

# Energy Digest

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A PUBLICATION OF THE KENYA RENEWABLE ENERGY ASSOCIATION

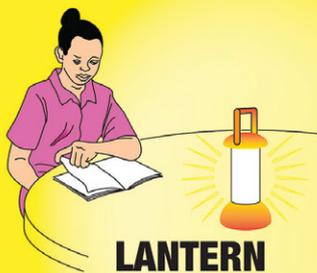
ISSUE 4 / 2016



## Rupingazi Hydropower Project Success Case Study for Feed-in-Tariff Project in Kenya

- Solar Powered Mini-grid on Ukara Island
- Lease to own biogas business model
- Cookstove women's empowerment program
- Solution for municipal waste menace

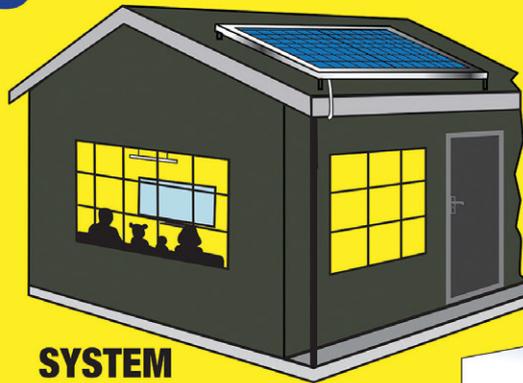
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**...for information on solar business and technicians  
providing good quality products and services**



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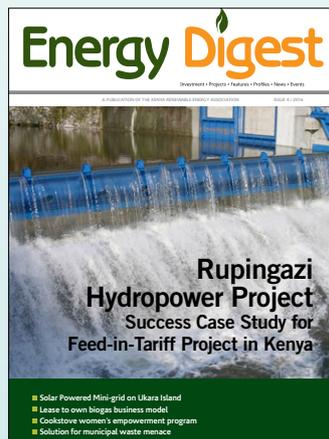
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# Letter from the industry



*Mr. Charles Muchunku,  
Chairman, Kenya  
Renewable Energy  
Association*

This edition of the Energy Digest makes its first regional venture; expanding its scope beyond Kenya to provide insightful news and information on Renewable Energy in the greater East Africa. Continuing the spirit of the publication being one for the industry by the industry, we retain our approach of the publication's articles and features being predominantly written by Renewable Energy sector players describing their initiatives from their perspective. This edition also features projects supported by two renewable energy programs supporting Renewable Energy projects in sub-Saharan Africa; the Energy and Environment Partnership Program and the Renewable Energy and Adaptation to Climate Technologies Challenge Fund.

2016 will prove a challenging year to solar PV off-grid businesses in the East Africa region. This is as a result of a change in the East Africa Customs Management Act which previously provided for import duty exemptions for specialized equipment that uses and/or stores solar energy, and their spare parts and accessories. The import duty, as well as VAT exemptions have had a key role in supporting the uptake of solar PV solutions as they have effectively reduced consumers prices by up to 41% (25% import duty and 16% VAT).

The amendment in the EAC Customs Management Act seeks to exclude appliances purchased with or for use in solar PV systems from exemption. In a similar move, the VAT Act in Kenya was previously amended to include the word 'exclusively' thereby requiring importers of these products to demonstrate that there was no way the appliances designed for use in solar PV powered systems could technically be powered by any other means. These amendments essentially seek to address leakage i.e. unscrupulous businesses taking advantage of the exemption provision to avoid paying duty and VAT on appliances that are not meant for use in solar PV systems. Unfortunately the exemption restrictions result in significant collateral damage for importers with valid claims.

It is also important to look at the bigger picture and the key role that private sector and solar PV systems plays in complementing government funded rural

electrification programs. Consider (1) the significantly high cost of conventional grid based rural electrification (2,000 – 3,000\$ per connection), (2) that most rural electrification strategies neglect households and small/micro businesses in sparsely populated areas, where grid extension or isolated mini-grids are not technically or economically viable and (3) that high population growth is a significant challenge for electrification, requiring a very high number of new connections per year just to retain the current national connectivity percentage (a challenge further exacerbated by a shrinking average household size).

Appliances designed for use in solar PV systems are significantly more efficient than those designed for use by conventional grid consumers. This is because, the amount of daily energy available on a solar PV system is limited and dependent of the installed capacity of the system. Any efficiency gains therefore help maximize the use of the limited energy available while also reducing the installed capacity requirements (which subsequently reduces the upfront solar PV system cost for the consumer). Unfortunately, there is a limited market for efficient appliances designed for off-grid applications and, as a result, these appliances are often more expensive than conventional electrical appliances. Levying import duty and VAT on solar PV appliances therefore imposes an unnecessary additional burden on those who are already disadvantaged because they cannot access a conventional electricity grid connection.

The issue of leakage does need to be addressed. Considering that, by design, solar PV appliances will have a significantly lower power rating than conventional grid appliances, the solution could be as straight forward as categorizing appliances (by application e.g. TVs, stereo, computer, fan, fridge) and providing exemptions to those in a given category with a power rating below a defined threshold.

We hope you enjoy reading this edition and that you find it relevant, informative and useful.

*Charles Muchunku*

# Policy Paper

## Considering Stand-Alone Solar PV Solutions as an option for National Rural Electrification Strategies for Off-Grid Households and Small Business

Considering Stand-Alone Solar PV Solutions as an option for National Rural Electrification Strategies for Off-Grid Households and Small Business

National rural electrification programs in sub-Saharan Africa typically apply the following electrification strategies: grid extension, isolated mini-grids and/or stand-alone RE based systems for public institutions/services (e.g. schools, health facilities, community water supply). Where grid extension or mini-grid strategies are applied, households and small businesses within the proximity of the grid are able to connect, if they can afford the connection fees. To address the barrier of high connection fees, complimentary government/donor funded grid densification or last mile connectivity programs are sometimes implemented.

A major shortcoming of most rural electrification strategies is that they neglect households and small/micro businesses in sparsely populated areas, where grid extension or isolated mini-grids are not technically or economically viable. In such areas, households and small/micro businesses are expected to find their own solutions with little or no support provided from rural electrification programs.

Solar home/business systems are a viable technical option in sparsely populated areas, and strategies to support their uptake and use should be considered for incorporation into national rural electrification programs. To justify the adoption of a policy that incorporates the use of solar home/business systems as a tool for rural electrification, it is necessary to think through how such a strategy could be implemented, the opportunities such solutions provide and challenges and the implications of adopting such solutions.

The aim of this policy paper is to present policy makers and implementers with some preliminary information on how such a strategy could be designed and implemented. This paper presents and discusses some key issues related to implementing such a strategy i.e.:

### a) Technical and Financial Considerations:

With the exception of electricity for medium to large mechanical (e.g. pumping, drilling, milling, cutting (wood or metal)) and heating applications (e.g. welding, industrial heating processes and hair dressing), solar PV solutions can provide sufficient

energy for most electrical appliances used by households and small business i.e. lighting, phone charging, refrigeration, fans, hair clippers, computers, tablets and printers. Furthermore, the availability of energy efficient DC appliances (often designed for use in boats and automotive vehicles) means that smaller solar PV systems can provide a high level of service. Examples include 1.5W LED lights with high lumen levels, 10-15W DC Colour TVs (19 – 21 inch) and 40-50W refrigerators (90 litres). A relatively small capital investment can therefore provide a high level of electricity service for household and small businesses.

The table below provides indicative solar PV system prices<sup>1</sup> for 3 different electricity service levels. When compared to the typical cost of rural grid extension (i.e. 2,000 – 3,000\$ per connection<sup>2</sup>), even the capital expenditure requirements to provide a premium electricity service level from solar PV are lower than the costs of extending the grid in areas with low population density. As capital costs for rural grid extension are subsidized using rural electrification funds, it is possible to justify using these funds to invest in solar home/business systems to provide electricity access

Service level	Services	Solar System size	Installed Cost
Premium	Lighting, phone charging, TV and refrigeration or for small business applications (e.g. large grocery shop, bar/restaurant, TV/video shows, barber shop)	180Wp	1,440\$
Intermediate	Lighting, phone charging and TV or for micro business applications (e.g. small grocery shop)	40Wp	320\$
Basic	Lighting, phone charging and stereo	15Wp	120\$

<sup>1</sup>Based on solar PV system retail prices in Kenya i.e. 6-10\$/Wp installed

<sup>2</sup>Reports from McKinsey (Feb 2015) and Norplan (Dec 2012) indicate rural grid connection costs of 2,300\$/connection in Tanzania and rules-of-thumb for rural electrification of 580-4,500\$/connection for 5-100 connections per km. Web links below [http://www.mckinsey.com/~/media/mckinsey/industries/retail/our%20insights/east%20africa%20the%20next%20hub%20for%20apparel%20sourcing/brighter\\_africa\\_the\\_growth\\_potential\\_of\\_the\\_sub%20saharan\\_electricity\\_sector.aspx](http://www.mckinsey.com/~/media/mckinsey/industries/retail/our%20insights/east%20africa%20the%20next%20hub%20for%20apparel%20sourcing/brighter_africa_the_growth_potential_of_the_sub%20saharan_electricity_sector.aspx) and <http://norplan.com/files/2013/05/Policy-Brief-1-Cost-benefit-analysis-NORPLAN-FINAL-Dec-2012.pdf>



An electrification model based on a large number of dispersed solar home/business systems does present some operational challenges with regard to how to cost effectively collect tariffs and provide timely maintenance services. Fortunately, technology advancements such as smart prepaid meters, mobile money transfer systems and remote monitoring and control of solar systems now make it possible to cost effectively manage such a complex system.

