulb burns out within 1,000 hours of use, making it at least seven times as expensive to buy over the same period, he said.

Nziramasanga said the LED consumes just 15 kilowatt-hours (kWh) of energy per year when used for eight hours a day, costing $1.50 on average annually, while an incandescent bulb uses 130 kWh – making it nearly nine times as expensive to run.

The Confederation of Zimbabwe Industries would like to see government back up the ban with incentives such as tax breaks to promote manufacturing of energy efficient lighting, said Busisa Moyo, who heads the industrial lobby group.

But that is unlikely to happen, said ZERA's Magombo.

"No financial support will be provided to help either traders or consumers ... as incentives are already in place, which include scrapping of (import) duty on CFLs," said Magombo.

With over 100 consumer action centres spread across the country, the Consumer Council of Zimbabwe, a semi-autonomous consumer representative body, has been working to promote efficient energy use in households since 2012, according to director Rosemary Siyachitema.

Combined with ZESA Holdings' distribution of bulbs, the council says its outreach is finding currency with users.

Marshal Chinyerere, a hotel chef in Bindura, replaced his old bulbs with the handouts three years ago.

"The new bulbs have helped reduce consumption of electricity in my home," he said.
Gambia’s power utility National Water and Electricity Company (NAWEC) has launched a request for expressions of interest to select companies to provide assistance in conducting feasibility studies for the viability of three different types of solar project across the country: grid-connected PV projects; hybridized PV projects with existing power plants; and off-grid PV installations.

The assistance includes, among other things, analysis of the existing generation and demand, assessment of solar resources, risk analysis and mitigation plan.

The feasibility studies will be financed by the World Bank, with additional funds coming from the Gambia Electricity Support Project, whose aim is to increase the availability and reliability of electricity supply for existing customers in the Great Banjul Area (GBA); Gambia’s westernmost region, suffering continuous shortages in the supply of water and electricity.

The project also intends to help NAWEC improve its generation capacity and efficiency at the existing Kotu and Brikama thermal power plants located in the GBA, and to modernize the local transmission and distribution network. The country’s electricity network consists mainly of mini-grids, which the government hopes to improve by making them into hybrid mini-grids integrated with renewable energy generation capacity.

The small African country, which still relies heavily on oil for its transport and power sector, has drafted a Renewable Energy Act in 2013, after the Ministry of Energy of the Gambia completed a Renewables Readiness Assessment (RRA) with the support of the International Renewable Agency (IRENA) and the ECOWAS Regional Centre for Renewable Energy and Energy Efficiency.

The legislation would include in theory simplified administrative and grid-connection procedures, fiscal breaks and other incentives (FITs and PPAs) for solar and renewable energies. According to IRENA, however, inadequate financial, human and institutional resources are preventing these plans from being implemented.

In late February, the African Development Bank (AfDB)-managed Sustainable Energy Fund for Africa (SEFA) approved a $1 million grant to the government of Gambia for implementation of a program to facilitate private investments in green mini grids through the creation of an enabling policy, institutional and regulatory framework, as well as direct support to project development and financing.
Giving women loans to buy solar panels for irrigation - and access to land - can help them build resilience to climate change.

Amrica Devi Yadav, a farmer from the Terai region in Nepal, is not alone in her struggle to grow food.

"I cannot grow many vegetables with just watering cans. But in our village, we do not have many options for irrigation. Electricity is not reliable and diesel pumps are too expensive for us," she explains.

Yadav lives on a one hectare farm, with her husband and two children in the village of Rayapur, in the Saptari district. During the long dry season, like many others, she finds it hard to cope with her workload, juggling between household chores, childcare and watering her vegetable plot.

Terai is Nepal’s food basket with 71 percent of paddy rice, 64 percent of wheat, and 58 percent of total vegetable production coming from the region. Yet the crop productivity in the many small farms of this region (on average 0.7 hectare) is low, partly due to the difficult access to irrigation.

Despite being blessed by abundant and accessible (only 5 to 15 meters deep) underground water resources, many Terai farmers do not get water during the dry season to grow cash crops like vegetables. Only a third use water pumps for irrigation and a meagre 11 percent of underground water is exploited, as pumping is either unaffordable (diesel costs) or unreliable (electricity).

Could solar pumping be a solution to address food security and poverty among smallholder Terai farmers like Yadav? This is one question the Water Lands and Ecosystems CGIAR research programme explored during the project "Multiple approaches to solving agricultural water problems in mid hills and Terai in Nepal and India”.

Led by the International Center for Integrated Mountain Development (ICIMOD), with the local NGO Sabal Nepal and the social enterprise SUNFARMER, specialized in affordable solar energy technologies, the project aimed to demonstrate the potential of low-cost solar powered irrigation pumps (SPIP) as an alternative for irrigation.

Three pilot solar pump sets were installed in Saptari district, one of them for the women farmers association in Rayapur village, of which Yadav is a member. Saptari was chosen as it ranks second among Terai districts for vegetable production, but is of the one of worst for productivity (15th ) and women’s land ownership is particularly low. This district also has the highest male migration rate among Terai districts and poor access to electricity (only 42 percent of households use electricity).

The impact of the pilot pumps on crop production and livelihoods in Saptari was very positive. With the three solar pumping sets, over nine additional hectares of land were irrigated from August 2015 to July 2016, increasing the cropped area by 28-30 percent. It significantly reduced the use of diesel pumps (from 792 to 206 hours), represen-
Yadav particularly appreciates the eased workload. "This solar pump has made irrigation physically easier for me," she says. "We were able to irrigate cash crops like eggplant, potato, chilli, garlic, coriander, onion seed, green leafy vegetables and pointed gourd during the dry season and get a good income."

Solar pumping is a viable option for farmers to boost their yields and incomes as current models could irrigate 3-5 bighas (approx 2-3.3 hectares) all year around with up to Rs 50,000 savings in diesel costs assuming that the solar pump replaces the use of diesel pump.

Yet, solar pumping technology is still out of reach for most Nepali farmers who do not have the financial means to pay upfront for such equipment. Only 15-20 solar pumps for irrigation were installed in the country at the time of the study compared to over 13,000 in India and 400 in Bangladesh. Scaling up would only happen if appropriate financial models adapted to smallholder farmers were developed.

What is the best model to scale up this technology?

To satisfy the growing demand for solar pumping, the project has tested three financing solutions to scale up the adoption of solar pumping sets.

Through a randomized controlled trial, 3 financial models are being offered to farmers in 93 Village Development Committees in Saptari to test their acceptance among farmers. The benchmark model (grant model) mirrors Nepal’s renewable energy policy by offering a 60 percent grant with the farmer paying 40 percent upfront. The other two models are a grant cum loan model, where in addition to the 60 percent grant, farmers also get a loan, and a pay-as-you-go model, where a 50 percent grant goes to a solar pump entrepreneur who in turn rents out the pump against monthly or seasonal fees.

To improve irrigation access for women, the grant is greater for them (70 percent instead of 60 percent), on the condition that the land on which the solar pump is installed is transferred to the woman.

More than 2,600 farmers attended live demonstrations during a 45-day-long campaign in September and October 2016. About a quarter of the participants were women. This campaign generated 65 demands for SPIP. The grant cum loan model generated 46 percent of the demand followed by the pay-as-you-go model which generated 33 percent of demand.

In a region where women’s land ownership is very low, 75 percent of the applications were from women. It shows that gender-differentiated grant schemes could spark a more equitable land access for women. Further down the line, it will be interesting to evaluate if solar pumping succeeds in boosting women’s empowerment, in a region where irrigation is seen as a male domain.

"This season, I have tried new vegetables like broccoli which is in high demand in the local market. The solar pump system is easy to operate and thanks to it, I will continue grow more cash crops," says Yadav. With continued government support and the right financial models, the benefits of solar irrigation will hopefully reach other Terai villages.

Alina Paul-Bossuet is a communications specialist for the Research Programme on Water, Land and Ecosystems of CGIAR.

First published: Thomson Reuters Foundation.
In the next five years, India plans to install 10,000 small-scale solar-power grids across the country to bring basic electrical power to communities without it.

But providing access to a minimal supply of clean energy – enough to power two LED lights for a few hours and charge a mobile phone – is probably not enough to significantly improve people’s lives, new research suggests.

A study in India’s Uttar Pradesh state, which looked at more than a thousand homes that had received basic access to clean electricity for the first time, found that spending on expensive kerosene for lighting had fallen, a benefit to families.

But access to a couple hours a day of electricity was not enough to boost savings, help launch new businesses, increase time spent working or studying, or otherwise significantly improve people’s lives, researchers found.

What appears to be needed instead are larger clean power systems capable of providing enough energy to power businesses throughout the day, said Michael Aklin, the study’s lead author and a political science professor at the University of Pittsburgh.

“Larger off-grid systems that offer more power could be used for appliances and machinery, with more potential for livelihood creation,” he told the Thomson Reuters Foundation in an email interview. Such systems could be used to run businesses such as internet cafes, fuel stations, repair shops and banks, as well as schools and health centers, he said.

Income-earning businesses of that kind would make it easier to pay back the higher up-front costs of installing clean energy systems – and “could make a major contribution to rural development in India”, Aklin said.

Adarkanta Jena, 53, an engineer with the government of Odisha state, agreed that at least eight hours of uninterrupted power a day are needed to run popular small businesses such as welding shops producing grills for windows, flour mills and machines for hulling or threshing rice.

And “in 24 hours, 12 hours is the minimum power supply that will enable children to study extra hours, provide women a lighted space to cook and the family not to eat dinner in the dark. Having electricity from 8 a.m. to 8 p.m., at least, could bring social and economic change,” he predicted.

Not enough hours

Frustrations with the power supply are hardly limited to clean power users in India. Even 75 percent of families connected to grid power in rural areas – 700 million people – regularly get less than six hours of uninterrupted power a day, according to a 2016 study by the Delhi-based Centre for Science and Environment.

India’s government aims to bring 500-megawatt mini-grid solar systems to about a fifth of the country’s 1.3 billion people in the next five years, according to a government draft policy.

More than 230 million people in India still have no access to basic electricity, often in rural areas...
where expanding the national power grid is too expensive.

Expanding access to power aims to boost household incomes, help students study, provide better access to information via radio or television and generally improve life for rural people, studies have suggested.

But the Uttar Pradesh study – which looked at 1,281 households in 81 communities – found that providing about two hours of electricity in the evening via clean energy mini-grids resulted in few significant changes.

Many households continued to use subsidized kerosene for lighting after the mini-grid power shut off, said the study published in Science Advances magazine.

Electrification programs that focus on off-grid technologies must think carefully about whether low-cost minimal systems are the right answer, authors of the study said.

Clementine Chambon, co-founder of Oorja Solutions, which will begin setting up clean energy mini-grids systems in the Bahraich district of Uttar Pradesh in June, said she agreed that providing larger amounts of power to supply businesses, rather than just homes, could help solar systems pay for themselves more quickly – and could subsidize household use of power.

“Oorja will cross-subsidise residential consumers through higher electricity tariffs for businesses. This renders clean energy affordable to all, whilst ensuring the profitability of the mini-grid infrastructure,” Chambon said.

India eventually aims to expand its grid power system throughout the country, but there will be five to 15 years while that is underway where other solutions – such as mini-grids – are needed, according to Ashvin Dayal, the Rockefeller Foundation’s managing director for Asia.

Those are crucial years both for meeting world goals to extend clean electricity to communities without it and to curb climate-changing emissions in line with the Paris Agreement, which calls for fossil fuels to be phased out by the second half of the century.

The cost of producing solar power in India has plunged in recent months, hitting a level that makes it price competitive with fossil fuels, including coal, experts say.

That makes it increasingly feasible to shift to using clean energy mini-grids, which could result in substantial savings on national subsidies for fossil fuel, according to Aditya Ramji, a Delhi-based renewable energy consultant.

India has the potential to produce nearly 750,000 megawatts of solar power, according to the Ministry of New and Renewable Energy. Given current patterns of household consumption, one megawatt can power about 1,500 rural households, Ramji said.

A 2016 sustainable energy study by the International Energy Initiative found that an average Indian household that relies on kerosene lamps for lighting spends 3,200 rupees ($50) each year on the fuel and emits more than 380 kg of climate-changing gases in the process.

Chambon said the results of the Uttar Pradesh study should not deter investment in solar mini-grids but instead help “improve the delivery and impact of rural electrification programs”.

Maniapdama Jena is an international environmental journalist and photographer and writes for Thomson Reuters Foundation and IPS - Inter Press Service News.

First published: Thomson Reuters Foundation.
In an innovative initiative to increase access to electrical power, the Royal Government of Cambodia (RGC) has adopted a rural electrification master plan that promotes the use of Solar Home Systems (SHS) to increase access to electricity in Cambodia’s rural areas. As a result of a long period of underinvestment in the electricity sector, the proportion of households with access to electricity in Cambodia stood at just 34% in 2013, a bare increase from the figure of 31% recorded in 2012. To address the adverse consequences of high electricity costs, the rural electrification plan aims to ensure that 70% of Cambodian households are connected to the national electricity grid by 2030. In the medium term, the plan promotes the development of mini-grids that use small hydro-power and solar PV systems, including SHS, to provide access to electricity in rural areas.

Under a five-year project first implemented in 2008 through the World Bank-funded Rural Electrification Fund (REF), around 12,000 households installed SHS. Initially, the rate of uptake of these systems by rural households was very low. This was mainly due to the fact that at first, the project required rural households to pay the installation cost upfront, with these costs amounting to US$ 260 for a 30 Watt peak system and US$ 333 for a 50 Watt peak system. Many poor households were unable to afford these costs. Thus, after five years, when the cause of the low rate of uptake was identified, a new business model was adopted. Under the new model, households were able to pay on the basis of a daily rate, spreading their costs across time. This new model resulted in a rapid uptake of the system towards the end of the project, which terminated in 2012. Following the termination of this project, in the period from 2014 to 2015, under the management of Electricity of Cambodia (EDC), the REF sold and installed 13,240 50 WP SHS to rural households in remote areas.

The lessons learnt from Cambodia’s experience could be valuable for a number of other countries and communities within ASEAN, where approximately 134 million people still do not have access to regular supplies of electricity. While at 31.1%, Cambodia’s rate is the lowest amongst these countries, it is closely followed by Myanmar, where the rate stands at 32%. In addition, the rate in rural areas stands below 50% in the Philippines and Lao PDR. Lack of access to electricity has a negative impact on human development, affecting health and education. It also constrains economic activity and can exacerbate environmental issues.

In fact, Cambodia recorded significant success in promoting SHS, despite the fact that the cost of this system in Cambodia was relatively expensive compared to the costs of similar systems elsewhere in the world. To better understand why rural households accepted the system to the extent they did, the Economic Research Institute of ASEAN and East Asia (ERIA) undertook an analysis of the Levelized Cost of Electricity (LCOE) provided by SHS.
and compared to its cost to the current electricity price in rural Cambodia. The study found that the current cost of electricity in Cambodia is very high, ranging from US$0.15/kWh in Phnom Penh to US$1.00/kWh in rural areas. This might explain the high level of acceptance of SHS, despite the relatively high upfront costs of the system in Cambodia. The study found that LCOE of SHS without any government subsidy is about 50 percent cheaper than the current electricity price in rural areas charged by electricity providers using diesel engine. With a government subsidy of US$100 per SHS unit, the LCOE of SHS falls to about one third of the current electricity price in rural areas.

The study proposed a number of recommendations that could be used to increase the uptake in Cambodia or elsewhere in Asia where the system may be implemented in the future. In particular, it found that the high initial cost of installing SHS was a major barrier on acceptance. Thus, it is very important to design an appropriate business model for rural households, such as by charging a daily fee rather than requiring households to pay the whole cost of installing the system upfront. It also emphasised the importance of efficiency throughout the whole SHS value chain, from procurement through to instalment, to ensure that transition and system costs are minimised.

The study also noted that compared to SHS, mini-grids powered by solar PV provided significant economies of scale, thus potentially offering lower systems costs. Thus, the authorities should consider measures to attract investments in these grids as a possible alternative.

Finally, the study noted that while these various systems had good potential to enable an increase in the rate of electrification, particularly in remote rural areas, the expansion of SHS and solar mini grid systems required that local technicians and small business entrepreneurs had the appropriate skills and capacities. Therefore, in order to ensure the success of programs that emphasise the use of these systems, measures to build these capacities are essential.

Dr. Han Phoumin is Energy Economist at Economic Research Institute for ASEAN and East Asia (ERIA).
Currently, an estimated 237 million people in India lack access to any form of electricity, while an additional 100 million have less than four hours of electricity per day. At the same time, the Government of India has set a target of generating over 175 gigawatts of renewable energy by 2022.

This is an ambitious target – even more so if we consider the government’s plan to provide power for all citizens by 2019. The fact that many rural communities have electricity grids that have been installed but are not always operational also presents considerable challenges.

Energy access is not just about electrifying a house: it is about helping social and economic growth within villages and communities, whilst building a cleaner and sustainable future for the whole nation. We believe that DRE can play a fundamental, complementary role, in working alongside the national grid to help achieve universal energy access – and quickly.

**Shifting the narrative**

Following last year’s India Energy Access Summit (IEAS), which brings together industry leaders and policymakers to explore the opportunities for scaling-up DRE, we developed a partnership with the Shakti Sustainable Energy Foundation, to help change the way in which DRE is perceived and positioned in India.

As part of this one year partnership, we have undertaken a literature review to identify how DRE systems have been addressed in India over time, and have planned strategic meetings and roundtables with key stakeholders from the DRE community.

Already, we have jointly hosted a successful roundtable session with Shakti Sustainable Energy Foundation consisting of 15 key stakeholders from the energy and business sectors, including the Rockefeller Foundation, KPMG and the Clean Energy Access Network (CLEAN). We identified how we can collectively develop common messaging to promote the value of DRE systems, in order to help engage government, investors, developers and thought-leaders on the issue.

We are still in the early stages of this project but we are making good progress. By discussing the challenges and opportunities of this approach in our workshops, we are also addressing policy gaps that are holding back integrated approaches to energy access.

**A growing sector**

The Government of India has historically developed a range of policies and schemes to promote DRE. In 1950, the first Indian Five-Year Plan laid the foundations for rural energy policy, with the specific goal of developing rural areas in both a social and economic context.

However, it was only in the early 1980s that the importance of renewable energy was formally
recognized in India, after which it became the first country to set up a dedicated government department - The Department of Non-Conventional Energy in 1982 (which was later converted to a Ministry in 1992 and renamed the Ministry of New and Renewable Energy in 1996).

Since then, the DRE sector has continued to grow. The Government of India has taken significant steps in reaching out to millions in rural communities with a promise to provide accessible, affordable and reliable power. However, there is still a gap between demand and supply, and there is some evidence to suggest that energy distribution companies are unsure of investing in areas with a limited customer base.

DRE is yet to achieve the scale necessary to reach rural communities in sufficient numbers, and much more needs to be done to achieve this crucial goal. This is why the communications element of this project is so important in helping us to raise awareness of this issue among key stakeholder groups.

We hope in the longer term that this project will help us to shape recommendations to the Government on the best approach to scale-up DRE and integrate it within the official overall electricity agenda, whilst highlighting how to overcome barriers to achieving this important goal.

Shilpi Samantray is Project Officer, The Climate Group, India.

First published: The Climate Group.
Access to credit is an important pre-requisite for facilitating access to energy. Owing to marginal and unpredictable incomes, rural and tribal families cannot afford to pay up-front the cost of basic systems. Over the years, solar products, heavily subsidized by multiple donors, have been installed in villages without adequate servicing and maintenance. The consequences have been disastrous as many of the villages have turned into junkyards of dysfunctional systems.

Strong doorstep service along with availability of affordable finance at the local level can lead to creation of sustainable long-term delivery models for energy access. Growing number of grassroots based energy enterprises partnering with local financial institutions have installed reliable home based solar systems in remote hamlets on the hills and deep in the forests.

**Why is access to credit important?**

Decentralized renewable energy (DRE) products when designed as long-term durable assets, their costs are higher than similar products with shorter life times. Cheaper long-term financing makes the expensive, but more durable, products more affordable to the poor: thus helping them own long-term assets. To make financing affordable, the financial products have to be designed to match the cash flows of the various targeted segments. Unfortunately, end-user financing for renewable energy products like solar is still not very prevalent in the many parts of rural India, especially in the tribal belts as the populations are considered very risky from a banker’s perspective.

On the other hand, there are inspiring role models for other bankers to emulate. On such example is Syndicate Bank in the district of Kalanhandi in Odisha. A project conceived by SELCO Foundation along with TATA Trusts, partnered with Syndicate Bank to facilitate long-term financing of solar lighting systems in the area.

Around 20,000 families reside deep in the forests of Thuamal Rampur, in the tribal district of Kalahandi in Southern Odisha. Less than 10% of these households had access to electricity as of 2011. These districts in southern and western Odisha are made up of mostly subsistence farmers with very unreliable incomes. Thuamal Rampur has two banks, but there isn’t much interaction between these banks and the tribal communities. With little or no assets and lacking a habit of savings, local bankers consider these communities “un-bankable” and highly risky to lend to.

**Bridging the gap between tribal communities and banks**

Supported by SELCO’s Incubation team, Prabhat Pradhan from Koraput started Mukti Solar Energy Pvt. Ltd. in 2015. Having served over 500 remote rural customers so far, the primary barrier to grow was access to credit for their end users.
and the local banks were unwilling to lend small loans.

The break came in early 2016. Syndicate Bank, one of the early pioneers of solar financing in Karnataka, showed interest in replicating their efforts in tribal Odisha. Initially the branch manager was hesitant as many of the households were living at quite a distance from the bank branch. Several field visits were arranged to convince the branch manager about the need for solar loans in the region. Finally, the upper management of the Bank was convinced and decided to go ahead with a pilot of 500 solar loans in the tribal belt of Odhisa. SELCO foundation, with financial assistance from Armstrong, deposited a partial risk guarantee fund in the local bank, in case of any defaults: thus making it easier for the bank to lend.

To reduce the processing time and transaction costs, group loan applications from Joint Liability Groups (JLGs) were preferred instead of individual loans. With 5–8 families each, JLGs also create peer pressure within the group to pay their share every month, and households can share the task of going to the bank to make payments. Households are also able to deposit money in their JLG accounts during higher income seasons, leading to saving for harder times.

**Impact: beyond solar lighting**

In the last 6 months, Syndicate bank has sanctioned solar loans for 200 households, and 300 more would be completed in the coming two quarters. With patient hand-holding, the savings and repayments have been successful in the past quarter. For easier repayment options, a banking correspondent and weekly kiosk in Thumal Rampur are being considered. Observing the experiment, other local banks have come forward to collaborate and replicate the efforts. Some of the other bank branches have also extended their loans from simple home lighting to income generating products like solar powered sewing machines, laptop etc.

The scaling effect of unlocking end-user financing is immense. While solar home systems help provide immediate energy access, they are in many ways an entry point to catalyze much larger development in the region. Banks have always been in a position to be at the forefront of enabling this change. In the process of obtaining a solar loan, remote tribal households are able to build credit histories. It is a matter to time that such examples can be replicated in other remote parts of India and the world: thus, enabling holistic development.

(The work of SELCO Foundation in the region of Odhisa has been supported by TATA Trust, Armstrong Foundation and GIZ India)

SELCO Foundation was founded in 2010 as an open source, not for profit, public charitable trust. It is headquartered in Bangalore, Karnataka.
When it comes to decision making, it is sometimes said that a good choice made in the wrong context can be just as bad as a poor one made in the right setting. Context is key. It’s even more critical when it comes to creating social impact. So why, then, do so many of us in the social impact space seem surprisingly indifferent to context? All too often we assume that just because something creates impact in one setting, it’ll work just as well in an entirely different one.

Our new research into the impact of off-grid energy access in emerging markets across multiple geographies, products, and companies is helping us understand when context matters and why.

**Energy provision across East Africa and India**

Two of the previously published studies from our energy impact series have focused on East Africa. This is a geography characterized by woefully inadequate access to grid-based electricity. Only a third of Kenyans, a fifth of Ugandans and a shocking sixth of Tanzanians have access to the grid. This widespread absence of traditional electrification means that the majority of households must rely on expensive and potentially dangerous alternatives, such as kerosene, to light their homes.

So when households gain access to improved solar power, we have seen significant improvements in economic- and health-related social benefits.

By contrast, in India, more than three quarters of the population have access to grid-based electricity. This extension of energy has in part been driven by the country’s ambitious goal to electrify all households by 2020. While this level of coverage sounds like good progress given India’s size, it still leaves 300 million people—a number equal to the combined population of 18 of East Africa’s 19 countries—either in the dark or reliant on dirty sources of energy. Moreover grid-based energy access is neither especially reliable nor is it equitably dispersed. In many parts of the country, particularly in rural areas, it is often the quality of electricity provided rather than access that prevents households from reaping the full benefits of energy provision.

For example in the northeastern state of Bihar, where nearly 90 percent of its almost 100 million people live in rural areas, average energy consumption is barely a sixth of the national average. This is precisely the reason that Acumen investee Husk Power Systems, a mini-grid company providing solar-powered electricity to thousands of rural Indians, chose Bihar to set up shop. As is the case with many solar companies operating in places where the grid is failing, Husk competes with a wide range of alternative sources of energy such as kerosene, diesel and torches. For providers of solar energy, this landscape is not especially unusual, but the competition is especially intense in India—the country is the world’s sixth largest subsidizer of fossil fuels, including major government subsidies for kerosene.

Because of these differing circumstances, we were eager to investigate whether the positive
impact of solar we had seen elsewhere would be equally effective in Bihar.

**Researching the impact of solar in rural India**

We set out to learn more about the impact Husk was having on various aspects of customers’ lives, such as their household assets, energy expenditure, nighttime activities, purchase of kerosene, and changes in children’s literacy and math skills. In partnership with researchers at J-Pal South Asia and with co-funding from LGTVP and USAID, we started a three-year, randomized controlled trial covering some 3,000 households across the East and West Champaran districts of Bihar. The researchers divided these households into three study groups—one with access to Husk’s services at full price, one with access to Husk’s energy services at a discount, and one that served as a control group with no access to Husk’s services.

Here’s what we learned:

Consumers of Husk Power are highly price sensitive. As part of the study, a quarter of the participants were offered a 50 percent discount on Husk’s monthly service price, from Rs. 200 ($3) to Rs. 100 ($1.50). In the areas where the price reduction was offered, demand for Husk’s services shot up from a two percent share of the market to an impressive 20 percent. As a result, the company is now looking at re-evaluating its entire pricing strategy. More broadly, households were more likely to purchase solar in areas dominated by diesel generators compared to those with a reliable grid.

Consumers of Husk Power use more electricity overall. Regardless of whether consumers of Husk’s services were offered a discount, their electricity usage increased significantly compared to the control group that did not have access. Families living in villages powered by Husk mini-grids saw a 38 percent increase in daily electricity use; those who received discounts increased their daily use by a whopping 77 percent. The researchers also saw double-digit increases in mobile phone usage, between 14 percent and 19 percent, respectively.

Kerosene purchase did not fall and total spending on energy remained unchanged. If there has been one consistent finding across Acumen’s surveying of thousands of low-income energy customers, it’s that when customers gain access to solar energy, kerosene usage falls dramatically (often to the point of total elimination). Much to our surprise, this fall in kerosene purchase failed to materialize for users of Husk’s mini-grids.

The reason for this is directly connected to the context in which Husk operates. In Bihar, kerosene is not readily available on the open market. Instead, families purchase an allotment, based on the size and poverty status of the household, from the government at a subsidized price. Anecdotal evidence suggests that families continue to take their full share of kerosene regardless of whether they use Husk’s services. They then find other uses for it, such as paint thinner or as a fuel additive, or they trade it on the black market typically in exchange for diesel power.

Better lighting had a small yet significant effect on educational performance. Unlike other studies on solar lighting’s impact on children’s study time, the researchers found that kids in homes with Husk Power Systems did indeed read more at night. As a result, those children saw an increase in scores by as much as 13 percent in both reading literacy and math.

**The effect of context on social impact**

These results, as compared to those from our studies in East Africa, paint a more nuanced picture of the impact of off-grid solar in India. Certainly, there are some highly encouraging findings, particularly those related to educational performance. However, the fact that overall spending on kerosene did not decrease—an almost universal finding elsewhere and something we at Acumen have historically considered a surefire sign of impact—suggests that the economic and environmental impacts of solar on households in rural Bihar may be lower than in East Africa.

The fact that context can play such an important role in impact suggests that for those serious about understanding and creating lasting social change it’s not enough just to assume that a solution, product or innovation will be impactful. This is true even where that assumption is predicated on significant prior evidence. Instead, in all but the rarest of cases, we need to investigate the impact we create with new data, direct from the end-consumers.

This should come as little surprise. Social transformation is complex, often personal and prone to change over time as societies themselves also
change. This is not cause for despair, but rather a reminder of the importance of continual learning when it comes to measuring social impact.

This is the third installment of a series of lessons from a range of new research into the social impact of off-grid energy in emerging markets. The research is complemented by Acumen’s own customer-based data collection applying our Lean Data approach. This work was originally conceived by Kat Harrison, formerly head of research and impact at SolarAid and now Acumen’s Associate Director of Impact.