#### b) Tariff and PPP considerations

One of the challenges with determining tariffs for off-grid consumers (i.e. those who access electricity through mini-grids or other decentralized solutions) is the socio-political implication of setting cost reflective tariffs; i.e. addressing the fundamental question of whether/why consumers who don't have access to the national grid (simply by virtue of their location within the country) should pay more for electricity than their fellow citizens who have access to the national grid. To address this inequality government's typically applies a uniform tariff policy which is subsidized directly by government or by consumers on the national grid.

For solar PV systems a cost reflective electricity tariff would typically be based on recovering the capital costs (over a given duration e.g. 5 years), covering the operational and maintenance costs

and a reasonable profit margin. A capex subsidy would reduce the amount of capital that needs to be recovered through the tariff and could therefore translate into a tariff subsidy.

The table below provides one example of how subsidized tariffs could be set. It is based on a Private Public Partnership model where the Rural Electrification Agency pays a private company 80% of the capex costs to procure and install the systems. The private company would then collect the 20% difference from customers over a 5 year duration (assuming a flat/fixed annual interest rate of 12%). The other elements of the tariff are to:

- Cover the costs of battery replacement (assuming a 5 year battery life with battery costs estimated at 30% of the system cost)
- Cover the costs of administering such a scheme e.g. maintenance and tariff collection. These costs are expected to be the same, irrespective of the system size.
- Provide for a margin for the private company. In this example it is calculated as 15% of the other tariff components

Service level	Installed Cost (\$)	80% Capex Subsidy (REA contribution)	Monthly tariff components (\$)				
			20% Capex recovery over 5 years	Battery replacement costs	Operational costs	Margin	Total monthly tariff
Premium (180Wp)	1,440	1,152	7.7	7.2	1.2	2.4	18.5
Intermediate (40Wp)	320	256	1.7	1.6	1.2	0.7	5.2
Basic (15Wp)	120	96	0.6	0.6	1.2	0.4	2.8



Since solar PV systems have a daily energy limit (primarily dependent on the installed capacity) a fixed monthly tariff is proposed instead of an energy based tariff. Customers would therefore need to select a system based on their anticipated needs and ability to pay. The flexibility to upgrade to a larger system (or downgrade) should be provided.

As the tariff is not energy/kWh based, the concept of uniform tariff policy would need to be considered differently. Statistics from the Kenyan electricity utility<sup>3</sup> indicate that the average monthly expenditure for domestic consumers countrywide is 11\$ per month. In the example provided, the average monthly electricity cost would be lower than 9\$ (anticipating that the basic and intermediate consumers would be significantly higher than premium consumers).

For the PPP to be effective, there should be sufficient incentive to create interest for private sector to provide both the solar PV procurement and installation services, as well as the operational services (tariff collection and system maintenance). In this example, it is expected that the private company will make a margin during the procurement and installation phase (as a large portion of this cost would be financed by Rural Electrification Agency). It is also anticipated that the 20% difference to be collected directly from consumers would be sufficient incentive for the private company to develop and implement an effective collection system while at the same time ensuring that the systems are operational over the first 5 year period. As a further incentive for the private company to continue offering services after the first 5 year period, the capex recovery tariff component would convert into a new revenue stream.

### c) Economies of Scale:

Such a centrally coordinated and funded electrification program would also create the

economies of scale that private solar companies in sub-Saharan Africa have been unable to achieve and create market opportunities for complementary products e.g. energy efficient DC appliances.

In Kenya, for example, rural electrification activities are primarily financed through the Rural Electrification Scheme Levy; a 5% levy charged to customers on unit sales. In 2015, 34 million dollars was collected through the rural electrification levy. Over the last 5 years the Rural Electrification Authority has achieved an average annual electrification rate of 90,400 grid connections. From the example above, assuming an uptake ratio of 20% premium, 50% intermediate and 30% basic service level systems, the average capex subsidy contribution per solar PV system would be 122.5\$. Therefore to achieve an equivalent number of annual connections through solar PV systems, only 33% of the funds collected through the levy annually would be required.

Kenya's arid and semi-arid lands (ASALs) make up 88% of the country and are inhabited by approximately 25% of Kenya's population. These areas have the lowest level of access to basic services. With Kenya's population at 8.5 million households<sup>4</sup>, and assuming that half of the ASAL population can be best served through a solar PV system, the solar PV electrification based target would be 1.062 million households. Which, at the rate of 180,000 connections per year and an annual budget of 22 million \$, could be achieved in 6-7 years.

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*“Over the last 5 years the Rural Electrification Authority has achieved an average annual electrification rate of 90,400 grid connections.”*

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<sup>3</sup> Kenya Power Annual Report 2015

<sup>4</sup> 2009 Population Census – Kenya Bureau of Statistics

# Good news for off-grid areas: reliable power supply doesn't need a grid

Harald Schützeichel

**T**he dream of most people who live off-the-grid is to be one day on-the-grid. The expectations from full power access are large: enough electricity for lighting, communications, entertainment, and livelihood. The connection to the grid represents the hope of a better life because full power access means that households, companies and communities have sufficient, affordable and reliable supply of all energy services and products which are needed to reduce poverty related to the lack of energy.

Sometimes governments take advantage of this high symbolic value of power grid and install, shortly before elections, at least the power poles. So they suggest: the electricity will also come to you - if you vote correctly.

## Bad news

When the current flows, the reality is, however, often sobering: the connection to the grid is expensive and therefore has to be heavily subsidized in order for a household to be able to pay for the connection at all. For example, the connection to the electricity network in Kenya costs around \$830. Far too expensive for many households. The price is therefore artificially subsidized by Kenyan Power to \$400. Still more than what a solar home system costs – and in addition there will be monthly follow-up costs.

Once you are connected, the household budget is often merely sufficient to operate two or three lamps. But that ultimately does not matter, because the feeling to be connected to the potential for more is what really matters for people. Too bad that the power supply is very unreliable, often fails and therefore people often sit in the dark despite the grid connection.

Besides, we won't be able to spare most people in developing countries the bitter truth that the hope for

a network connection will never become a reality for them. Simply because the costs of connecting many remote regions are too high.

## Good news

The good news for people in off-grid regions is that a technical alternative is available: full power access through solar-based off-grid solutions.

The disadvantage of this technically optimal alternative: it has the image of being only a kind of "first aid" since off-grid solar power is today predominantly marketed with small mini-systems, which consist either of mobile lamps or micro systems with 2-3 LED. This is of course better than nothing - and no household will resist taking this first help. But it is not enough to cope with the promise of the power grid that you can now (theoretically) have full power access, which allows an access to prosperity, development and a better life.

The bad thing: solar-based off-grid solutions could thoroughly provide this full power access! For the power requirements for lighting, refrigeration, entertainment, communication, economic and communal life no expensive power grid is needed. And in contrast to grid, this full power access would even be affordable without subsidies and also reliable.

Stand-alone solutions for developing countries have the image of being only a "first aid" not only for off-grid customers: also governments, investors, power companies, banks (in particular the World Bank and IFC) 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". And on the other hand, the fact that the few investment funds, used for stand-alone technologies, go only to micro systems (especially mobile hand lamps) and not to full power



access, contributes to the stabilization of the negative image of being a “substitute”.

### Full power access without the grid

Maybe 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. Yet completely unnoticed by the off-grid scene of developing countries, off-grid technology has become an issue even in some industrialized countries. Triggered by the dissemination of LiFePO<sub>4</sub> batteries, more and more companies arise, focusing on the offer of “solar plus storage” - and therefore advertising that households can make themselves completely independent from the grid.

This has now become a large market in Australia: studies forecast that by 2018 half of the local households will have said goodbye to the power grid and will have gone off -grid.

Of course, we are not talking here about “Solar Home Systems”. Due to developing countries, the term has the strong image of an “energy for the poor”. Instead, we speak of “NanoGrid” and mean the electricity grid within a house, starting from the battery as central storage unit.

The NanoGrid market in industrialized countries has already a size of \$ 1.2 billion, far more than the

SHS market in developing countries. Its potential for 2024: \$ 23.1 billion - according to a recent study by Navigant.