Tom Adams is the Director of Impact at Acumen. First published: Acumen.
Even as Australian power prices continue to rise, and the costs of solar and battery storage continue to fall, it remains relatively rare for established, grid-connected households to cut the cord, so to speak, and leave their local electricity network.

But it is happening. In the Victoria’s Latrobe Valley region, for example, local business Gippsland Solar has recently helped to fit out a home with everything it needs to go it alone: a 15kW (3 phase) system with battery storage “in the middle of Traralgon!”

The project (pictured above and below) ranks as one of Gippsland Solar’s biggest ever residential jobs, including the installation of 54 LG NeON2 mono panels – north and west to spread the generation across the day and increase self-consumption; a Fronius Symo 15kW inverter; three Victron Quattro hybrid units; and a 48V, 600ah battery bank, using Narada lead-carbon batteries.

With all that installed, the client now plans to monitor the system over the winter months and, once satisfied it can meet the household’s needs year-round, remove the smart meter and disconnect from the grid.

So what motivates a consumer to go to such lengths? According to Gippsland Solar’s founder and managing director, Andrew McCarthy, the client – who had spent months researching his options for going off grid – was largely motivated by self-sufficiency: “the peace of mind that comes with having complete control over his own electricity production and storage.”
But McCarthy says the client also wanted to rid himself of the house’s grid-connected smart meter to prevent the utility from collecting data about his electricity usage across the day.

This suggests a sort of disconnect with the energy establishment that ought to be making utilities uneasy; not to mention the Australian Energy Market Operator, which – under the guidance of its enlightened new CEO, Audrey Zibelman – has finally woken up to the importance of rooftop solar and storage in maintaining whole of grid security in the new energy future.

“If you have solar on your roof and you are putting in storage, it is saying that during certain hours of the day you use solar to charge up the battery, and then, rather than relying on grid, you reduce demand on the grid,” Zibelman has said.

“For us (the grid operator) that’s the same as increasing generation... and a lot cheaper than building a new power plant that is only used for a few hours a year.

“Some call this the democratisation of energy .... but it is essentially about the ability for people to use their own resources, and to get reward for it.”

The problem is, a growing number of Australian households have become tired of waiting for democracy to kick in, and are taking matters into their own hands. At the same time, the cost of doing so is becoming more and more attractive, while the cost of staying on the grid, even with solar and storage, appears to becomes more and more punitive.

“Clients wanting to disconnect from the grid are becoming increasingly common,” McCarthy told One Step Off The Grid on Tuesday. “Even in the middle of towns and suburbs.

“Consumers are well aware that with the uptake of residential solar, the power companies are looking to increase service and demand charges to recover their costs. The only way to protect themselves against this is to disconnect from the grid entirely,” he said.

And like his Traralgon client, McCarthy said there was also a concern around energy providers having access to consumers' consumption data via the smart meter roll-out.

"Privacy is a big issue, so going off the grid is appealing to many of our clients."

But perhaps even more worryingly for Australian network operators and incumbents is the increasing number of new home builders – particularly in Australia’s regional areas – who are simply bypassing the grid altogether.

According to McCarthy, as much as half of all new-build homes his company deals with are making those homes completely energy independent, right from the outset, preferring to spend the tens of thousands of dollars often required to connect to the grid on solar and battery storage.

"We have been particularly shocked at how many (customers) are turning their back on the grid, and installing a stand-alone system on their new home," he told One Step.

"Of the dozens of new homes we have installed solar for in the last 12 months, nearly half of them elected not to connect to the grid.

"In regional Victoria, the typical grid connection cost can be anywhere from $10,000 – $25,000, and pushing up towards $80,000 for longer distances.

"These clients are telling me that they don’t want to pay those prices to connect a smart meter, and still be held hostage to ever-increasing service charges."

Sophie Vorrath is a clean energy journalist and Deputy Editor of “One Step Off The Grid”. 
First published: "One Step Off The Grid".
Mohammad Aslam has finally found a way to give his family relief from extended power cuts. In February this year he installed a 300-watt solar power generating system on the roof of his house.

In Pakistan, power outages scheduled by the country’s strained public electric utilities frequently hit households, lasting as long as 10 hours a day in towns and cities and up to 16 hours in rural areas.

The situation is worst during the brutally hot summer months, when air-conditioners often overload the national grid.

Buying solar panels to create power at home might seem an obvious way to bridge the gap. But although the panels have been available since 2014 in Aslam’s town of Larkana, in the southern province of Sindh, the 35-year-old entrepreneur waited two years before finally installing one.

Cost wasn’t the problem. Instead, he said, he was put off by rumours that solar panels would actually make things worse.

Unscrupulous local utility officials, he says, told him that the dark-coloured solar panels, built to absorb the sun’s rays and convert them to electricity, would increase the ambient heat in the buildings they were attached to, pushing the temperature indoors even higher.

According to Aslam, the officials even said that the growing use of solar panels was to blame for the more frequent and intense heat waves that Pakistan has experienced – something scientists say is entirely untrue.

Climate change and worsening extreme heat is instead driven largely by a huge expansion in the use of fossil fuels such as coal, oil and gas since the start of the industrial revolution, they say.

"I discovered it was a fake rumour only after I installed the solar system on the insistence of my friend, a graduate in electric engineering," Aslam told the Thomson Reuters Foundation in an interview.

His friend assured him that the rumours were just a trick by utility company employees bent on discouraging wide-scale adoption of solar energy adoption in order to safeguard their jobs.

Tariq Mehmood, general manager of the Islamabad Electric Supply Company (IESCO), a public power utility, said he was not aware of any IESCO employees spreading rumours.

"Our power utility has nothing to do with (any rumours) and disowns them. People shouldn’t believe them," Mehmood said in a telephone interview.

'A Great Relief'

Aslam’s new solar home system – two solar panels, four ceiling fans, four energy-saving lights and a rechargeable battery – cost him $500.

During the day the system powers the ceiling fans and stores enough electricity in the battery to run the fans and lights for six or seven hours at
night if the grid electricity supply goes off. The battery can recharge in sunlight in three hours.

“We have fans and lights (that) remain on whenever power outages hit us. What makes me more happy is that my family feels a great relief thanks to it,” Aslam said.

Abdul Karim, a solar panel retailer at the Aabpara electronic market in Islamabad, Pakistan’s capital, said prospective customers often mention having heard the rumours that solar panels add to heat problems.

“To prove these rumours wrong, often I have to take them to the rooftop of my shop to show them the solar system that powers my shop,” Karim said. “Then many buy solar systems from me.”

As solar home systems become more affordable, many households see them as an alternative to trying to get a new electrical connection via the public power utilities.

According to Mir Ahmad Shah, executive secretary of the Pakistan Renewable and Alternative Energy Association, public utilities that control power distribution and supply fear that the gradual adoption of solar energy will make people less reliant on the national grid.

“Employees of the public power utilities are hampering this growing shift to solar energy through rumours, because they fear the growing adoption solar energy systems will lead to overall revenue decline from new connection applications,” Shah said.

Cash for Service?

Retired Pakistan Railways employee Raja Jameel said he was unsuccessful in getting a grid connection two years ago for his new home in Ghouri, a rural locality on Islamabad’s outskirts.

“What (finally) worked in a matter of a few hours to get what I was denied for nearly four months was a $50 bribe to a superintendent of IESCO,” Jameel said in an interview.

He said he believes that in some utility companies, employees responsible for approving new power connections try to dissuade potential solar adopters by spreading false rumours about the panels, largely because they do not want to lose potential bribes for approving new grid connections.

Jameel plans to build a second storey onto his home to rent out, but he says he will install a 2-kilowatt solar home system to power it, rather than begging for a new power connection from the utility.

IESCO’s Mehmood said that although the utility had periodically received complaints from customers about bribe-taking, it had taken steps to reduce the problem.

“IESCO management has controlled (bribe-taking) through a strong online public complaint redressal system established a few years ago. Besides, we have made the process of sanctioning and issuing new electricity connection systems more transparent and hassle-free,” Mehmood said.

In an interview outside the Parliament building in Islamabad, Minister of State for Water and Power Abid Sher Ali did not deny that power distribution companies, including IESCO, have had problems with corruption, but said the government took all complaints regarding such matters seriously.

“We have a zero tolerance policy regarding bribery in the public power utilities across the country,” Ali said.

The minister added there is a robust complaints mechanism, and that any employees found to have been corrupt are demoted or dismissed.

Saleem Shaikh and Sughrina Tunio are writers for Thomson Reuters Foundation.

First published: Thomson Reuters Foundation.
So much has been said about the indispensability of renewable energy and as the energy messiah it is believed to be. We have talked loudly and written enough, but what remains to be seen is the tangible action, in line with the Sustainable Development Goals (SDGs) 7 (affordable clean energy), 13 (climate action) and 11 (sustainable cities and communities). However, this does not mean to say that other sustainable goals are not important in this regard, mainly because SDGs are strongly interlinked, interrelated, and on paper, they highly influence each other. But in practice, in scope and content, I continue not to beg to differ as I articulated in my article last week article, but to emphatically say, although on paper they possess all the qualities of sustainability, they are not as inclusive as they purport to be. The mantra that, “no one will be left out”, is exclusively designed and suitable for utopian environments, thinking and imagination. Of course, it does not mean that because of their operational gaps, we have to ignore them, we have to give them the attention and respect that they deserve no matter their somewhat inadequacies, life goes on.

Back to the issue of solar energy, the biting costs of importing power from neighbouring countries and the costs of the country’s inability to sustain its local demands, can drive our government and its local supplying authorities to rethink on how best they can transform and manage their energy matrix. As I have alluded to earlier on, if they are not sure about how best they can engage in the solar energy revolution, they can just start with some pilot projects in order to evaluate how sustainable this could be. A pilot solar energy project is good for introspection and can afford chances for modifications, with the future in mind.

What is more worrying is that, those who are being solar compliant in Zimbabwe, do that out of their own volition, not from anyone’s benevolence, including the government or non-governmental organisations, as these people have discovered that waiting to be delivered from energy poverty, is like waiting for the second coming of Jesus Christ.

Apart from the business-minded and entrepreneurial practitioners, the majority of local communities in this country continue to sing energy blues, whether renewable, hydro or thermal generated and are yet to realise the significance of the solar energy revolution. National solar-energy uptake has been moving at a snail’s pace, not because of lack of demand, but due to astronomical and skyrocketing prices of solar products in Zimbabwe. Even influential people and institutions are not leading the way to invest in solar energy.

The country should see how it must tame beyond reach renewable energy costs by building its own solar grids for storage purposes. From the situation on the ground, it may not be easy for the relevant authorities to convince the people that, easily available and cheap coal is dirty and not
sustainable. This is due to the fact that the people cannot see the viable energy alternative which has been talked about so much in meetings, at conferences and in the political corridors, for glossing purposes of course. The responsible authorities should demonstrate that, indeed yes, coal is bad, dirty and can damage the environment. The government can only do this by flooding the market with affordable, but sustainable solar energy products for the country’s resilience.

Surely as onlookers and bystanders, we patiently wait for the anticipated energy transition to take place and usher new horizons in the people’s livelihoods. If the solar revolution was adding up, we could be talking of percentages and statistical representations to re-orient our thinking and satisfy our aspirations. As things stand, it’s too early to consider doing away with thermal power generation as we don’t have any meaningful alternatives to back up hydro or thermal power generation. Otherwise as things stand, it is folly to write off other forms of energy completely, before doing a thorough housecleaning.

Surely people cannot be prevented from ending energy poverty because of the unavailability of the solar grid as the storage system for back up purposes, yet the power of the sun is abundant and unlimited. If the grid is available, we can use electricity during the day without a myriad of energy commandments. It’s not comfortable or sustainable on the part of the local power authorities to continue paying for the costs of hydro and thermal electricity yet they can be self-sufficient in their own right.

The thrust of this energy transition, is not only that renewable energy is cleaner and cheaper in the long run, but it will go a long way in helping to reduce greenhouse gas emissions that cause global warming.

Finally, for a country to move out of the intricate energy importing matrix, it should reconsider seriously the costs of being an energy slave of other countries in the region.

Peter Makwanya is a climate change communicator.

First published: News Today.
To be able to facilitate more off-grid population, the authorities will have to interact with all stakeholders to strike a fine balance between import and local production of solar panels and other necessary kits, writes Wasi Ahmed.

It is heartening to see that the country has struck a breakthrough in the use of renewable energy. Bangladesh is now a big name in the use of Solar Home Systems (SHS) -- an important segment of renewable energy, which has been acclaimed as the largest off-grid renewable energy programme in the world. This has been revealed in a recent report of the Paris-based energy think-tank, REN21. According to the report, as of 2016, more than six million SHS and kits were in operation worldwide, with 25 million people benefiting from them. Bangladesh, the largest SHS market worldwide, now has more than four million units installed.

This by all means is a laudable achievement. Infrastructure Development Company Ltd (IDCOL) Bangladesh, the main entity to run the initiative, started the SHS programme in early 2003 to meet basic electricity needs of the off-grid rural people as well as supplement the government’s vision of ensuring access to electricity for all citizens of by 2021. Up to October 2016, about 4.1 million SHSs have been installed under the programme in the remote areas where electrification through grid expansion is challenging and costly. Thus the programme has ensured supply of solar electricity to 18 million people i.e., 12 per cent of the country’s total population who previously used kerosene lamps for lighting purpose. IDCOL has a target to finance six million SHS by 2021 with an estimated generation capacity of 220 MW of electricity. The multi-donor funded programme has proved highly beneficial, especially in the far-flung off-grid locations, including among others the char areas where grid connectivity is too remote a dream for the people. As per the energy and power ministry data, currently, 2.86 per cent of all power generated in the country comes from renewable energy, including solar power.

The REN21 report lauded the role played by micro-credit schemes in Bangladesh for helping the growth of SHS consumption. “Markets for both mini-grids and stand-alone systems are evolving rapidly. Bangladesh, with four million units installed, has the largest solar home system market using mainly micro-credit schemes,” said the report. The REN21 report noted that mini-grids and stand-alone energy systems are evolving rapidly, as does the growth of pay-as-you-go business models supported by mobile technology.

That solar home systems have done a miracle in vast swathes of off-grid regions is a reality not many of the people living in the urban locations are aware of. Most of the char and island locations and low-lying haor areas are benefiting hugely from the technology. While initially, for most users, installation of SHS was meant to have their houses well lit, the technology soon emerged to change their life style by adding value to their economic life, catering for critical needs such as irrigation among others. Small businesses, hitherto unthin-
kable in those locations, are evolving with the support of innovative technology.

The spectacular growth of the SHS market in Bangladesh is awe-inspiring. It has been gathered that in 2012, investment in solar companies was to the tune of only $3 million, and by 2015 investment rose to $158 million, and in 2016 to a staggering $223. With the momentum on, SHS is highly likely to reach out to increasing the number of the population in the near future. Currently, the country has around 38 per cent of the population without access to electricity. With grid connectivity growing as a result of the newly installed power stations, a sizeable population in remote areas will still remain off-grid. This is where SHS is to fill in the gap.

Under the prevailing situation, there is definite logic to help expand the SHS market in the country. With the mechanism in place and benefits visible, it’s only a matter of time to see its all-round positive impact. In this context, the decision of the government to withdraw 10 per cent import duty on solar panels proposed in the 2017-18 national budget will hopefully provide the required boost. However, there seems to be a lack of harmony in imports and local production. The local manufacturers want a considerable gap in import pricing through import duties so that investment made in the sector can be secured. There is thus the need to assess the ground reality, especially the domestic manufacturers’ capacity to meet the growing demand as well as the quality of their products. To be able to facilitate more off-grid population, the authorities will have to interact with all stakeholders to strike a fine balance between import and local production of panels and other necessary solar kits.

There is an equally important issue that needs to be addressed. It has been reported that in many rural areas where the locals have put in their money for installation of solar panels are now in a tricky situation as some of those locations are being brought within grid connectivity. There is thus a critical need for harmony in government planning in this regard.

First published: The Financial Express, Bangladesh.
China’s energy, pollution and climate change issues produce a steady blizzard of headlines: it has become the world’s biggest carbon emitter, the world’s largest energy producer, and the biggest producer, consumer and importer of coal. Nonetheless, it has stepped into a leadership role on climate change after the US withdrew from the Paris Agreement. And so on.

Often lost in all this is a major advance: China has achieved full electrification for its population of 1.4 billion, even in its remotest villages. About one billion people worldwide have no electricity, and another 1.5 billion lack reliable electricity so China’s success offers useful lessons for other countries struggling to connect remote, poor areas.

Electricity matters
I would like to provide a personal perspective. I was born in a small village in Hunan province, in central China, and am old enough to remember a life without electricity. Many people today would panic after an hour’s disconnection from the electricity grid. Where to charge their phone? What to do without a wi-fi connection? Back then, for my family it was normal. Kerosene lamps for light, a wood-save stove for cooking – a model that was already an improvement on previous versions because it used less wood. However, the smoke remained a major source of air pollution, and was especially harmful for women and children, who spent most time indoors.

Providing electricity to all is about humanity. Without electricity, other essential steps for human development such as providing modern public health services or narrowing the digital divide, are

Huge hurdles
China’s road to full electrification has been rough. Initially reliant on imports for its grid and generating capacity, China then had to reshape its institutions to create the financial arrangements to incentivise investment and grid connection. Admittedly, many Western countries achieved electrification for large populations from the 1950s to 1970s. So what’s distinctive about China’s experience?

China tackled rural electrification in two waves. The first wave provided electricity to 97% of the population by the late 1990s. Extensions to the power grid carried electricity to about 80% of rural Chinese, while the rest gained access through small hydro and small coal-fired power plants (up to 50 megawatts) connected into local and regional grids.

Winning the battle to bring electricity to the final 3% was much harder. Success came from China’s notable advances in extending and renovating rural grids.

Even so, grid extensions could not reach everyone in a cost-effective manner.
In 2012, the central government issued a 3-year action plan, "Electricity for All (2013-2015)”, to connect the final 2.73 million people. It succeeded. China declared full electrification in 2015.

What can the rest of the world learn? There are three lessons from China’s final, successful effort to electrify.

1) **Co-ordinate all stakeholders**
   Despite prioritising electrification, the central government alone could neither implement the necessary investments, nor manage highly decentralised infrastructures. China’s central government therefore provided policy leadership and investment, but with extensive local coordination. Provincial governments examined local conditions and coordinated project implementation. Some conducted trials of different approaches and technologies, as the best strategies for ubiquitous electrification were not obvious.

   Central government also sat at the centre of vital cost sharing schemes. For example, between 2013-2015 it allocated 24.8 billion yuan (approximately US$4 billion) for grid extensions and small off-grid solar photovoltaic (PV) systems. Roughly 60%, or 14.6 billion yuan, came from central budgets. State-owned power companies and local governments provided the rest. Officials also used private firms to fund and implement PV projects. Central government investment sharing varied province-by-province, ranging from 20% to 80%. For instance, the poorest region involved was Tibet, where development projects are particularly expensive, so central government paid 80% of the costs, higher than average.

   What’s important to learn from the Chinese approach is the indispensable role of reliable funding, which in China’s case, came from the centre, along with the importance of guided experimentation and learning.

2) **Select appropriate technologies**
   The final round of electrification was split 50/50 between grid extension and off-grid solar PV. Although more reliable, grid connection proved too expensive and inflexible for the remotest populations. Trials showed costs as high as 100,000 yuan (US$16,000) per household, depending on terrain and distance to the substation.

   Distributed solar PV at 0.5-1kW per household had better system reliability, but such micro-grids were also costly, averaging 9,000-20,000 yuan (US$1,400-3,200) per household.

   Individual solar PV at 0.3-0.4kW per household was the cheapest option, costing between 7,500-11,200 yuan (US$1,200-1,800) per household. Generally, such systems were preferable, according to National Energy Administration guidelines, anywhere with less than 20 households per square kilometre. Grid systems were prohibitive yet households preferred their greater reliability and responsiveness to demand.

   Connecting the remotest households involves major trade-offs between power quality, level of supply and cost, though they may be lessened by continued improvements in remote off-grid systems.

   In other countries, off-grid systems have faced the challenge of ongoing maintenance costs. China addressed this by covering them with the nationwide renewable energy fund. It collects 1.5 cents RMB (yuan) per kilowatt hour, rising to 1.9 cents RMB per kWh in 2016 to close the funding gap created by soaring renewable generation.

   In areas that were prohibitive to serve with any system, the government rehoused people in more hospitable terrain.

3) **Embed electrification in development plans**
   As in the US and other industrialised countries, China embedded electrification within its poverty eradication strategy, mainly through the "Infrastructure to Every Village Project," which covered power, roads, water, and telecoms. Electrification facilitates rural economic growth, and higher incomes leads to greater electricity use, justifying further investment in rural electrification. This feedback loop enables sustainable electricity supplies rather than relying solely on government subsidy. Like the US, this process was hastened by policy measures such as China’s “home appliances to the countryside” programme, which subsidised purchases of TVs, washing machines, and mobile phones.

   Of course, there is also much about China that is different from other countries.

   China’s authoritative central government can mobilise large amounts of capital relatively easily, and bring together state-owned power firms and local officials. Less authoritative governments can
find those tasks more difficult. Moving people from isolated locations, for example, is not something all countries can do, and raises important questions about justice and people’s ability to adapt.

Nonetheless, while remembering differences and potential risks, China’s achievement offers lessons and blueprints. New technologies are rapidly making off-grid systems more viable, though grid systems remain the backbone. Continued improvements such as cheaper batteries and better systems integration, could shift the balance of economic merit to off-grid solutions.

Providing electricity for all the world’s poorest is an ambitious goal. Careful planning and coordination between different stakeholders is needed to align the desired investment, human resources, and action plans.

Integrating electricity access into local economic development helps ensure more sustainable electrification. This is a key lesson from electrification of the advanced industrialised nations that China’s experience reinforces.

He Gang is an assistant professor in the Department of Technology and Society at State University of New York at Stony Brook.

First published: chinadialogue.
Ruchi Soni

Mini grids: Providing electricity to Myanmar’s communities away from the grid

Ma Khine, a mother of four, talks about how the installed solar mini grids in the Myin Chi Naing village in Myanmar electrify the streetlights that make her feel safer. Her friends excitedly share how the electric-powered pesticide sprays save them time and effort in their farms. Another villager in the Ton Lon village proudly displays how the diesel mini grid powers a submersible water pump from a 200-foot well. The villagers are also grateful for the mini grid to provide light after daylight hours to allow them to sort crops, something they wouldn’t be able to do previously after it got dark. The new batteries store enough energy to allow the villagers to store their rice and turmeric harvest.

These are just few of the experiences people shared during a visit to the village as part of an event on Upscaling mini grids for least-cost and timely access to electricity services, held in Nay Pyi Taw, Myanmar in February 2017. The World Bank’s Energy Sector Management Assistance Program (ESMAP) and the Climate Investment Funds (CIF) jointly organized the event.

Event participants visited two villages in central Myanmar – Myin Chi Naing and Ton Lon – that are away from the country’s main grid and are currently served by mini grids, one powered by diesel and one by solar PV. Both mini grids are owned and operated by the local Village Electricity Committee (VEC). Residents of those villages were eager to share how electricity generated by the mini grid has provided many opportunities for men and women in central Myanmar, which are not connected to the main grid.

In Myanmar, approximately 70 percent of the population and 84 percent of the rural households do not have access to electricity. The Myanmar National Electrification Plan (NEP), funded by the World Bank and other partners, aims to achieve 100 percent electrification by 2030. However, the challenge to reach this goal is huge. Electricity shortages and supply disruptions are widespread in Myanmar due to under-investment in the sector.

Mini grids using locally engineered and financed technology have played a crucial role in the provision of electricity for thousands of villages in the country. These mini-grids largely emerged due to the entrepreneurial drive from the local private sector and community organizations with little or no public sector support. They also simultaneously reflect the determination and ingenuity of many local communities in finding alternatives to candles and kerosene.

In the village of Myin Chi Naing (Kyaukse Township, Mandalay District), three identical 3.6 kW solar PV mini grids provide electricity to 200 households. Yangon-based company (SolaRiseSys) built the mini grids, as part of an Asian Development Bank (ADB) mini grids’ pilot program. Collectively the three systems in Myin Chi Naing village provide electricity to 200 households, a monastery, and a library.
It operates through a pre-pay metering system where households purchase electricity using magnetic cards. All customers are signed up for the basic package, which provides up to 100 watt-hours per day and a maximum of 50 watts at any time. Tariffs are 1500 kyat (approximately US $1) per month. The system powers two five-watt LED lights, a USB charging port, and a 230-volt electrical outlet, in each household. In addition, many households use the electricity to charge cell phones and watch TV. Currently, the households consume up to 3 kilowatt-hours per month, and pay about US $1.2, based on their consumption. An interesting feature of this system is its "grid-readiness," that is electricity is distributed on grid-ready concrete poles. In addition, the inverter has the ability to connect with the grid, using grid power to charge batteries and providing the mini grid with a supplemental source to the solar. This is to say that the present inverter could be swapped out for an inverter with the capability for bidirectional power flows, injecting solar electricity into the grid when batteries are charged and the solar panels are providing a surplus.

The second mini grid is a 10 kW diesel unit in Ton Lon village, which is an example of typical village-operated mini grids found in much of rural Myanmar. Ton Lon village has 97 households, of which about 30 are served by a diesel generator-powered mini grid. The VEC comprising of 14 individuals own and manage the generator, and split into groups of two to start and stop the generator every day. Each household pays an approximate fee of US $1.84 (2,500 kyat) per month for a 26-watt CFL or US $3 (4,000 kyat) per month (for powering a CFL and a television). Payment of the monthly fee entitles the household to use of pumped well water available from a water tank immediately adjacent to the generator. The remaining 60+ households cannot afford the monthly fee and thus, are not served by the mini grid. The generator was provided to the village in FY 2015-6 and this installation is one of many similar installations by the Department of Rural Development (DRD) in the area. This case represents thousands of other diesel mini-grids established by local communities. In addition, to diesel mini-grids, Myanmar has a strong prevalence of locally designed and implemented biomass gasifiers and micro/mini hydro projects.

There is a Burmese phrase used by local practitioners – “ko-htu-ko-hta min-lin-ya” – which literally means "self-reliance electrification." Visiting these two sites show the incredible ingenuity by the local communities in developing these systems, while also highlighting the significant opportunities that exist to both to upgrade existing mini grids and to develop new sites. The takeaway is that there are untapped opportunities that exist for providing better access to reliable and affordable electricity that can in turn enable pro-poor growth.

First published: UN Foundation.
Mid-morning at Gaitheri Secondary School in central Kenya’s Murang’a County, and students are busy with their daily routine, as at any other school. But their establishment is different - boasting a better power supply than most rural classrooms.

One of its iron-sheet roofs is covered in tiles fitted with energy-producing solar cells - an innovative solar-power technology known as “building-integrated photovoltaics” (BIPV).

The tiles, designed to be laid on roofs during construction, offer an alternative to adding solar panels on top to produce power from the sun’s energy.

Solar tiles are starting to be rolled out in other countries too. Electric car maker Tesla Inc is taking orders for its tiles in Britain and the United States, where the first such roofs have recently been installed.

Tesla has said the product will be pricier than a conventional roof but will look better and ultimately pay for itself through lower electricity costs.

In Kenya, the tiles at Gaitheri school, which has 275 students, were made by Kenyan firm Strauss Energy and paid for with a grant from the United States African Development Foundation.

“They wanted an institution that is away from urban centres and where grid power connectivity is poor,” said teacher Jackson Kamau Kiragu.

The project started in 2016, and has enabled students to improve their performance thanks to more reliable power, which means they can study even after dark.

The solar power is stored in batteries, ensuring a continuous supply at night and on cloudy days.

Kiragu said the BIPV technology has also allowed the school to offer computer lessons. "We’ve got 18 computers, but power was a challenge before Strauss Energy came on board,” he said.

The school is also connected to the national grid but the power this provides is expensive and suffers from frequent outages, especially in the rainy season.

The solar tiles have reduced the school’s spending on electricity to 1,500 Kenyan shillings (about $14.50) a month, which is largely a fixed charge for access to grid power. "Irrespective of the weather, we rely on solar power,” said Kiragu.

A large share of Kenya’s population of some 45 million still has no access to electricity, particularly in rural areas, while demand for green energy is growing as the country steps up efforts to curb climate change.

A survey commissioned by Christian Aid and the Pan-African Climate Justice Alliance early this year showed that only about 57 percent of Kenyans are connected to the grid, indicating huge potential demand for off-grid energy.

The situation has sparked innovations like Strauss Energy’s BIPV technology.

Charity Wanjiku, the company’s chief operations officer, said it was motivated to develop the...
patented technology because Kenya has abundant sun that is not being fully exploited.

**Building regulation**

Wanjiku said the technology could help make up a shortfall in hydropower, whose production has declined as drought has hit water levels in rivers and reservoirs.

BIPV can also create jobs, as the tiles must be made and fixed onto roofs by technicians, she added.

While the technology is gaining ground, Wanjiku noted the construction industry in Kenya is rigid when it comes to adopting new technologies. Market penetration is still slow given the technology is new and will require some time to build trust and acceptance among a wider customer base, she added.

But the solar tiles have come onto the market at a time when the country is experiencing a policy shift on utilising solar energy in the construction sector.

In April, Kenya’s Energy Regulatory Commission directed property owners whose buildings use more than 100 litres of hot water per day to install solar water-heating systems.