### Grid power is as antiquated as landline phones

Many people see in stand-alone systems, the future for a reliable and affordable energy supply in industrialized countries. The grid, with its large central power plants, is outdated technology of the 20th century. Independent, decentralized power supply units are the future.

The players in the off-grid industry in developing countries should rediscover and implement with more self-confidence the wish of their customer to get full power access. For, stand-alone solar technology offers to these people, far more than the old grid power technology, the chance of affordable and sustainable full power access. That would be - after the first wireless revolution with the spread of mobile phones - the second wireless revolution!

What a signal it would be if the wireless revolution in the power supply would come from the developing countries and not from the industrialized nations!

*Dr. Harald Schützeichel is founder of the Solar-Federation ([www.solar-federation.org](http://www.solar-federation.org)) and editor of Sun-Connect News.*

# Kenyan Women find Power in Clean Energy

By Dr. Rim Razzouk, Kassy Buck, and Dr. Anshuman Razdan, Arizona State University

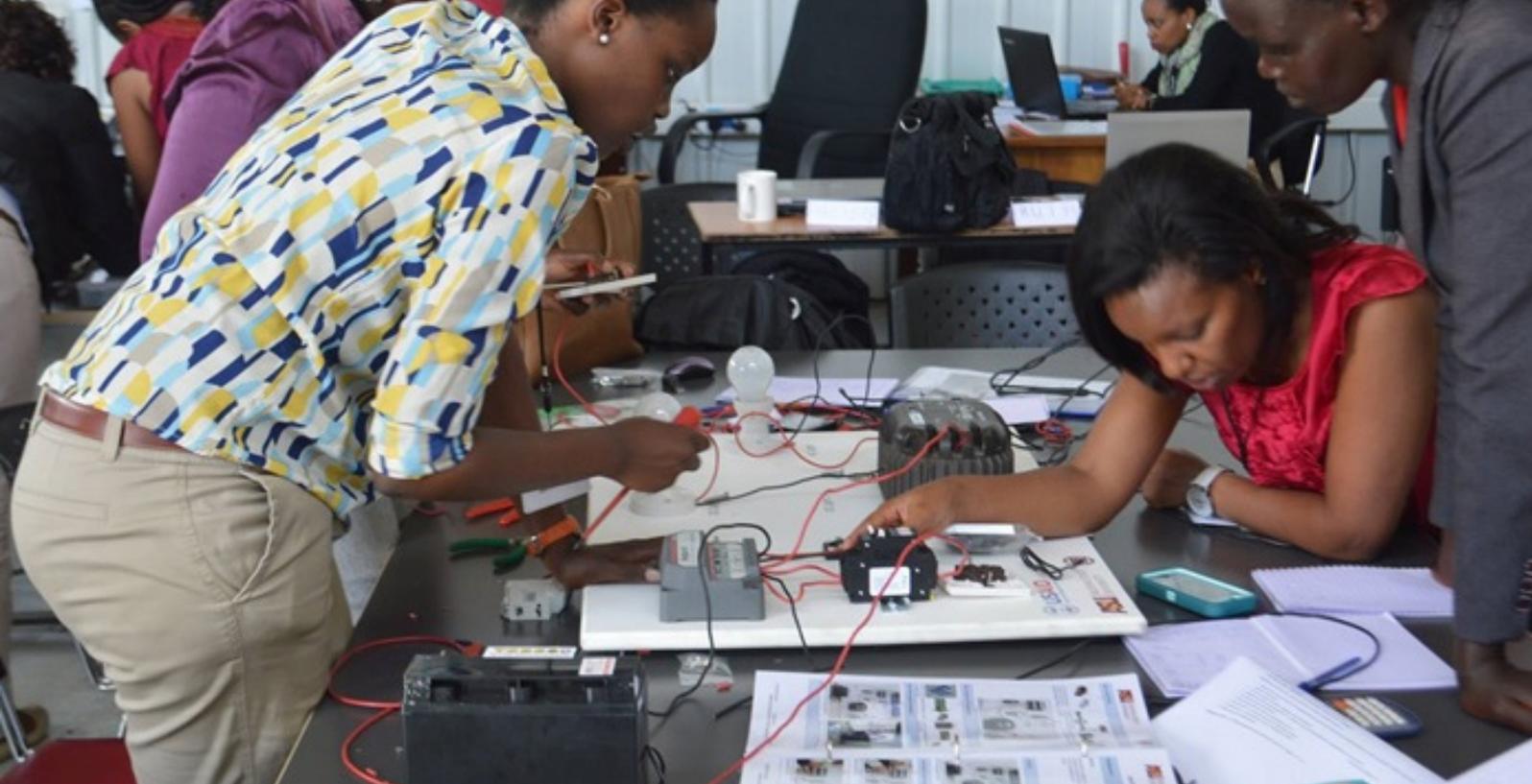
“The opportunity overall was unique, highly educative and transformational. I am so equipped for the solar industry now!” enthused Ms. Mary Mindo, a Geographic Information System Analyst at Jomo Kenyatta University of Agriculture and Technology (JKUAT) in Kenya, about the solar photovoltaic (PV) training she completed in Nairobi, Kenya. This training is one of many provided by the Vocational Training and Education for Clean Energy (VOCTEC) program, which seeks to enhance local knowledge and capacity to design, install, operate and maintain small-scale clean energy systems in developing countries.

The Vocational Training and Education for Clean Energy (VOCTEC) program is a global program initially funded by the United States Agency for International Development (USAID) and implemented by Arizona State University (ASU) in the USA. VOCTEC is a multitier vocational training program for Technicians, Trainers, and Policy and Decision Makers. VOCTEC’s technical focus is on sustainable, renewable energy systems including solar PV, micro-hydro, and wind technologies.

Over the past two years, together with its Kenyan partner Strathmore University (SU), ASU has implemented innovative all-female educator solar trainings. The goal for the training was to develop solar champions who will later train technicians – including more women – to strengthen their respective organizations and institutions across Kenya.

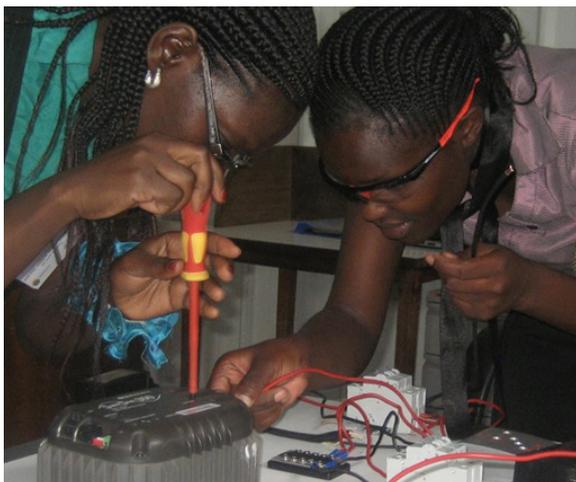
The attendees were so inspired by the trainings that they formed a local group called Women in Sustainable Energy and Entrepreneurship (WISEE). The group aims to empower women to acquire, use and promote renewable energy technologies in order to increase their participation in the energy and entrepreneurship sectors in Eastern Africa. Noted Ms. Daisy Karimi Muthamia, a Project Electrical Engineer at Kenya Electricity Transmission Co. Ltd. (KETRACO), “With all the many skills available in this network, we will be able to move forward stronger than just working individually.” The WISEE members are giving a “voice” to women working in the energy sector to improve energy access and build the capacity of low-income communities in the region.





To ensure skill building, VOCTEC incorporates unique assessment and evaluation measures and utilizes its innovative, proprietary solar PV lab-in-a-box, called the Mobile Training Toolkit (MTT) for real-world, hands-on training. These key elements have shown to be successful, resulting in a greater than 25% increase in the trainees' knowledge by the end of the training.

Participants also expressed a high level of satisfaction with the training program which increases the trainee's motivation to apply the acquired skills in their career. For instance, one of the trainees reported that after returning home, she successfully diagnosed and fixed a faulty solar PV home system, which allowed her to land a new job related to solar PV installation.



In addition to being successful in Kenya, VOCTEC has been effective in other regions such as the Pacific Islands, India, Nepal, the Caribbean and West Africa. It continues to expand by taking on new projects and conducting more trainings on clean energy around the world to ensure that the workforce possesses the skills needed to design, install, and maintain clean energy systems.