Wanjiku hopes such policy changes will drive adoption of the solar-tile technology.

“(It) is ideal for estate developers, schools and hospitals,” she said, adding it may still be expensive for individual homes.

The tiles cost between $20 and $250 each, depending on their size.

Research and development is underway to improve the product and bring down costs while enhancing efficiency, Wanjiku said.

Strauss Energy plans to construct a plant with the capacity to produce 10,000 units daily.

**Constant power**

Kiragu, meanwhile, is convinced the solar tiles can be a boon to schools. Putting them on even one school building can make a difference in providing cheap, reliable power, he said.

In addition, the tiles are made of clay and durable plastic, so can be used to harvest rainwater for domestic use, he added.

At Gaitheri, the school building was not designed for solar-tile roofing, so the tiles were placed on an existing roof.

They are arranged in batches of 12 comprising a single circuit. Power from the circuits is channelled into batteries fitted with a charging unit that indicates the amount of power being generated.

The school has 300 tiles, producing a combined 300 kilowatts, and eight batteries with a 25-year lifespan linked to a 48-volt system.

“We usually monitor the two sources - grid and solar (power) - and we have noted that while the grid power shows fluctuation, the solar power is constant,” Kiragu said.

Muddy Ramrakha, board treasurer for the Kenya Green Building Society, said BIPV technology could make a significant contribution to easing dependence on the national grid.

But that will require overcoming a number of challenges, including raising awareness among potential users.

And while photovoltaic equipment is getting cheaper globally, the cost and durability of battery technology will remain a barrier for some time to come, he predicted.

Wider access to finance that promotes the use of green building technologies would help expand the adoption of clean energy innovations like the solar tiles, he added.

Justus Bahati Wanzala is a freelance contributor for the Thomson Reuters Foundation, based in Nairobi. He works for the Kenya Broadcasting Corporation.

First published: Thomson Reuters Foundation.
Growing population and a rapidly rising demand for electricity in both rural and urban areas, and across sectors, has put an extreme pressure on the ecology. With one of the lowest per-capita electricity consumption and one of the largest solar generation targets, India is paving the way forward to bring sustainable and clean electricity to millions. The tropical country has a vision of reducing its emissions intensity by enhancing the share of renewables in its energy mix. The real thrust on clean energy came with the launch of the National Solar Mission in 2010. As part of the mission, over 1,600MW of grid connected systems and 253MW off-grid systems were installed and commissioned during 2010-2013, during the phase 1 (see chart). The phase 2 of this mission will steer the pumping of 800MW of off-grid systems, primarily in rural areas. In the 2015 Union Budget, Prime Minister Narendra Modi increased the targets of the National Solar Mission 2010 fivefold. The plan of scaling up generation targets from 20GW to 100GW (60% through large and medium scale solar projects, and 40% through rooftop solar projects) by 2022 is the largest ever clean energy target set by any developing country. So far, India has achieved over 8,000MW of grid connected solar power. Currently, India is at the fourth place on the global largest solar power generators’ leader board. These statistics are definitely a ladder to one’s cognitive abilities for computation of volumes of panels, batteries and other associated electrical and electronic components that are being pumped to meet clean energy targets.

The missing piece

It is now time to address the elephant in the room. A 2016 report published by the International Renewable Energy Agency (IRENA) projects India as the producer of over 78 million tonnes of solar e-waste by 2050. While solar technologies enable us to generate enormous amounts of green energy, the components used for generating electricity are themselves not biodegradable. Hence, proper handling of components, after their useful life is over, becomes imperative. With exponentially ramping up of solar power generation, how would we address the prospect of used panels inundating landfills and leaching toxic waste into the environment?

India’s existing rules document—E-Waste Management Rules, 2016—clarifies on the roles and responsibilities of the key stakeholders involved in the e-waste value chain. This is the set of rules referred to in most of the solar power tenders for solar projects in India. However, it does not specifically mention about the issue of management of used components of solar power systems—it only addresses household electronics and not PV panels. Advanced markets like Japan and the growing market of the US face challenges similar to that of India, with no specific regulation for the solar was-
Countries
tegenerated in these countries, as PV panels are still not identified by the law for specific recycling and regulation. However, in the UK and Germany, its collection, treatment and recycling have been reflected in the respective implementation of the Waste Electrical and Electronic Equipment (WEEE) Directive. This has led to the creation of a separate category for PV panels. Germany has also established a collective producer responsibility system for end-of-life management of business-to-consumer PV panels.

What is holding us back?
At present, the business doesn’t find solar waste management a very lucrative opportunity. In the off-grid sector, owing to the lack of aggregated volumes of PV waste, large players keep their hands off. Large utility scale power projects are not expected to produce PV waste immediately. In general, it will be almost after two decades of the installation and commissioning of a power plant when the efficiency of panels would have fallen below acceptable levels. It is then that the project owners would treat used PV systems as scrap. In the future, it is also expected that power plant owners and commercial spaces would replace PV installed systems, before useful life of panel is over, if very high-efficiency panels are available to them.

In the current situation, it is mostly the unorganised waste collectors who are interested in aggre-
gating e-waste, including panels and batteries. This is evident from the fact that, by the end of last year, there were less than 200 recyclers and dismantlers of e-waste registered with the Central Pollution Control Board (CPCB) of India. There is also a fear that raising concerns about the toxic nature of components used in solar PV system will discourage uptake of solar systems. This will hamper the green tag associated with ambitious clean energy programmes of the government and civil society institutions. Further, doing so might give rise to a wave of pressure groups and environmental advocates who would promote other green technologies such as small hydro and wind energy. Consequently, existing business sentiments might get hampered and the cost of ongoing projects might rise.

A stitch in time saves nine
India has set an example by leading the green energy revolution. It is now time for the country to become an early starter by setting up mechanisms for solar waste management at an early stage; and the efforts in the country have already started. For example, with support from the Norwegian ministry of foreign affairs, The Energy and Resources Institute (Teri) think tank is undertaking a long-term project for recycling of solar PV modules and battery technologies. As a first step, in the off-grid sector, manufacturers and retailers of off-grid products must be mandated to ensure inclusion of relevant text about safe disposal of panels and batteries in user manuals of products such as solar lanterns and solar home light systems. In big-sized tenders, bidders must be mandated to submit proof of evidence for having trained manpower resources and adequate facilities for management of solar waste. In the off-grid areas, setting up institutional mechanisms for waste aggregation will prove to be useful.

For example, the network of the already operational Akshay Urja Shops can be leveraged for aggregation of larger volumes of solar waste at the block or district levels. Institutionalising waste management as a service offering, apart from retail sales, will open newer avenues for micro-entrepreneurs who are operating in the clean energy access space. However, putting regulations into place would not suffice until strict compliance is ensured. In the power sector, we are gearing up
to put future-ready systems in place. Similarly, for waste management, it is important for us to plan for the future. It is for us to decide whether we want to interpret green projects in the way we had interpreted the Green Revolution in India, or we wish to look at them through the lens of systems approach.

Martand Shardul is Associate Fellow at Teri and Representative for SDSN Youth in South-Asia; Aashna Aggarwal is from the Duke University, US. First published: Financial Express.
Can a share of the money saved from kerosene subsidies be provided to states to reinvest in cheaper, cleaner and more efficiently-run subsidies for clean energy?

The health hazards of household kerosene consumption are well recorded. Yet, India is one of the largest consumers of kerosene on an absolute and per capita basis. Because there are no accessible, affordable and established sustainable alternatives, poor rural households, especially in remote areas, continue to use kerosene as their primary lighting fuel.

This may soon change following announcements by the central government to reduce the volume of subsidised kerosene allocated to states and gradually increase the price of subsidised kerosene.

What are the implications of this policy for India’s states? And, crucially, how can states negotiate with the Centre to protect their rural populace as well as reinvest the kerosene subsidy savings?

There are three factors at play here. Firstly, it is not clear, to date, whether the central government’s fiscal saving on kerosene subsidies have been shared with states. Secondly, states are now bearing the burden of lighting expenditure so they should ask for compensation from the Centre. Lastly, kerosene pricing reform presents an opportunity for transitioning rural households to solar lighting.

Transferring savings

Nearly a decade ago, in 2008, the Chaturvedi committee reported that rural households used PDS kerosene primarily for lighting and not for cooking (while the reverse was true for urban poor households).

Due to challenges in access to grid based electricity, the unelectrified and under-electrified rural households continued using kerosene for lighting, driving up consumption. However, between 2011 and 2017, household electrification rose significantly and kerosene consumption fell (see Figure 1).

Figure 1: Kerosene consumption falls as household electrification rises

Source: Household electrification data: Ministry of Power, Govt. of India. Kerosene consumption and reduced under recovery: Petroleum Planing & Analysis Cell (Ministry of Petroleum & Natural Gas, Government of India).
However, this fall in kerosene consumption has also been driven by two central government policies to reduce kerosene subsidy expenditure.

First, since the previous UPA regime, the Centre has been decreasing quotas of subsidised PDS kerosene that it allocates for states to distribute. The volume of reductions became larger in 2015 when the BJP government came to power and the global oil price fell (see Figure 2). The sharpest reduction was seen in 2016-17 when allocation nationally was reduced by over 20% from the previous year. The primary motivation for reducing allocation is controlling the subsidy expenditure borne by the central government. Other motivations include the large losses of PDS kerosene to the black market, which prevents intended poor beneficiaries from accessing subsidised kerosene, decreasing the efficiency of targeting of this subsidy.

Second, since August 2016, it has progressively hiked the price of kerosene every fortnight by 25 paise per litre. Together, and in combination with the oil price crashed after 2013, these measures have created significant savings on the subsidy bill. In 2016-17, kerosene under recoveries (initially borne by the oil marketing companies but later compensated by the government) were reduced to Rs 7,606 crores, compared to Rs 29,409 crores in 2012-13 (see Figure 3).

State tax revenue

Kerosene and other petroleum products are currently under the 5% tax bracket of GST (goods and service tax) (formerly some states charged VAT

Figure 2: Kerosene Allocation to All States is Reducing

Source: Ministry Of Petroleum and Natural Gas, Government of India

Figure 3: Reduced kerosene allocations is reducing under-recovery

Source: PPAC, Ministry of Petroleum and Natural Gas

All these reductions in kerosene allocations have generated savings for the central government, but there is no clear mechanism by which we can tell whether or not they have been passed on to states. Some policies do exist. To further incentivise reductions in kerosene subsidy expenditure, for example, the Centre awards cash compensation to states that undertake voluntary reductions in the distribution of subsidised kerosene. Only a few states like Karnataka, Haryana and Telangana undertook voluntary cut for which about Rs 112.4 crore was transferred to them in 2016-17.

Given the central government’s plans to continue reduction in kerosene allocation, a significant amount of fiscal savings may accrue, but with no formal plan as to how they will be shared between the Centre and the states. Some states, therefore, run the risk of increasing costs for rural households’ lighting needs, with hardship most likely to increase in states where household electrification rates are low or poor quality, and a larger percentage of households are rural and poor such as Odisha, Bihar, Jharkhand and Uttar Pradesh.

Odisha, for example, in 2012, was home to 42 million people, of which 14 million are poor and as per Socio-Economic Caste Census (SECC 2011), 87% of the population resides in rural areas where electricity supply is poor.

How should savings be distributed if the funds spent on kerosene subsidies have, in the past, effectively functioned as a form of transfer between the states and the Centre?
between nil to Rs 5 per litre of PDS kerosene). When people consume less subsidised PDS kerosene, the states collect fewer taxes. Though this argument will not hold steady if households transition from PDS kerosene to other lighting fuels (grid electricity, solar etc.) on which the state may collect more GST. And hence any losses in revenue from kerosene tax revenue may be offset by higher tax revenue on other lighting products.

What remains clear is that because of reduced allocation, the Centre’s burden on lighting expenditure for the poor is being passed on to state governments. This is a strong rationale for states to negotiate with the Centre for higher compensation allowances—at least by states with a higher rural population.

**Solar lighting opportunity**

One welcome impact of the increase in kerosene price is that clean lighting solutions like solar lanterns become more cost-competitive: as prices have increased, a new set of policy briefs from the International Institute for Sustainable Development (IISD) has found that switching to a branded company’s entry-level solar lighting system will slightly reduce the annual cost of lighting for the household (see Figure 4).

**Figure 4: PDS kerosene prices are rising, making solar lanterns competitive**

Despite these favourable cost comparisons, solar lighting still faces a barrier that kerosene lighting does not: a high up-front house for using a system, which most poor households cannot overcome.

Given the net cost savings, states should consider negotiating for a share of kerosene subsidy savings in order to promote solar lighting solutions as a first-best response to meet the energy lighting needs of households.

**Sum of their parts**

Government efforts to reform kerosene subsidies make sense, as kerosene is expensive, dirty and the distribution system is prone to leakage and diversion. But for households without good access to electricity, there are significant energy access challenges to address.

The answer to this should lie in the savings that come from kerosene subsidy reforms themselves: Can a share of the money saved be provided to states to reinvest in cheaper, cleaner and more efficiently run subsidies for clean energy?

Shruti Sharma is policy advisor, International Institute for Sustainable Development. This article is based on three IISD policy papers, which examine the impacts of kerosene subsidy reform in India.

First published: The Wire.
As Nigerians marks the 56th year of the country’s independence today, several citizens of our great nation continue to struggle with basic amenities including the lack of electricity supply. More importantly, the impact of our current electrification rates are felt more by a majority of the rural poor.

To feel the impact of this freedom and prosperity enshrined under our Independence Day declarations, it is important that we think of collective ways to create conditions for Nigerians to achieve their optimal socio-economic goals. We must make issues of energy access a priority and this is why we believe that Nigeria needs an ENERGY REVOLUTION.

In 2013, Nigeria reportedly ranked 25 (from the bottom) on power consumption per capita, with reported estimates for the demand for electricity in Nigeria, to be in the region of 12,800MW as of January, 2016. Based on the country’s current GDP and global trends, Nigeria’s electricity consumption should be four to five times higher than it is today. However, at just 126kWh per capita, as a country we lag far behind other developing nations in terms of grid-based electricity consumption. For example, Ghana’s per capita consumption (361kWh) is about 2.9 times higher than that of Nigeria, and South Africa’s (3,926kWh) is 31 times higher.

Nigeria’s current grid capacity is able to generate about 12,000 megawatts and yet only 5000 megawatts is actually available to meet the needs of the country’s teeming population. This means that about 60% of Nigerians lack access to the grid. This lag between demand for electricity and available supply means that many Nigerian businesses and home owners are in the business of widespread self-generation of power for their commercial, industrial and residential uses. Furthermore, with an ageing grid system, several Nigerians connected to the grid face extensive power outages due to low reliability from the grid. Therefore, the use of diesel fuelled generators as an alternative to the grid and kerosene lamps for the rural poor are still widespread and compensate for the lack of electricity supply across the country. Furthermore the increased militancy on oil and gas pipeline means that there will be increasingly low reliability to generate power from the grid.

However, there is another path-way that is a cheaper, simpler and more sustainable way to get electrified in Nigeria. That way is through Decentralized Renewable Energy; more specifically, mini-grid systems and stand-alone home systems. These systems are easy to deploy – usually within a 6 months’ time frame; and the costs for the end user, especially when spread-out over time are comparable to both grid based electricity connections. Decentralized Renewable Energy is certainly cheaper than the diesel and kerosene alternatives that many Nigerians currently deploy in their self-generation efforts.
The market for Decentralized Renewables market in Nigeria is at the cusp of a major take-off, however some of the market enablers for this market to truly emerge are not yet in place. Despite little incentives from the government for private investor participation, we have seen increasing interest and projects targeted at this market. There are several programs and projects springing up in several rural and peri-urban communities across Nigeria either as pilots or commercial ventures and increasing more-so in urban centres across the country. These projects are funded either with capital from grant donors or through commercial partnerships including bank loans and credit facilities. The projects range from Stand-alone Home systems (SHS), mini grids systems as well as solar home appliances such as lamps and cooking stoves. Yet for this market to scale up and meet the latent demand for electricity across the country there has to be the right enabling policies and market incentives for this to happen. It is also important to have clear targets and timelines for the Decentralized Renewable Energy sector and broad support by stakeholders.

This is why the preparations for the emergence of an industry association to help catalyze a collective voice for the sector is one of the most important things happening in recent times. This industry association aims to be a reputable umbrella association, supporting and enabling the sustainable growth of the renewable energy sector throughout Nigeria. The mission of the association is to promote all forms of renewable energy technologies into the mainstream of the Nigerian economy and lifestyle by emphasizing the need for quality and best practices in the sector for the benefit of members, consumers and other stakeholders. The association also seeks to facilitate information dissemination, formulate proposals for improvements in the renewable energy sector and make recommendations to the responsible governing and policy authorities amongst the other stated goals. We believe that decentralized renewable energy will play an important role in meeting these objectives and will help in activating and supporting the market in sustainable ways, particularly as this sub-sector is the quickest and cheapest way to grow the renewable energy industry and market overall.

One of the best ways to accelerate our renewable energy rates and penetration is to integrate rural access with decentralized renewable energy development in Nigeria. With the high demand for electricity amongst urban and rural dwellers, and with Nigeria having one of the best solar radiation rates in the world, achieving rural access electrification is a quick win using Decentralized Renewable Energy. With several countries in East Africa like Kenya, Tanzania, and Uganda, already leading the way in deploying decentralized renewable energy to increase and optimize their electrification rates, particularly in rural communities, Nigeria cannot afford to be left behind. Although, financing the sector remains a challenge, the government with active stakeholder participation can make policies, and build partnerships with the private sector to subsidize the cost of financing such projects in rural Nigeria to solve the country’s energy challenge.

The opportunity for Decentralized Renewable Energy especially solar energy to advance Nigeria’s energy access is so large that it has become hard to ignore. This is why, Power For All - a global decentralized renewable energy campaign organization as part of its mission in Nigeria, is participating in resource mobilization for the DRE sector on behalf of stakeholders. The Power For All campaign promotes technology transfer, promotes sound business practices and standardization of products within the sector and promotes enterprise development. The campaign provides platforms to share information, and provides tools to accelerate the growth of the DRE market. The Power for All campaign further sees distributed renewable energy (DRE) as the key to achieving universal energy and the main way to exit Nigeria from her current shortfall in energy access.

It is clear that Nigerians have a choice. To choose the old pathway to electrification through on-grid methodologies; which has kept electricity access rates static for many years now, or choose a new path which involves making decentralized renewable energy main stream to meet improved electrification rate. As many Nigerians, especially the growing workforce of the country, buoy by the teeming youth population depend on electricity to make ends meet it is clear that turning around our current economic crisis while growing and contributing to the GDP of the country, is dependent on deploying Decentralized Renewable Energy. The
time to gain independence from blackouts is now. The time to act is NOW!! Decentralized Renewable Energy provides the way forward.

Ifeoma Malo is the Campaign Director for Power For All in Nigeria and is Co - Founder of the Clean Tech Hub. Segun Adaju is the interim president for the industry stakeholders association (REAN) and CEO of Consistent Energy.

First published: Offgrid Nigeria.
Juliet Chasamuka, 34, was six months pregnant when I met her in the Gutu district of Masvingo, a rural community 300 kilometres south of Harare, Zimbabwe. The now mother of five has had many different experiences when giving birth.

For her first two births, as is the norm at many poor health care centres in the remote areas of this largely agrarian country, Chasamuka was expected to bring her own candles, matches and kerosene lamps. Expectant mothers are sometimes even asked to bring water for cleaning and washing during their stay at a clinic.

Buying these resources was a problem, says Chasamuka. "My husband has never been employed," she explains. "As a family, we depend on working in other people's fields in return for either food, money or clothes. It was therefore difficult for me to buy the required supplies."

For her next two children, she decided to give birth at home due to the expense. "I was assisted by a village midwife, and fortunately it went well," she says. As is common here — almost 22 per cent of women in Zimbabwe give birth without skilled health care staff present — the midwife Chasamuka used did not have formal medical training.

The situation is made worse in rural areas like Chasamuka’s where energy access is a major problem. The most recent World Bank data shows that, in Zimbabwe, 83.4 per cent of people in urban areas have access to electricity, as compared to 9.8 per cent in rural areas. This is despite the fact that 68 per cent of the country’s 16.2 million inhabitants live in rural areas. In serious need of electricity, the Mazuru clinic turned to solar energy.

What it’s like without power

The Mazuru clinic serves approximately 15 pregnant mothers every month, and supports a population of 6,700 people. Like most of Zimbabwe’s rural health clinics, Mazuru’s maternity ward has been limited in the care that staff can provide. The infant mortality rate in the country is 60 deaths per 1,000 live births, while it’s estimated that 614 mothers die for every 100,000 live births (100 times that of the rate in Canada).

"If I was using the torch on my mobile phone, I had to hold it in my gloved hand while operating, sometimes with blood on the glove," says Ratiel Chikuvire, 52, a head nurse at Mazuru clinic. "Sometimes I held the phone with my teeth, especially when I was repairing a torn cervix or suturing perineal lacerations, since I needed direct light to enable me to carry out the process."

But in 2012, with support from Oxfam Zimbabwe, a solar water pump was installed at the Mazuru clinic. "We installed a solar pump, a 5,000 litre water tank, and this has made life easier for not only the clinic staff and patients, but for the surrounding communities," says Conillius Muchecheti, formerly Oxfam Zimbabwe’s Coordinator for the Rural Sustainable Energy Development (RuSED) Project.

How solar energy is helping brighten childbirth in rural Zimbabwe
After the water pump was installed, they still needed electricity, so in 2013, the community purchased a "solar suitcase." It holds three strong solar-powered lights, a blood pressure gauge, a fetal scope and mobile phone charging sockets, which means expectant mothers can now attend the health centre with fewer concerns.

"There are no user fees, and no need for candles and kerosene lamps," Chikuvire explains, adding, "now we can do birth deliveries at night with no worries about lighting."

Following the installation of solar power at the clinic, Chikuvire says there has been a 50 per cent increase in the number of women giving birth there. Chasamuka contributed to the increase; she chose to have her fifth child at the now powered clinic. Aside from the Mazuru clinic, the RuSED project equipped four other clinics in the Gutu district with solar pumps.

Zimbabwe’s health sector leans heavily on support from development partners. The country’s 2017 budget statement reveals that the health budget is at 6.88 per cent of the overall government expenditure with about 93 per cent of that going toward salaries. This is well below the 2001 Abuja Declaration commitment — at the time, leaders from African Union countries met and pledged to set a target of allocating at least 15 per cent of their annual budget to improve the health sector. On top of this, the national health strategy indicates that, in 2012, over 40 per cent of health sector funding came from overseas development assistance.

In 2016, the African Development Bank noted that, while women and men have different energy needs linked to their gender roles, women are affected more than their male counterparts by poor access to energy.

"It’s difficult for staff to work effectively with kerosene lamps, mobile phone torches or candles to carry out operations or suture tears," says head nurse Chikuvire, adding that smoke from kerosene lamps and candles cloud up the maternity ward, causing newborn babies and their mothers to cough.

There are over 1,400 health clinics in Zimbabwe. The Rural Electrification Agency’s (REA) public relations and marketing executive, Johannes Nyamayedenga, says that while the organization has supported the electrification of 852 rural health facilities, some 202 are still awaiting electricity. Nyamayedenga says the agency is unable to provide energy in all the rural institutions because of funding shortages. "That means these women will continue to be impacted negatively," he says.

The move towards solar

Zimbabwe was once considered the breadbasket of southern Africa, but due to drought and political turmoil, the economy stalled in the 1990s. A structural adjustment package imposed by the World Bank and the International Monetary Fund resulted in a period of deep cuts and officially mandated austerity. A government adopted program of radical land reform, which involved kicking white farmers off their fields, has led to international sanctions and created economic chaos.

"Zimbabwe is a country with huge renewable energy resource potential, yet their exploitation to address energy poverty is negligible due to prevailing economic challenges," according to Sustainable Energy for All. They are likely referring to the political and economic chaos that has become normalized under President Robert Mugabe’s leadership.

What has all of this amounted to in practical terms? In 2017, the Africa-EU Renewable Energy Cooperation said electricity supply had dropped to less than half of what the country used between 2015 and 2016. The crisis was mostly the result of declining water levels at the Kariba hydropower plant and technical faults at the coal-fired Hwange power station.

In February 2016, Lake Kariba was operating at 11 per cent of its full capacity, the lowest in 20 years. Maintenance and repairs led to extensive "load shedding" — meaning rolling blackouts — causing regular power interruptions, lasting up to 18 hours, across Zimbabwe.

Despite government efforts to expand existing facilities, energy experts say there is a need to develop decentralized energy systems based on renewable energy sources, mainly in rural areas. When it comes to things like providing solar energy at health clinics, the REA’s Johannes Nyamayedenga says the funding the agency receives from the government isn’t enough. He urges rural communities to come up with ways to maintain and repair equipment that they have installed, instead of depending on the REA to fix everything.
Kudzi Chitiva, solar energy expert and director of the Zimbabwean company Natfort Energy Efficiency, says solar is notoriously expensive and requires constant maintenance. There is poor regulatory policy and little oversight, according to Chitiva. "An anything-goes mentality means that far too many substandard products are installed," he says.

In the case of the Mazuru clinic, the solar pump was purchased with Oxfam's support. The organization also helped the clinic set up a community energy fund (CEF), financed in part by selling solar lanterns. The fund is meant to ensure the long-term sustainability of the project and put communities in charge of decision making about their energy needs. The community then used the CEF to buy a $2,800 solar suitcase for the maternity unit. To support the CEF, community members contribute between 50 cents and a dollar every month.

Juliet Chasamuka insists that paying a dollar towards solar energy system repairs and maintenance is better than having to pay for the supplies needed to give birth without electricity. "If we don’t," she says, "the burden falls heavily on us as women."

Though Chasamuka and other women who live far away from the community still grapple with walking the long distance to the clinic, the challenge of bearing significant costs when giving birth is over — at least for now.

Sally Nyakanyanga is an independent journalist based in Zimbabwe focusing on gender equality, human rights and bilateral trade between China and Africa. This content was produced with the support of the Access to Energy Journalism Fellowship and Discourse Media.

First published: Discourse Media.
Success on Solar Irrigation System in Bangladesh yet to achieve

In the last few years, farmers are moving to the solar-based irrigation pumps in different parts of Bangladesh, since the cost of diesel pump is higher compared to the solar pump. Few more aspects could be brought to light regarding this innovative irrigation system.

Over the period, technology has been changed dramatically in the irrigation scheme of Bangladesh. But this innovative irrigation system is executed not only for the matter of costs to purchase diesel fuel, but solar-powered pumps are a realistic choice in the context of sustainable agricultural practices, as it is a global demand for renewable energy technology.

A new way of lifting groundwater using solar energy, regular peak irrigation, an effort by public-private partnerships, and least requirements of diesel imports have opened up a new door in the agriculture sector of Bangladesh as farmers can boost their farming yields through irrigation round the year.

The use of solar energy in irrigation is popular now owing to cost-effective financing and innovative business model. In a bid to promote alternative energy, perhaps, Bangladesh has speeded up installing solar-powered irrigation pumps in 2012. However, it started first in 2010 and the implementing agency, Infrastructure Development Company Limited (IDCOL), a non-bank financial institution, bankrolls renewable energy projects in Bangladesh.

However, farmers usually use irrigation pumps to supply adequate water for their crops where the fuel-based traditional irrigation system is still popular with most of the farmers in the country’s agriculture. During the peak season of irrigation, about 20% of our total produced electricity is used by the farmers. As a result, there is a short supply of electricity in many areas of the country, especially at the time of irrigation period.

Earlier, rely on expensive diesel irrigation pumps consume 1 million tons of diesel worth $900 million every year. Farmers are often dependent on middle-men during peak irrigation and cropping season. But, the success stories on solar irrigation pumps have brought up light from the piloted Upazilas of Dhaka, Chittagong, Rajshahi, Rangpur and Khulna regions.

Farmers in those pilot areas have been switching from diesel-run to solar irrigation pumps, which are more reliable and easier to maintain compared to their diesel counterparts, also reduces government’s fuel subsidy for the agriculture sector as well as diesel imports. And given Bangladesh’s fragmented land ownership, a group of 20-25 farmers can associate to buy water from one irrigation pump.

In this development, Power Division aims to replace about 150,000 diesel and conventional electricity-run irrigation pumps with solar-powered ones by 2017. As a part of Bangladesh’s readiness, the World Bank is supporting the government’s
effort to install 1,250 solar-powered irrigation pumps by 2018. The low-cost technology is well suited for the country's flat terrain and abundant sunshine. Even better, the country will be able to reduce 5,000 tons of carbon emissions per year once all the 1250 pumps are in operation.

In addition to the World Bank, the Bangladesh Climate Change Resilience Fund (BCCRF), Global Partnership on Output Based Aid (GPOBA) and U.S Agency for International Aid (USAID) has provided financing for the solar irrigation pumps.

Already, over 600 solar irrigation pumps have been installed by IDCOL and more to come to cut dependency on electricity and diesel used to operate more than 1.6 million tube wells and pumps for irrigation. It plans to set up more than 1500 pumps within 2018.

“Solar-driven irrigation models are usually run by experts and as a result, use of water for producing per kg of paddy is relatively lesser than other irrigation systems,” said Siddique Zobair, member of Sustainable and Renewable Energy Development Authority (SREDA).