About VOCTEC: The VOCTEC program, located at Arizona State University's Advanced Technology Innovation Center (ATIC) is a global program under the leadership of Dr. Anshuman Razdan. Through partnerships and grants, VOCTEC aims to improve the sustainability of renewable energy infrastructure in developing countries by increasing awareness, knowledge and capacity of local stakeholders. VOCTEC's unique Curriculum and Assessment materials and hands-on Mobile Training Toolkits have been applauded by other institutions around the world as innovative and effective. For more information, visit <http://voctec.asu.edu> or contact Dr. Razdan at ATIC@asu.edu

Arizona State University (ASU): ASU was recently ranked, by the U.S. News & World Report, as No. 1 among the "Most Innovative Schools" in America for 2016. ASU has developed a new model for the American Research University creating an institution that is committed to excellence, access and impact. ASU measures itself by those it includes, not by those it excludes. ASU pursues research that contributes to the public good, and it assumes major responsibility for the economic, social and cultural vitality of the communities that surround it. ASU today enrolls more than 75,000 students on four campuses in metropolitan Phoenix, maintaining a tradition of academic excellence in core disciplines while gaining recognition as an important global center for innovative interdisciplinary research. ASU has extensive programs in renewable energy arena including solar, bio-fuels and fuel cell systems.



*It has been a great three years since SunCulture launched in Kenya. I'm excited to share with you what we've achieved and give you insights into where we're going.*



# The year at SunCulture

*At SunCulture, year one was about proving the tech, year 2 was about proving the model, and this last year was about proving growth. And we grew a lot.*

## Team

We learned the hard way that hiring is one of the most important things a company does. A majority of my time over the last 12 months has been spent recruiting the best individuals. We've grown from 13 to 30 in the last year and I can confidently say that each member of our 30 person team is the best at what they do. Nobody is better. And I'm damn proud of that. Each and every person on our team is brilliant, hard working, and inspirational, and I'm honored to work beside them every day.

## Geography

Not only have we experienced incredible organic growth in Kenya, but we have also started to sell our solutions outside of Kenya. We have made strategic sales in Tanzania, Uganda, Ethiopia, Somalia, and South Sudan to customers who are potential distributors. We are formalizing our distributor program and look to build distribution partnerships in Q3 this year.

## Product

One question I'm often asked is how we plan to distribute drip irrigation, as drip irrigation is bulky, complicated, and quite expensive. A farmer needs a pickup truck to transport one acre of drip irrigation, a highly-skilled technician to spend three days installing a kit, and \$1,300.

Not anymore.

We have successfully designed a drip irrigation kit that will fit in the back of a sedan, take a technician one day to install, and only costs \$890 which includes delivery across Kenya, saving farmers the hassle and expense of traveling to the city to collect their irrigation system.

More so, we are thrilled to announce our newest product, Mist irrigation, which will finally make irrigation affordable for millions of farmers across the continent. At only \$390 per acre, Mist gives

subsistence farmers access to irrigation for the first time ever. This is the most affordable irrigation kit on the continent.

Both of these kits are DIY. Think IKEA for irrigation. We are really proud of the progress we have made re-imagining irrigation to make it accessible to those who need it most, and Charlie will set up a dedicated R&D facility in Cambridge, UK later this year to enable us to continue to excel at this.

### Distribution

Until December 2015, lead time for a farmer having a technical survey completed by one of our technicians to having an irrigation kit installed was minimum five days, and they had to pick up goods from Nairobi. SunCulture's new process – which includes distributed technicians, central warehousing, using a third-party logistics company for delivery, and the successful design of a DIY irrigation kit – now cuts this lead time to one day.

Unlike any competitor, SunCulture's irrigation kit prices now include free delivery across Kenya. The goal is to increase access to SunCulture's products without expensive retail investments.

African women traditionally provide the majority of on-farm labor, but SunCulture's systems reduce labor requirements

### How we see the world

While we've grown a lot, we've also been fortunate to have been given a seat at many tables this last year. We've been invited to speak at a number of events such as the Vienna Energy Forum, the World Climate Summit at COP21, and the UK Parliament addressing parliamentarians from 36 countries. We have been recognized as the best food innovation in the world and as a World Energy Council Future Energy Leader. This has given us access to some of the most amazing thought leaders in our space and has given us perspective on how global leaders think about the world. Here are two themes I think are important and have been constantly discussed over the last year and have shaped our thinking on the future of our business:

### What is impact investing?

The impact investing world is a very interesting scene right now. There are a lot of funds and donors putting money into sustainability in Africa, which is fantastic. In fact according to a report put together by the Global Impact Investing Network and Open Capital Advisors with support from UKAID, DFIs have invested about \$5.6b in East Africa in the last 5 years. And we're sitting in the hub of all of this - according to the report, more than half of all impact capital disbursed has been in Kenya and at least 48 impact fund managers have staff placed in Nairobi, which is more than three times as many local offices as in any other country in the region.

But what we're seeing is that a lot of these funds' LPs have not spent time in the places they wish to allocate capital. This is not a good thing. When a fund is created, investors create an investment thesis and then a mandate is set outlining future investment parameters - how much each deal will be, what sectors they will invest in, and what impact they will

achieve. The issue we see is that these parameters are being set by people who do not have much experience on the ground, i.e. the negotiation is happening without fully understanding implementation. What that translates to is a lot of money coming into the space, but with impractical restrictions. This is further exaggerated because most of the limited partners investing in impact funds are the same, which means we have a high number of funds that have the same, impractical mandate.

However, there is some silver lining. We've finally started to see a shift in the way people are measuring impact. We are very vocal and challenge funders to take a long-term approach at looking at impact (e.g. number of jobs created over time) vs. a short-term approach to satisfy program cycles (i.e. number of bad products sold to people who don't want them). Good news is a lot of funders are taking a more long-term approach to measuring impact. Investors and donors alike are looking at the depth of impact per person (e.g. increase in income) and what used to be "secondary" measures of impact, like numbers of jobs created per item sold. This is promising to watch and we hope that funders continue to revamp the way they evaluate opportunities.

### Agriculture is sexy

When we first started SunCulture, people were excited about the energy aspect of our business. We launched the company at a time when Kenya reached grid parity and organizations were allocating capital into renewable energy projects. The first two grant programs we were part of were the Renewable Energy and The Energy and Environment Partnership and the Energy Efficiency Partnership. Over the last 12-18 months we've seen an uptick in excitement around agriculture. We have recently started working with USAID's Powering Agriculture and Securing Water for Food programs. The dollar value of AgTech investments in 2015 were greater than cleantech investments and nearly doubled from 2014 (\$2.36b in 2014 to 4.6b in 2015, only \$0.9b in 2013).

Both energy and agriculture are exciting and advancements in these sectors will change the lives of billions of people. We're especially bullish on the application of off-grid renewable energy for productive use. \$276 million was invested in the off-grid solar industry in 2015, a 15-fold increase since 2012. The World Bank estimates a \$3.1 billion market opportunity for the off-grid solar industry by 2020, reaching 99 million households. Agriculture is the perfect application for productive use renewable energy and an even larger opportunity. By 2030, the World Bank estimates Africa's farmers will create \$1 trillion agribusiness market – if they can access the capital, knowledge and technology necessary to increase yields, which trail world averages by as much as 50%. Over the last three years operating in both the off-grid renewable energy and agriculture spaces, we've come away with significant results and major learnings and are uniquely positioned to meet the needs of these African farmers.

### SunCulture 301: Learning by doing

When Charlie and I founded SunCulture, we didn't know much about farming, but we shared a

passion for using our skills to solve big problems. At SunCulture, we're pushing the limits to solve some of these problems and are proud of the progress we've made so far. Farmers currently using SunCulture's solution are (annually):

- Saving 1,711,200,00 liters of water.
- Saving 360,000 liters of diesel fuel.
- Generating 90,00 kilowatt-hours of renewable energy.
- Reducing 397,440 kilograms of carbon dioxide emissions.
- Growing 9,300,000 kilograms of fresh fruits and vegetables (which is enough food to meet the FAO's minimum required fresh fruits and vegetables consumption for 42,466 people).
- Realizing \$3,237,450 in savings and increased yields.

Our progress has been driven by our constant need to push boundaries and desire to continually learn. I'm going to share three major insights we have gained over the last three years that have shaped our thinking on what boundaries we're pushing next.

### SunCulture farmer ready for market

#### Lesson #1: Farmers need a solution

One of our key early learnings is that great technology is just one part of the solution and that companies serving rural African customers have to offer an

array of services to facilitate adoption of new tech. SunCulture was founded on a drive to build something meaningful and on an understanding that we must create solutions with farmers for farmers. One of the biggest mistakes we see entrepreneurs, donors, and investors make is thinking that they hold the key to solving the world's biggest problems. Our success in the early days of SunCulture stemmed from our understanding that our customers held the key to our success, so we worked with them to design a solution for them.

As I've said many times, the best things that we did when we were piloting the AgroSolar Irrigation Kit was use farmer feedback to create what is now our current solution: a combination of tech + value added services.

In addition to industry-leading solar-powered irrigation systems, we offer end-user financing through bank partnerships. SunCulture-trained technicians and agronomists provide on-farm training, soil analysis and agronomy support by mobile phone. Next-day delivery and installation anywhere in Kenya is included in the price of the system. We've found that providing these complementary services instead of focusing strictly on technology has enabled us to better meet the needs of our customers and build trust necessary to facilitate adoption of new and sometimes unfamiliar technology.