According to the official data, Bangladesh’s installed capacity of power generation is around 15,594 MW now and the projected power demand will hit 34,000 MW by 2030. However, the current contribution of renewable energy is around 1.5 percent of total power generation. “The government has a target of producing 10 percent electricity from renewable energy by 2020,” Siddique said.

In this backdrop, the government has proposed import duty on solar panels in the budget for the recent fiscal 2017-2018. Imports of solar panel, the main component of a solar power system are subjected to 10 percent customs duty, VAT and other taxes, totaling an additional cost of 37.5 percent in the next fiscal year, whereas the sector has been enjoying zero duty.

The country’s solar energy initiatives have to face a setback because of this imposition of a duty on imports of solar panels, as it will be difficult to make solar irrigation projects viable even after the government bears 50 percent of the installation cost. It causes a homogeneous catalyst to the solar revolution in irrigation to attain the 10 percent renewable energy generation goal by 2020.

If we consider for our long-term benefits with the electricity demand and supply, switching to the solar-based power pumps should give priority to building a sustainable agricultural practice in Bangladesh.

On the other hand, the burden of government’s ability to produce electricity will be decreased, and consequently, the overall cost of fuel based electricity production and pollution will be reduced gradually.

Physical degradation like loss or unproductive of the land body, water body, and biodiversity will not be encouraged if we continue to use our sunshine as the source of our energy in all the development sectors of Bangladesh. However, these are the overall major dimensions of achieving sustainability goals through the solar-based irrigation system in Bangladesh.

As part of sustainable agricultural development, the solar-run irrigation system has a high potential value in terms of previous sustainability benefits. In this development, the opportunity for solar power conversion into energy promotes the access of farmers to continuous energy supply which is significantly needed for an agricultural drive.

Zulker Naeen is a Climate Tracker Fellow based in South Asia.

First published: Perspective.
How unreliable power supply affect bloggers in Nigeria

Paul Aroloye

I started blogging around 2012 when I created my first website which was Arotips.com but I went to college and didn’t have time for my blog so it died.

Mid-way into college my brother encouraged me to start another blog since now I was more experienced in my tech field, so I started Nairatips back in 2014. I was blogging from college which wasn’t easy but I made it work and even back then there were challenges with power supply in my school which made me miss some postdates and deadlines.

Running a blog in Nigeria is not easy because the most important tool a blogger cannot do without is power supply, so imagine you are in a country with unreliable power supply? What happens? You automatically fall behind if you don’t put in extra efforts and invest money to make it work.

Speaking from a realistic point of view, I will give two categories and say my personal experience, challenges I faced and how I overcame them as a full time blogger and a part time blogger. I have lived both lifestyles.

**Full Time Blogger/Self Employed Entrepreneur**

A full time blogger or self-employed entrepreneur who doesn’t have a 9 am-5 pm job, your main job is to create content for his websites or blogs, do other related internet activities all day like surfing the web, doing research, replying comments, keeping up to the trend in his niche which means he needs constant reliable internet and power supply.

Getting a reliable internet connection is easy but the problem lies with the power supply which is out of your hands, when you got a post idea and you quickly need to write an article on it or a draft and your laptop battery is dead, your phone is dead, your power bank is dead, you have to result to turning on a generator which cost more money to buy and fuel. I’m sure some children in some parts of the world don’t even know what a generator is.

As a full time blogger or self-employed entrepreneur, in other for you to be productive and counter the unreliable power supply in Nigeria, you have to do the following:

1. Buy a good Generator and have a budget for weekly fuel
2. Have a strong power bank to charge your smartphone and laptop if possible. I have a laptop power bank and it has saved me on multiple occasions.
3. Invest in inverter with solar panel but if that is too expensive, a small laptop and fan only inverter can work.
4. Get a laptop with moderate - long battery life to counter situations where you are writing an article and your laptop battery is low making you hibernate your laptop. Don’t over use the hibernation function in windows, one the long run your motherboard will explode (true life story) giving you more expense and less income.
5. You need to study when power comes, there is always a routine. For my area, we always have...
power supply from 11PM - 7AM why? I have no idea. Studying and identifying the power supply patterns would make you know when power comes so you can be plan and modify your content calendar to fit the power supply routine. Which means most times I don't sleep at night because I am busy writing content for my websites and blogs.

Everything mentioned above requires money, additional cost you have to incur to battle unreliable power supply! If you were living in a country with reliable power supply, you won't need to spend more money just because you are a blogger or self-employed, you simply go with the flow - Wake up - blog - make money which means what you most likely spend money on is internet connection making your profit from running a blog or running your own business in a country with reliable power supply is much higher than someone in a developing country.

**Part-Time Blogger/Employed**

You fall under this category which means you have a 9AM-5PM job and of course you are getting paid and you like that don't you? Everything has its advantages and disadvantages. For someone that works a job for more than 10 hours, he or she comes back home then suddenly remembers there's a pending blog posts to be written but there's no light.

All day at work, there's power supply most likely from a Generator. So what do you do when after getting home from work, there's no power supply to encourage you to update your websites and blogs? You have to blog at work.

Blogging at work may not be welcomed or even possible depending on where you work and their policies, some companies can be so strict that when they catch you doing something that's not "company work related" you can lose your job so be careful when deciding to blog at work.

This is the hardest part when it comes to blogging at work, you need to share your time - Personal blog time and Company time, write it down so you don't forget. Plan every day, every hour and every minute but this is not easy emotionally speaking because when you have an urgent company work to do, you face that with all your might and when you done with that company task, 3 days have past which means you are behind schedule then you have to recollect your thoughts, clear your mind and write a blog post. In most cases, right in the center of writing an article, an urgent company work comes your way.

What do you do? What takes priority? Do you pause your delayed blog post? Do you start the urgent company work? this is where the you need an emotional balance.

Looking at the situation from another perspective, you are part-time blogger working a 9-5 job and when you back from work, maybe around 6PM, you can dedicate 1-2 hours to spend on your website or blog.

This works better than having to come back home, pour fuel in the generator, turn on the generator, charge your dead laptop, phone and cook dinner. The processes involved are just so stressful, remember you are stressed from work in the first place so must times you find the average working class part time blogger just coming home and sleeping off till the next morning then work continues. It's a never ending roller-coaster.

**Effects of having unreliable Power Supply as a full time blogger**

The effects of having unreliable power supply can be devastating and if not managed well can lead to your dream been killed. I had a dream of becoming a YouTuber in Nigeria, I started my own YouTube channel but I couldn't sustain it because you required fast unlimited internet to upload videos and reliable power supply. I had the fast unlimited internet but not the reliable power supply so most times when uploading my videos

- You are always behind schedule
- Spending more money to battle unreliable power supply.
- Lack of creativity and inspiration: When your country cannot provide one good thing for its citizens such as reliable power supply it takes more effort to be inspired and creative which usually leads to wonderful blog ideas.
- Boredom and Loss of focus
- Wasted time: Sitting idly or sleeping waiting for power to come on maybe because you are out of cash or out of fuel for your generator.

**In Conclusion**

This article is not all about excuses and how
hard it is to succeed as a blogger but also on the various ways you can overcome the unreliable power supply in Nigeria and still succeed against the odds. I am a tech blogger, I am from Nigeria, I will be successful.

Paul Aroloye is ICT professional in Nigeria and founder of www.nairatips.com.

First published: Sun-Connect News.
Access via distributed energy solutions powered by renewable sources is often the most viable and cost effective for communities living in energy poverty. It provides a ‘win-win’ opportunity for both local development and for environmental protection, helping to address climate change.

The agricultural sector, particularly rural smallholder farming, has the potential to play a central role in development and alleviating poverty, but is held back by a lack of access to modern energy services for productive uses and reliable water sources. This is especially true of Kenya’s arid and semi-arid rural areas, home to the poorest people. Few farmers can afford to irrigate their crops, and low rainfall means that rainfed agriculture is increasingly unsustainable. There is a strong case for adopting irrigation and crop cultivation methods that combine judicious water use with increased yields and for providing distributed renewable energy solutions to power more sustainable and productive agriculture.

Between 2011 and 2014, CAFOD and partners tried to address this water-energy-agriculture challenge in Kenya as one aspect of a Community Based Green Energy Project (CB-GEP). The project worked with 56 women’s farming groups to increase their incomes and reduce environmental degradation by providing the groups with greenhouses equipped with solar-powered water pumps and drip irrigation facilities for horticulture production, along with a range of supporting services.

A new report analyses this greenhouse component of the project using the energy delivery model (EDM) toolkit, a participatory approach to designing energy services for poor and marginal groups that IIED and CAFOD began developing in 2013. The findings from testing the EDM approach with partners in Indonesia, along with the full EDM Toolkit, will soon be available.

**Findings**

1. **Increased rural incomes for 56 women and youth groups through energy systems investments in greenhouse cultivation: Impact achieved**

   Horticulture in greenhouses has resulted in higher incomes: farming group members are earning between USD50 and USD200 per year from profits. Initially, solar water pumps reduced labour, time and cost on irrigation. However, the breakdown of solar water pumps within a year of installation affected profits as groups had to buy fuel for diesel generators. Nonetheless, the group horticulture production still benefits individuals, giving them higher incomes and access to valued ‘table banking’ facilities (the local term for the group savings and lending strategy), a benefit that was not fully anticipated at the project’s design stage.

2. **Improved food security for the target groups by improving their incomes: Impact not achieved/difficult to identify impact**
While improved food security in the region was an intended outcome of the project, there is little evidence from the research to suggest that this target was achieved. The current small scale of the project means that the volume of produce from the greenhouse is too small to address this ambitious target. However, the greenhouses enable groups to produce vegetables during the dry season (May to September) and adds to the nutritional value of food sources consumed by group members and their wider community.

3. Reduced environmental degradation and enhanced environmental protection: Impact partially achieved

Water and energy supply and use were the two critical environmental factors for the project. For water supply and use, the drip irrigation systems enabled efficient water usage in a water-scarce area, and introduced the technology for the first time to most of the farming groups. For energy supply and use, the solar-powered pumps provided distributed clean energy to address a livelihood challenge. However, almost all the pumps broke down within 12 months of installation due to the ingress of muddy water, and many groups reverted to or began using diesel power. These technical problems could have been prevented at the design phase.

4. Improved partner and community capacity to manage and maintain energy services in target areas: Impact not achieved

Project design included activities to enable longer-term partner/community capacity to maintain the solar pumping systems after project closure, but the challenges were underestimated. Inadequate group training on using the pump systems and inadequate services for maintenance and repair meant that most groups were unable to prevent the pumps from breaking down. Moreover, service providers in charge of maintenance had neither the local networks nor the capacity to address multiple solar pump failures.

Surabhi Rajagopal has been working with SELCO Foundation since 2011, facilitating Ecosystem building activities for the Decentralized energy access sector. Ben Garside is a Senior Researcher leads IIED’s work on energy access and renewable energy; Sarah Wykes is the Lead Analyst for Climate Change and Energy at CAFOD; and Lazarus Walker is the Livelihoods Programme Officer at CAFOD Nairobi.
Mining is more than a political cause célèbre for coal-happy politicians, it’s an essential industry to move the world forward. Here are four key changes needed to continue greening mining.

Donald Trump’s presidency in the United States has turned mining—and the coal industry in particular—into a political cause célèbre over the last year. In June, during his first White House cabinet meeting, Trump suggested that his energy policies were putting miners back to work and transforming a troubled sector of the economy.

But Trump is mistaken to think that championing the cause of miners and paying respect to a difficult profession will be sufficient to make mining sustainable. To achieve that, a far more complex set of interdependencies must be navigated.

Debates about mining and the environment are often framed in terms of a "nexus" between extraction of a resource and the introduction of other resources into the extraction process. The forthcoming Routledge Handbook of the Resource Nexus, which I co-edited, defines the term as the relationship between two or more naturally occurring materials that are used as inputs in a system that provides services to humans. In the case of coal, the "nexus" is between the rock and the huge amounts of water and energy needed to mine it.

For decision-makers, understanding this linkage is critical to effective resource and land-use management. According to research from 2014, there is an inverse relationship between the grade of ore and the amount of water and energy used to extract it. In other words, misreading how inputs and outputs interact could have profound environmental consequences.

Moreover, because many renewable energy technologies are built with mined metals and minerals, the global mining industry will play a key role in the transition to a low-carbon future. Photovoltaic cells may draw energy from the sun, but they are manufactured from cadmium, selenium, and tellurium. The same goes for wind turbines, which are fashioned from copious amounts of cobalt, copper, and rare-earth oxides.

Navigating the mining industry’s resource nexus will require new governance models that can balance extraction practices with emerging energy needs—like those envisioned by the UN’s Sustainable Development Goals (SDGs). Value creation, profit maximisation, and competitiveness must also be measured against the greater public good.

Some within the global mining industry have recognised that the winds are changing. According to a recent survey of industry practices by CDP, a non-profit energy and environmental consultancy, mining companies from Australia to Brazil are beginning to extract resources while reducing their environmental footprint.

Nonetheless, if the interests of the public, and the planet, are to be protected, the world cannot rely on the business decisions of mining companies alone. Four key changes are needed to ensure that the industry’s greening trend continues.

First, mining needs an innovation overhaul. De-
Climbing ore grades require the industry to become more energy- and resource-efficient to remain profitable. And, because water scarcity is among the top challenges facing the industry, eco-friendly solutions are often more viable than conventional ones. In Chile, for example, copper mines have been forced to start using desalinated water for extraction, while Sweden’s Boliden sources up to 42 per cent of its energy needs from renewables. Mining companies elsewhere learn from these examples.

Second, product diversification must start now. With the Paris climate agreement a year old, the transformation of global fossil-fuel markets is only a matter of time. Companies with a large portfolio of fossil fuels, like coal, will soon face severe uncertainty related to stranded assets, and investors may change their risk assessments accordingly.

Large mining companies can prepare for this shift by moving from fossil fuels to other materials, such as iron ore, copper, bauxite, cobalt, rare earth elements, and lithium, as well as mineral fertilisers, which will be needed in large quantities to meet the SDGs’ targets for global hunger eradication. Phasing out coal during times of latent overproduction might even be done at a profit.

Third, the world needs a better means of assessing mining’s ecological risks. Although the industry’s environmental footprint is smaller than that of agriculture and urbanisation, extracting materials from the ground can still permanently harm ecosystems and lead to biodiversity loss. To protect sensitive areas, greater global coordination is needed in the selection of suitable mining sites. Integrated assessments of subsoil assets, groundwater, and biosphere integrity would also help, as would guidelines for sustainable resource consumption.

Finally, the mining sector must better integrate its value chains to create more economic opportunities downstream. Establishing models of material flows—such as the ones existing for aluminum and steel—and linking them with “circular economy” strategies, such as waste reduction and reuse, would be a good start. A more radical change could come from a serious engagement in markets for secondary materials. “Urban mining”—the salvaging, processing, and delivery of reusable materials from demolition sites—could also be better integrated into current core activities.

The global mining industry is on the verge of transforming itself from fossil-fuel extraction to supplying materials for a greener energy future. But this “greening” is the result of hard work, innovation, and a complex understanding of the resource nexus. Whatever America’s coal-happy president may believe, it is not the result of political platitudes.

Raimund Bleischwitz is Deputy Director of the University College London Institute for Sustainable Resources.

First published: Eco-Business.
Mohit Anand

Unlocking an energy revolution in Ethiopia with lessons from the black market

Selling solar products through the informal sector is not just financially attractive in places like Ethiopia—it’s also the key to reaching the largest number of customers.

“Ninety thousand solar lanterns sold last quarter,” said Mr. Li. He was sharing sales numbers for his solar appliance business in Ethiopia, and I couldn’t believe it.

To put that number in perspective, the Global Off-Grid Lighting Association pegs the average number of all solar lighting products sold in Ethiopia in a single quarter at around 250,000 units. Close to 80 percent of Ethiopians live in rural areas with little to no access to electricity. Assuming two lanterns for every household with an average five people in each, Mr. Li might have provided energy access to close to a quarter million people within months.

As far-fetched as that sounds, it is actually quite possible. The catch, however, is that Mr. Li’s sales are illegal. He sells his products on the informal market, outside of the government net, avoiding taxes and the country’s formal quality regime. As a result, his sales, though meaningful, are at risk of coming to a halt.

A rapidly growing market for solar lanterns and home kits is driving an energy revolution in Ethiopia. Like many low-income countries in Asia, Africa and Latin America, Ethiopia is a point of focus for international development and finance institutions as well as donors. Such organizations are channeling tens of millions of dollars into Ethiopia for energy access. In order to maximize the impact of their investments, they need to have an understanding of local requirements in order to provide tailored financial flows.

To that end, I visited Ethiopia earlier this year as part of a study for the United Nations Sustainable Energy for All (SE4All) program. In collaboration with partners, we at TFE Consulting helped SE4All understand the quantity and type of financing needed for energy access in five developing countries across Africa and Asia. Ethiopia was a focus country, along with Nigeria, Kenya, Bangladesh and Myanmar.

What I learned in Ethiopia was encouraging. On the face of it, the market has a high focus on quality: the World Bank’s "Lighting Africa" quality certification is mandatory for products, and most key suppliers have this. Additionally, distribution networks are well established and run deep. Financing support is also available through micro-finance institutions offering consumer financing and banks that provide corporate credit to suppliers. Overall, the growth rate of energy access businesses is between 10 to 20 percent, and there is tremendous optimism about the size and future of the market.

Despite these promising facts, sales volumes across the formal sector are actually quite low. One reason is that foreign exchange is scarce, which makes imports difficult. Also, debt comes
with crippling conditions like interest rates of 12 to 15 percent and high collateral requirements. As a result of these barriers, most businesses operating in the formal sector sell between 2,000-5,000 lanterns a year. The volume of solar kits is a third of that.

Even the largest formal supplier we met sold fewer than 20,000 lanterns a year. These numbers are an order of magnitude lower than those in the informal sector, where some suppliers, like Mr. Li, sell more than 100,000 lanterns a year.

Mr. Li is a true entrepreneur. He runs a cottage-industry-style assembly line for solar lanterns on the outskirts of Addis Ababa. To avoid customs that confiscate products lacking certification, he imports individual components and assembles them locally. Once assembled, he sells wholesale to agents. His price is 20 percent below any formal market product. He is greatly optimistic about his business and plans to convert his makeshift assembly line into a proper factory by the end of the year.

Mr. Li is not alone. From our interviews and data, we estimate that as much as 65 percent of Ethiopia’s solar lantern market transacts in the informal sector. In the vast, highly congested bazaar at the edge of Addis known as Merkato, thousands of vendors sell a wide range of consumer products at cutthroat prices entirely outside the tax and regulatory net. Deals here are large, conducted on trust, not paper, and executed quickly. This is where business gets done.

The Merkato, and other markets like it, are the beating heart of the energy access market in Ethiopia. They are deeply connected to informal networks that have low transaction costs, high flexibility, wide geographic reach and access to the most remote areas of the country.

These features make such networks the backbone of many developing markets like Ethiopia and the channel of choice for energy access suppliers looking for large transaction volumes, low costs and speed-to-market.

A focus on volume is understandable in a market that offers razor-thin margins. Customers have very low purchasing power and are therefore highly price sensitive. A slight increase in prices can put products out of reach for a large segment of customers. Selling through the informal sector then is not only financially attractive for enterprises due to scale and lower transaction costs, but also a key lever in reaching the largest number of consumers.

The Merkato is notorious. It is a black market, and the authorities continuously try to crack down on it. Formal businesses complain about unfair price competition due to avoided taxes. Many buyers with access to formal markets often avoid it for fear of being cheated. Moreover, access to financing of the kind our project was trying to solve altogether overlooks this market segment.

If international financiers, government, donors and consultants like us are serious about improving energy access for the poor, there is a tradeoff to address. We have to recognize the advantages of the informal sector and develop an approach that incorporates and leverages its many strengths. For a start, we need to recognize the scale and reach of informal markets and find ways to include them when planning financing for energy access. By failing to do so, we are failing to turn lights on.

Mohit Anand is an expert on energy in emerging markets. At TFE Consulting, he leads projects to help international companies navigate the energy transformation underway globally.

First published: Greentech Media.
Around one billion people globally and around forty million in India rely on healthcare facilities that do not have electricity access. A first-of-its kind study, *Powering Primary Healthcare through Solar in India: Lessons from Chhattisgarh*, published recently by the Council on Energy, Environment and Water (CEEW) and supported by Oxfam India, finds immense opportunity for solar energy to bridge the gaps in electricity access in rural healthcare facilities, writes Sunil Mani and Sasmita Patnaik from CEEW.

In rural India, Primary Health Centres (PHCs) provide the last-mile delivery of healthcare services. Yet, according to the fourth round of the District Level Household Survey, in 2012, one in two PHCs in rural India was either un-electrified or suffered from irregular power supply. In the absence of reliable electricity supply, services provided by PHCs such as deliveries, paediatric emergencies, and administration of vaccines get severely affected.

### Off-grid solar photovoltaic (PV) systems

In 2012-13, one-third of the PHCs in the power surplus Indian state of Chhattisgarh did not have regular access to electricity supply from the grid. To augment the electricity supply in the PHCs, the Chhattisgarh Renewable Energy Development Agency (CREDA), installed off-grid solar photovoltaic (PV) systems of 2kW each in 570 PHCs (of a total of 800 PHCs) between 2012-16. These systems were primarily connected to support critical functions such as the cold chain equipment and lights in the labour room, to ensure uninterrupted services. CEEW conducted an independent evaluation of the intervention in 2017, and found that among PHCs with less than 20 hours of power supply per day, solar powered PHCs admitted over 60% more patients and conducted almost twice the number of child deliveries in a month compared to the PHCs without a solar system.

About 90% of the PHCs with solar systems reported savings in energy expenditure, and a quarter of them depend exclusively on solar systems to enable round-the-clock functionality of cold chain equipment. The PHCs also reported reduced incidence of equipment damage, due to voltage fluctuation, after the equipment were connected to the solar.

The operations and maintenance unit of CREDA regularly monitors the performance of all the installed systems, and provides repair and replacement services, free of cost for a period of five years. Similar initiatives have also been adopted in various other states of India, like Maharashtra, Tripura, and Andhra Pradesh.

### Solar initiative for healthcare

The Indian Council of Medical Research (ICMR) has signed an MoU with CEEW to launch the 'Initiative on Solar for Healthcare'.
The initiative aims to conduct pilots across three states of India, where solar systems will be installed at selected PHCs, followed by a detailed monitoring and evaluation of the impact of improved electricity access on healthcare delivery.

Another project under this initiative includes a proposal by the Department of Science and Technology to fund the installation of solar systems in health facilities across Odisha.

The Department will provide a list of selected healthcare facilities to the Odisha Renewable Energy Development Agency (OREDA), which will design the solar PV systems, considering the power requirements of each.

OREDA will commission the systems, maintain them for a period of five years and impart training to the designated staff of the healthcare facilities for the upkeep of installed systems. Solar systems will supply electricity for different services like heating water for sterilisation, neo-natal care and refrigeration of essential medicines and vaccines.

**Electricity access for healthcare: Evidence from other parts of the world**

A study by the World Health Organisation (WHO) in 2012 revealed that 58% of the healthcare facilities in Uganda had no access to electricity. The acute nature of the problem is reflected in the whole of sub-Saharan Africa, where only 28% of the health facilities have reliable access to electricity. As in Chhattisgarh, similar interventions have been done in sub-Saharan Africa to address the lack of electrification in the health facilities. For instance, in Liberia, owing to very limited grid coverage, solar PV systems are being used to augment electricity access for health facilities.

The World Bank conducted a study of all first-line public health clinics in Liberia and found that electricity access increased from 54% in 2011 to 62% in 2012, mainly due to the installation of solar PV systems.

About 46% of clinics use solar PV systems for their primary energy needs, and 81% of these clinics reported availability of electricity on the day of the survey, as compared to only 52% of clinics with generators as primary energy source.

**Viability of solar in comparison to generator**

Despite the fact that solar is significantly more reliable, generators are still the most preferred choice of backup. For instance, two-thirds of PHCs in India have a working generator available, as a source of backup, while solar is only experimented in a few states.

This is because a conventional generator set is easily available, and installing it requires very less upfront investment.

However, in a 2016 study, *Energy Storage in India: Applications in the Renewable energy Segment*, based on Life Cycle Cost (LCC) framework, CEEW showed that one unit of electricity from a conventional diesel generator costs about INR 24–26 ($0.40) per kWh, while solar with battery costs around INR 12–14 ($0.22) per kWh.

Because of such obvious long-term benefits, it is important to scale the initiative on solar for healthcare. This would require combining support from national and international health budgets with private-sector investment.

**Role of the private sector**

Given the limited funding on public infrastructure, driving private investments could play a vital role to bridge the gaps in access to electricity in the healthcare facilities in the developing world.

An alternative public-private partnership model could be contracted where upfront payment for the solar systems can be covered by a private investor, and PHCs will make the payments on a monthly basis (from the savings on electricity bills) for a defined period of time. Similar strategies are needed to improve electricity access of healthcare facilities across the developing world.

CEEW’s study establishes a strong correlation between sustainable development goals (SDGs), focusing on good health and well-being (SDG3), and focusing on affordable and clean energy (SDG7).

Sustained engagement with policymakers and the private sector, along with regular assessments of on-going efforts, is key to simultaneously address the goals of healthcare, energy access and resource management.


First published: ESI Africa.
Investing in solar-powered energy and water solutions is one of the most sustainable and efficient ways to help Somalia rebound from years of conflict.

In late 2011, I visited Mogadishu to observe first-hand the Somali capital’s fresh wounds from the latest round of fierce fighting. Glimmers of hope appeared that this time would be different, that some semblance of stability and governance could take hold. As a graduate of electrical engineering with a specialization in renewables, I was pleasantly surprised in the immediate interest by some businesses and non-governmental organizations in solar power. They connected the dots between one of Somalia’s greatest resources — its reliable sunlight — and one of its greatest needs — reducing the extraordinarily high costs of energy for households and businesses.

Having studied engineering at the University of Nairobi, I knew the potential for the market to take off in Somalia. I was witnessing solar solutions in Kenya go from a novelty to a multi-million dollar sector. So I made the decision in 2012 to return to Mogadishu and found SolarGen Technologies. Like other start-ups, we tried everything in the early days to gain our first clients, access our first seed capital, and — most importantly — deliver high quality products and services to those who were willing to take a chance with us.

At SolarGen, we take great pride that our projects are contributing to the recovery of Somalia’s economy. We remember our early projects like the installation of 79 solar street lights in Mogadishu which provided light for security at night for residences, as well as helped businesses stay open later. Likewise, we helped electrify an important marketplace in Mogadishu with a 20 kilowatt photovoltaic system, and installed a 17 kilowatt system to power a water pump for a borehole that served both a large number of internally displaced persons as well as a nearby dairy farm.

International donors funded these type of projects, but after less than two years the always entrepreneurial Somali business community began to make their own investments in solar-powered solutions. In 2014, we completed a large solar-powered irrigation system outside of Afgooye — an important farming town 30km away from Mogadishu. The system is still producing 2,800 cubic meters of water a day for the farmer who grows lemons and bananas. We also began to work with local businessmen who were operating diesel-powered generators to run community boreholes. We explained the economic advantages of solarizing their systems: large reductions in fuel costs and fewer down-times. We then helped them access finance to make the upfront investment in the solar technology. These businessmen have already made a profit and, because of the consistent volume they are producing, they have also dropped their prices.

As early champions of the solar industry in Somalia, we are excited to take part this week in Mogadishu in a forum focused on financing sustainable energy. The Federal Government of Somalia, the United Nations, international donors,
and the private sector will be sitting down to discuss how to increase rapidly energy access to underpin the larger goals of economic recovery and nation-building. The challenges are enormous. Despite progress this decade, Somalia remains one of the most energy deprived countries in the world. The majority of Somalis do not have any access to electricity and those who do pay between 10 and 30 times the amount that their neighbors pay in Ethiopia and Kenya. Somalia cannot fully recover unless we bring these costs down and provide affordable solutions to more people.

SolarGen, after five years of growth, will play its role. We have now grown to 40 employees and we are implementing projects for the public and private sector across the country. In 2017 alone, we installed more than 30 solar-powered water pumps for communities with a collective capacity of more than 500 kilowatts. Thanks to our design and installation, a leading livestock company in Kismayo is now relying on a solar system to provide water to its quarantine facility, and a large dairy farm outside of Mogadishu will soon have a solarized cooling tank.

What we are most excited about is the potential for solar mini-grids to provide electricity to the millions of Somalis living in rural areas. These systems, which we have designed and constructed in Kenya, can provide basic lighting and charging points for small and medium appliances, power critical water pumps, and serve the energy needs for small and medium enterprises. Even more, the systems can be designed in a way that reduces the cost per user by between 50% and 75% of what they are currently paying for old diesel generator systems.

We are about to begin our first mini-grid in Somalia and we think the potential is limitless. As is the case in many countries rebounding from conflict and natural disasters, like this year’s severe drought, financing will be one of the greatest obstacles. There are so many other competing priorities for the government, civil society, private sector, and international community. Nevertheless, we must all come together to find innovative ways to match resources with the new green technology solutions that will help Somalia recover and ultimately thrive in the 21st century.

Aidarus Abubakar is Founder and managing director of SolarGen Technologies, a leading renewable energy and water solutions provider in East Africa with offices in Somalia and Kenya.

First published: Medium.
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