This has resulted in major farmer success.

Item	Costs using petrol pump + furrow irrigation	Costs using AgroSolar Irrigation Kit	Benefits by using AgroSolar Irrigation Kit
Labor	1,035	537	498
Fuel	2,640	0	2,640
Pump maintenance	27	9	18
Chemicals	1,260	1,116	144
Revenue loss due to decreased yield	7,116	0	7,116
<b>Total</b>	<b>12,078</b>	<b>1,662</b>	<b>10,416</b>

#### Lesson #2: Our solution is the best

We obsess over understanding the impact our solution has on our customers and are motivated by what we've found. The chart below shows real savings one of our customers enjoyed by switching from traditional irrigation methods to using our solution. This farmer grows cabbages and saves over \$10,000 per acre per year by using the AgroSolar Irrigation Kit.

What's more impressive is that this farmer had an annual revenue of \$14,000 (compared to ~\$600 the year before growing maize)! Our most successful farmers have annual revenues upwards of \$25,000 per acre! We have not found another smallholder irrigation solution that enables farmers to achieve these numbers.

However, the biggest barrier of adoption for the SunCulture solution is the upfront cost. Not all smallholder farmers have the capital necessary to purchase an AgroSolar Irrigation Kit (\$2,700 for a complete one acre kit), high quality inputs (~\$450 per acre per season), and a water tank (~\$350). If they do have the capital, they're payback period is just one growing season, but only a small minority of smallholder farmers globally can afford this. They

need financing.

#### Lesson #3: Farmers need financing

The fact that farmers need access to affordable end-user financing is well known and has been a major point of discourse around the world. Development finance is a topic I'm particularly passionate about and end-user financing is one of the many bottlenecks technology companies face when scaling up.

While SunCulture has the most affordable drip irrigation kits in Africa and the most affordable solar-powered water pumping systems for its class, a majority of smallholder farmers in Africa still cannot afford them. Because of this, SunCulture has partnered with banks in Kenya to facilitate end-user financing. The results have been underwhelming, which is a theme across agriculture lending in Africa. Despite 65% of Africa's labour force being in agriculture, less than 1% of outstanding commercial bank loans actually go to the agricultural sector.

There needs to exist a more reliable way to enable smallholder farmers in Africa to purchase high-quality assets.

The emergence of PAYG companies has shown



that, with financial and technological innovation, companies are able to make life-changing products available to the mass market. Companies such as M-Kopa, Mobisol, Off.Grid:Electric, Nova-Lumos, Greenlight Planet and more have done a great job selling solar home systems and household consumer goods to hundreds of thousands of people across Africa.

However, no company has leveraged PAYG technology to finance agricultural assets past the pilot stage for a number of reasons:

- Agriculture is a complicated sector with a very disconnected value chain.
- Agribusiness is inherently high-risk and susceptible to a number of external factors including weather patterns and crop prices.
- Success in agribusiness depends on farmers having access to high-quality inputs and agronomic knowledge support. Most banks or MFIs lack capacity to offer these complementary products and services.
- Farmer cash flows are inconsistent and loan repayments must be flexible to accommodate this.
- Companies must do as much as possible to ensure farmers are successful in order to de-risk their loans. This is extremely risky for companies that do not understand agriculture.

At SunCulture we occupy a unique position in the agricultural value chain with years of in-field experience understanding and managing agribusiness risk for our customers. We are the only SME globally to provide a turnkey solar-powered irrigation solution to farmers bundled with the ancillary products and services farmers need to succeed (i.e. pay loan back). Because of this, SunCulture is piloting a PAYG solar irrigation model and will be the first company in the

world to roll it out at scale.

### The future of SunCulture

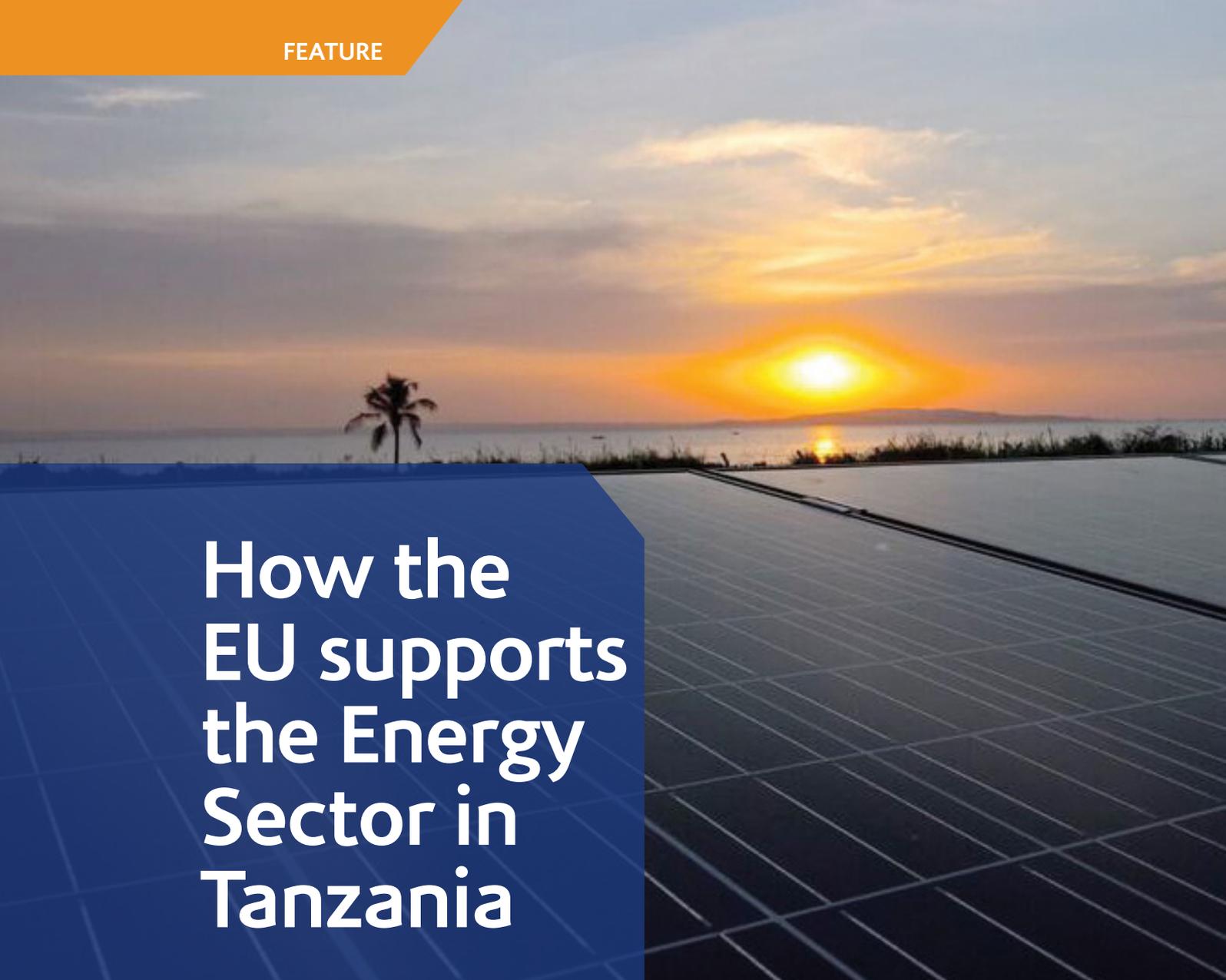
In our first annual letter I wrote in 2014, I said, “Charlie and I think about scale as a problem of access to three things: information, product, and finance” and that “[we] have established the framework to ensure that we can manage growth.” This framework has developed over time, but the fundamentals are still true today. SunCulture’s future growth is driven by Access:

- Information Access – For farmers to learn about SunCulture’s products.
- Product Access – For farmers to physically access SunCulture’s products.
- Financial Access – For farmers to pay for SunCulture’s products.

In the west we’re often taught to choose one thing and be the best at it. In the markets that we work in, there does not exist an ecosystem that allows us to focus on succeeding in one area alone - we have to be the best at everything. Over the last few years, the most successful startups in Africa have been ones that design, manufacture, finance, sell, distribute, and provide after-sales support for their own high-quality products. And we’re going to do the same. We’re already on the path and have shown early success at being a product design company, a manufacturing company, a bank, a sales company, and a distribution company and being damn good at them all.

### How in the world can we figure all of this out?

By having the right people at the right time. We have the best people and we are at the forefront of global agriculture innovation.



# How the EU supports the Energy Sector in Tanzania

For almost a decade now, the EU has joined forces with Tanzania to fight against energy poverty. It has promoted the introduction of innovative approaches for decentralised solutions to energy supply based on renewable sources such as hydro and solar, including mini-grids development and new connections in rural areas. Support has also extended to strengthen capacities of key stakeholders in the sector, in rural electrification planning and policy, as well as regulatory reforms. The EU continues to work closely with the Ministry of Energy and Minerals (MEM), the Rural Energy Agency (REA), the regulatory authority EWURA and the power utility TANESCO.

The EU, in cooperation with its member states and other key development partners, delivers its cooperation through grant financing to project developers or public institutions. It also provides the blending of grants with other types of funding, such as loans or equity, to maximize financing for priority projects.

## Scaling Up EU Support for Energy

Under the 11th European Development Fund energy has been prioritised as a key sector of EU –Tanzania cooperation. With a focus on energy sector reforms

and improving access to electricity and modern energy services in rural areas, a total budget of up to EUR 180 million has been earmarked for this focal area for the period 2014-2020.

To mobilise this funding, the EU has assisted the Rural Energy Agency (REA) and TANESCO to conduct preparatory studies to improve access in rural areas through grid extensions and new connections. It is expected that through this initiative alone, between 250 and 275 villages in 23 districts in the regions of Mwanza, Geita, Simiyu, Manyara, Morogoro, Dodoma and Singida (and possibly others) will gain access to electricity. This programme, which is part of the ambitious rural electrification effort undertaken by the Government of Tanzania, will see an estimated 80 000 – 90 000 new grid connections during the first four years for over a total population of 720 000 people (119 000 households).

Planned support interventions will be complemented by new important instruments for the financing of private sector led electrification initiatives based on sustainable energy solutions including the Electrification Financing Initiative (ElectriFI).

ElectriFI is an EU initiative to support electrification investments that will lead to new and improved



*“To mobilise funding, the EU has assisted the Rural Energy Agency (REA) and TANESCO to conduct preparatory studies to improve access in rural areas through grid extensions and new connections.”*

The target range of financing solution provided by Electrifi will be EUR 0.5-5.0 million

Electrifi expects to launch a second round in the fourth quarter of 2016.

For more information visit: <http://electrifi.org/>

Under the EU funded Zanzibar Renewable Energies (RE) and Energy Efficiency (EE) programme a detailed assessment of the potential capacity of wind and photovoltaic energy integration into the Zanzibar power grid system is being carried out.

Early results of wind data shows constant mean wind speeds above 6 m/s at 70 m and moderate wind gusts. The wind direction is constant (SE). Solar data from Makunduchi on main island of Unguja (time resolution 10 min) has shown Global Horizontal Irradiance (GHI) max = 1623 W/m<sup>2</sup> and a GHI avg = 388 W/m<sup>2</sup>. The measurement stations are being improved and upgraded to allow for further detailed resource assessment on all five sites of which 3 are on Unguja and 2 on Pemba.

In addition to detailed wind and solar measurement, EU technical assistance will also provide full scale feasibility including technical, social, environmental, economic and financial aspects of wind and photovoltaic for electricity generation in Zanzibar. Long-term technical assistance is also in place to assist in establishing a conducive legal and regulatory framework for private sector involvement in developing renewable energy generation and promote energy efficiency actions in Zanzibar.

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connections, with strong potential for scalability. Electrifi will be flexible in allowing the support of different business models, utilities and mini-grids. Electrifi can boost investments by making support available throughout the entire process, from the project idea to its successful implementation and scaling up.

Electrifi received 290 applications during its first Invitation for proposals which closed on 6 May 2016. Tanzania topped the list of number of applications and the other East African countries were high on the list as well. Key selection criteria for projects will be:

- New or improved access to energy (households and enterprises)
- Green, sustainable, inclusive growth that contributes to job creation
- Projects must be capable of reaching financial sustainability
- Electrifi must be complementary to existing financing solutions



*Kleen Energy signs the PPA with KPLC in August 2015*

# Rupingazi Hydropower Project

## Kleen Energy

Kleen Energy's venture into Kenya's renewable energy sector as a project developer has seen the company adapt and take up new opportunities over the last decade to emerge amongst the industry's leading private sector players. The company is developing a 6.8 MW small hydropower project along Rupingazi River in Embu County of Kenya.

Having come a long way since the project's ideation, the company recently signed a 20-year power purchase agreement (PPA) with the Kenya Power and Lighting Company – the national utility – to supply an estimated 28,000,000 kWh per year.

Once the company embarked on the pre-feasibility study, it determined that at least 800 kW could be developed at the site, and it therefore proceeded with the study aiming to develop a project of at most 1MW. However, in 2010, the river which they had earmarked for hydropower development dried up for the first time in the living memory of the

locals. The very promising project came to a sudden end at this discovery and the Mugos were back at square one.

However, rather than give up on the idea of developing a project, the company decided to seek further advice. Engaging in numerous discussions with a variety of technical and financial advisors, they identified an unexpected alternative – development of a larger scale project. The FiT was again one of the key considerations at that time. Revised in 2010, the previously unattractive FiT now made larger scale projects (over 1 MW) more economically attractive, leading Kleen Energy to consider developing a project of at most 5MW. The company therefore identified a new site along Rupingazi River and proceeded to carry out pre-feasibility and feasibility studies for a proposed 3.8 MW project. The outcome of this study showed that hydropower potential of 6.8MW could be exploited, and the company jumped at this chance to further increase the project scale.

## Opportunity

Rupingazi River was ideal in a number of respects. First, hydrology data was mostly available as the river had been gauged by the government over 30 years preceding the feasibility study conducted by the company. Although gauging has stopped and there were few data gaps, the information was immediately available and useful.

Based on the location of the river, the project design showed that the canal could pass through forest land. The company therefore secured a 30-year lease from the Kenya Forestry Services. The company also purchased privately owned land adjacent to the forest for the development of the power house. These two aspects enabled Kleen Energy to mitigate risks associated with land acquisition. At the time of selecting a project site, the company had an option of selecting a site with an extra head of 30 meter. However, this option was not considered further as the land was community owned, and the project prioritized mitigation of any possible risks.

Kleen Energy found a lot of interest and good will from government offices including the forest and water docket. For instance, KFS was willing to sign a 30 year lease to provide the project with adequate time for project eventualities such as technical studies, negotiations, construction, commissioning and decommissioning.

The company was also able to tap into local expertise especially during pre-feasibility studies, and international expertise during the feasibility studies. The outcomes of both processes were found to be highly complementary as the feasibility study essentially confirmed the initial findings, providing the project with a higher level of certainty.

Looking back over the project's life, Kleen Energy has come a long way. Power supply reliability in Embu Town is no longer as much of a concern as when the project idea was first developed in 2002.

Amongst other factors that came into play was that the company was limited in its ability to pre-empt government policy, constructive feedback was limited as the area was quite new in the country, and engagement with stakeholders was in some instances demanding due to low levels of awareness of renewable energy projects.

The company, through the PPA, is therefore looking to sell its electricity to KPLC, while remaining a consumer of the national utility. This has been a remarkable change in the project's premise, but Kleen Energy sees this as a win-win situation as they have accomplished more than what they had set out to do. However, they are aware that policies and regulations such as wheeling would allow companies such as theirs to select and distribute to consumers of their choice and therefore improve their project's financial returns.

## Financing

The project has secured various sources of funding over the course of its implementation. The detailed feasibility study was supported by the French Development Agency (AFD) through the Kenya Association of Manufacturers' Regional Technical Assistance Program (KAM RTAP). Kleen Energy was in fact the first project developer to be awarded USD 100,000 in Technical Assistance.

Project capital financing has been derived from debt (70%) and equity (30%). Debt financing has been provided by AFD through a local AFD partner bank. This loan will be repaid over a period of 10 years, following a 2-year grace period for construction. The company indicates that in its experience, AFD understands the details of what makes renewable energy project viable, including interest rates and transaction currency considerations; aspects of utmost importance to the PPA. The terms of the loan were enablers of the project, with no collateral required.



*Rupingazi River Project Site*



Excavation of the Canal

30% equity by the company has been provided in terms of privately owned land, and in-kind contribution to the project by undertaking all civil/construction works. The company has provided its own team of experts required for hydropower project development. In this way, it has also innovatively cut costs by about 30-50% which would have been paid to contractors as a margin on the project.

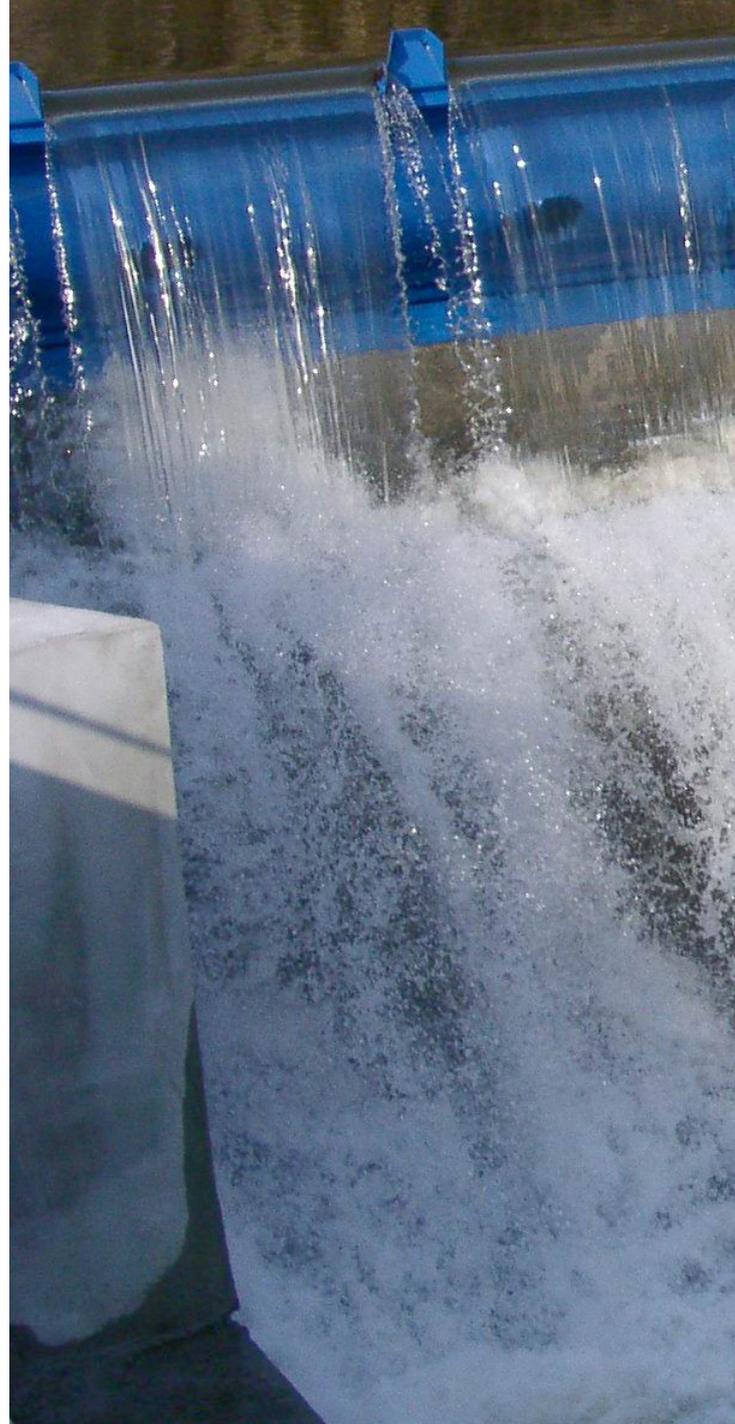
### Challenges

Kleen Energy's project by its nature is an inherently challenging project. It has taken the project over 5 years – since deciding on a 6.8MW project - to complete pre-feasibility and feasibility studies, secure the necessary licenses and permits, financing and the PPA. However, it has taken over 10 years when reiterative processes such as environmental and impact assessments, licences and permits, PPA negotiations are considered. This was partly as a result of the changing policy landscape, as well as the company's strive to adapt and take up new opportunities as they emerged as in the case of the FiT.

The civil construction works is expected to take an additional 1.5 years, in which an approximately 3.6 kilometers stretch of land is to be covered, part of which is forest. Further, there is significant rock excavation required to up to 4 meters, but with some areas as deep as 14 meters.

The project has experienced a number of issues which the company has taken in stride. In terms of financing, the project was initially unsuccessful in securing financing from mainstream alternatives. Large development partner institutions indicated that the proposed project scale was too small for their financing instruments, while commercial banking institutions did not appreciate the specific nature of renewable energy projects and sale of electricity as a bankable commodity.

From a technical standpoint, the most difficult challenge has been excavation of the river bed. First, there have been delays due to rain, which has made



excavation work more demanding. Secondly, as a condition of receiving financing from the bank, the project had to seek and secure the agreement of the turbine manufacturer to provide O&M for a period of 2 years from commissioning of the project. The turbine manufacturer has therefore seconded one of its employees as an international expert to the project. Further, Kleen Energy has contracted local graduate experts in electrical and mechanical engineering as understudies of the international expert, and is planning to facilitate their training over a 6-month period abroad.

### Parting Shot

The main lesson the company has learnt is in terms of civil construction works. If given a chance to do something differently, they would select excavation of the canal and concentrated on finishing the weir. The project has experienced delays during heavy rains due to collapsing of the weir walls.

Kleen Energy's parting short is that project developers embarking on such projects should have



the patience and commitment to stay the course at all costs because it is a long journey which cannot be completed overnight. "If a company gets into the business for quick returns on investment, then they are in the wrong business. Returns are a long way off, but given the right circumstances should be rewarding", Rosemary says.

### **About Kleen Energy**

The company was registered in 2008 as an independent power producer (IPP), following the development of Kenya's Feed in Tariff (FIT), which allowed small power producers to generate electricity and sell it to the national grid. Its main focus is the development of projects for power production from clean energy sources: hydropower, wind, biomass and solar.

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*Head Race Canal*

# Inauguration of Solar Powered Mini-Grid on Ukara Island



Ukara Island, Mwanza; Tuesday 5 April 2016: - JUMEME Rural Power Supply Ltd. in Tanzania, together with its partners celebrates this day the launch of its solar-powered mini-grid on the Lake Victoria island of Ukara. The occasion is attended by Ukerewe District Commissioner, Mr. Joseph Joseph Mkirikiti, European Union (EU) Delegation Head of Natural Resources, Mr. Gianluca Azzoni, Chairperson of the Bwisya Village Power Committee, Mr. Lazaro Kabunga, officials from the Local Government Authorities and partners.

The project "Micro Power Economy, Tanzania Roll-out", developed by JUMEME and its international partners, aims at implementing and operating Solar-Hybrid Mini-Grids in remote settlements in Tanzania. This project has a total budget of 16 Million EUROS (around 38.4 Billion TZS) and is co-funded by the European Union under the European Commission ACP-EU Energy Facility with a commitment of 7.4 Million EUROS (around 17.8 Billion TZS). 50% of the project cost is covered through private investment (both equity and debt). The mini-grid in Bwisya is the first of 30 systems to be installed by JUMEME over the next 2 years, supplying reliable electricity to around 100,000 people.

"Our goal is to set up 300 systems and serve up to 1 million people in rural areas across Tanzania by 2022, making JUMEME the largest mini-grid operator in the country", said Rev. Dr. Thadeus Mkamwa, one of JUMEME's Directors and Vice-Chancellor of St.

Augustine University of Tanzania. He continued to explain that the power system was set up in Bwisya, the largest village on Ukara, where initially 250 customers will be connected to a hybrid power station consisting of a 60 kilowatts peak (kWp) solar PV system, a 33 kVA diesel genset, and a 240 kilowatt hours (kWh) battery bank. The system will be extended in the second half of this year to connect the other villages on the island with a total of 2,000 customers.

For the implementation of the pilot project in Bwisya, JUMEME receives additional co-financing from the Energy and Environment Partnership Programme with Southern and East Africa, Phase II. Grants for technical assistance are provided by the Overseas Private Investment Corporation, the Sustainable Energy Fund for Africa and the Global Climate Partnership Fund.

"The pilot project on Ukara Island is a first step towards a sustainable power supply for many of the remote communities in Tanzania that are still without access to electricity", said Mr. Joseph Joseph Mkirikiti, District Commissioner of Ukerewe District, Mwanza Region. "We endorse this project and the approach of JUMEME, as it is in full compliance with the goals of the Government of the United Republic of Tanzania to bring reliable electricity supply to all Tanzanians and to provide the right conditions for sustainable economic development in the rural areas", added the District Commissioner.

The EU Delegation Head of Natural Resources, Mr. Gianluca Azzoni said: "This project is yet another showcase of Europe's commitment to help ensure access to affordable, reliable and modern energy services not only to Tanzanian households in remote settlements but also to agricultural enterprises, businesses and public infrastructures. By 2018, the EU funds in this project will see several Mini-Grids installed providing electricity to 11,000 households, 2,600 agricultural enterprises and businesses, and more than 80 public infrastructures (schools, clinics, religious buildings)."

Mr. Lazaro M. Kabunga, the Chairperson of the Bwisya Village Power Committee, said: "We are extremely grateful for the collaboration with JUMEME. We are not only expecting a general improvement of living conditions at household levels, but also a boost of economic activities. We acknowledge the fact that JUMEME is a private company that charges the real cost for the provided services. The costs are significantly lower in addition to the better quality compared to the energy sources we have been using up to now."

### Background:

JUMEME was founded in 2014 to develop, build, own and operate rural Mini-Grids in Tanzania. The company is a partnership between INENSUS, a leading German company specialized in development, technology and consultancy services on rural mini-grids, TerraProjects, an Austrian specialist in renewable energy project development, and St. Augustine University of Tanzania, an independent higher learning institution based in Mwanza. Just recently, RP Global, an Austrian developer, investor and operator of renewable energy projects, joined JUMEME as the newest and largest shareholder.

The modular design of the power stations allows for a constant extension with growing electricity demand, making it possible to supply electricity to any existing or future customers such as shops, workshops and small to medium sized industrial users, in addition to households and public infrastructure. This enables customers to make full use of their development potentials while creating fair returns for JUMEME and its investors, thus ensuring long-term viability and scalability of the approach for the benefit of all parties involved.

To ensure successful implementation of the projects, JUMEME has joined forces with a number of experienced project partners: GVEP International, an NGO providing energy advisory services to micro, small and medium energy enterprises, the Sustainable Business Institute (SBI), a German research institute focusing on sustainable economies, and Excel Hort Consult Ltd., a Ugandan agribusiness and development company.

For more information on the project visit these websites:

RP Global: <http://www.rp-global.com/> INENSUS: <http://inensus.com/en/home0.htm>

TerraProjects: <http://www.terraprojects.at/> SAUT: <http://www.saut.ac.tz/>

GVEP: <http://www.gvepinternational.org/> SBI: <http://www.sbi21.de/index.php?id=10&L=1>

EHC: <http://excelhort.com/>

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## Building a sustainable "last-mile" distribution network of off-grid solar for the BOP in Kenya



### ST100 + DIGITAL TV

- 6 lights
- Battery 12V/80Ah
- Solar Panel 100W
- TV 24 Inch digital (DVBT2)
- Phone Charging Kit
- DC/AC Inverter
- Wiring cables included
- Installation service provided

### Sun transfer Solar Centres

1. Loitokitok Solar Centre -	0720 333 102/0733 397 795
2. Sultan Hamud Solar Centre -	0722 174 371
3. Nanyuki Solar Centre -	0718 226 836
4. Tala Solar Centre -	0706 243 948
5. Nairobi Solar Centre -	0704 227 229/ 0714 921 999
6. Narok Solar Centre -	0704 229 390
7. Kajiado Solar Centre -	0716 516 747
8. Trans-Mara (Lolgorian) Solar Centre -	0791 479 346
9. Voi Solar Centre -	0706 243 931
10. Kibwezi Solar Centre -	0792 344 865
11. Homa-Bay Solar Centre -	0717 929 520
12. Ewuaso Kedong Solar Centre -	0717 929 401

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Pata solar kwa malipo ya pole pole

Kenya Power Solar PV – Diesel Hybrid Mini-Grid  
in Lodwar Town, Turkana County



# A Ray of Hope for Kenya Off-Grid Citizens to Get Electricity

It is 19:00h local time in a village somewhere in Turkana County, Kenya – 100km from the county headquarters, Lodwar, where the nearest mini-grid is located. The sweltering sun has gone down and you come back to your house from the daily toil in building the nation. Supper is served in the common family room, lit by a paraffin tin lamp. Paraffin for lighting is difficult to get in this village these days due to the heavy rains which have cut off the road infrastructure, and it is expensive too: You have to pay about 1.5 times more for a litre than in the capital city, Nairobi, which is 780km away. The little paraffin that is available has to be used sparingly. You reach out for the family dry cell powered radio to catch up with the latest news only to realize the batteries have run out

of charge and need to be replaced. Your son, who is in class eight, preparing for his final primary school exam informs you that his Mathematics exercise book needs to be replaced too. You send your son and his little sister to the local shop to purchase the exercise book and a pair of dry cell batteries.

## **Kenya Power Solar PV – Diesel Hybrid Mini-Grid in Lodwar Town, Turkana County.**

The little ones return after ten minutes and inform you that the shop is already closed as the shopkeeper ran out of paraffin. You can't even reach him via mobile phone since your handset is out of charge and at the local barbershop, where the villagers usually charge

their phones the diesel generator broke down a week ago. It is yet to be brought back from Lodwar, where it was taken for repairs. With no other option, your family goes to bed at 20:00h, hoping for a better day in future – if not for you, then at least for your children. This is your way of life for as long as you have been living in this village, you are used to it anyway.

However, there is a ray of hope for such remote off-grid villages in getting connected to clean energy through solar hybrid mini-grids. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH through the Promotion of Solar PV Hybrid Mini-Grids (ProSolar) project aims at assisting private sector companies in developing and operating solar PV hybrid mini-grids (SHMGs) in Kenyan off-grid areas. The project's objective is to improve the electrification of remote areas in Kenya with the participation of the private sector. It furthermore contributes to the improvement of the regulatory framework governing electricity supply in Kenya. Institutional support is provided to public as well as private sector actors to strengthen their capacities in implementation and operation of sustainable and environmentally friendly SHMGs.

GIZ ProSolar has received additional funds from UK Department for International Development (DFID) through the Energizing Development (EnDev) programme, to further support private mini-grids project developers through the provision of Results

Based Financing (RBF) incentives. The RBF project will be implemented by Barclays Bank of Kenya (BBK) with GIZ ProSolar providing technical support and monitoring. GIZ ProSolar together with the other stakeholders (Ministry of Energy and Petroleum (MoEP), the Rural Electrification Authority (REA) and respective County Governments) have already identified some sites for the development of SHMGs. Interested private project developers are competitively bidding for these sites by submitting technical and financial development proposals to BBK.

Successful bidders will sign RBF incentive contracts with BBK, source for project finance, acquire all applicable permits for power generation, distribution and supply, and then develop the SHMGs. Incentives will only be paid to the project developers upon achievement of the pre-agreed results with BBK. The incentives will be based on SHMG project commissioning, number of connection made to the customers and the amount of energy delivered to the supply village. The RBF programme will support up to 20 SHMGs in the off-grid counties. So far three sites in Turkana County (Kataboi, Lolupe and Naduat) have been selected as the pilot projects. The advertisement for expression of interest to develop these sites has been published and currently proposals are being received from shortlisted companies. A recent visit to these sites with the prospective project developers, local leaders and the county government confirmed the need for electricity supply.

*The off-grid residents are very much looking forward to these village mini-grids – to light up their premises and power up their devices and businesses...*



Lolupe Trading Centre in Nakalale Ward, Turkana County – one of the villages targeted for development of a SHMG supported by the GIZ RBF programme.

The off-grid residents are very much looking forward to these village mini-grids – to light up their premises and power up their devices and businesses; the county government and local leaders are

supportive as they appreciate the challenges, needs and opportunities of clean energy supply; and the private sector is ripe to invest in off-grid SHMGs in Kenya. Through the RBF programme, the off-grid citizens can dream of a brighter future.

*Jackson Mutonga,  
Project Officer – GIZ ProSolar Project.*

## Special Feature

### Infrastructure Top 50 – Mibawa Suppliers



**Mibawa solar solutions  
transform lives.**

Mibawa Suppliers is a social business, providing borehole solutions that include equipment supplies and service, as well as providing off-grid solar solutions for low-income villagers across Kenya. From its head office in Nairobi, Mibawa's six-year tenure has matured into an unparalleled understanding of the market and its needs, which it facilitates through its network of 80 distributors. These efforts have raised Mibawa onto an international platform, having received recognition and patronage from President Barack Obama.



Under the leadership of CEO Michael Wanyonyi, this hard-fought enterprise continues to bring trailblazing service to some of the most remote regions in East Africa. As Michael explains, "we have improved people's lives by easier access to ground water and more efficient and cleaner lighting for rural folk.

"We endeavour to provide the best workmanship within the timeframes or deadlines prescribed by our clients. Within this, we have sought to deal with reputable product manufacturers and partners."

With their innovative solutions being devised through a reliance on constant feedback from their grateful clients, Mibawa Suppliers has achieved a great many feats of construction, all in the interests of enlightening areas of East Africa most in need of it. This has led them into partnership with prestigious organisations, providing invaluable enhancements to their work.

"We partnered with the US African Development Foundation (USADF) and the Global Village Energy Partnership (GVEP) in providing over 5,000 home lighting kits to homes across rural Kenya, thereby bringing a great deal of positive change to the affected clients."

Such cooperation and assistance from international organisations has proven to be a valuable learning experience for the young company. "We learned that building strong working relationships with such partners involves a lot of hard work, patience and credibility." Indeed, Michael believes that in the wake of this joint venture, the dramatic impetus for the company will spur them on to establish further relationships, and further expand their mission.

Since then, Mibawa have continued to provide their pioneering services to communities across the country. It is, doubtless to say, a difficult and task to cover an area as vast and challenging as rural Kenya, but this has not deterred Michael.

"We have recently rolled out over 25 borehole solar pumps in Machakos County in Kenya. We introduced solar inverters to power the already existing pumps, which were previously run on less sustainable generators and mains electricity. For community projects, this would be the best solution since it involves a simple one-time cost.

Commenting on the business ethic at the heart of Mibawa, Michael explains concisely, "we attempt to understand the client's needs so as to customise our solutions to their requirements where possible." Alongside this flexible attitude to dealing with special cases and unique circumstances, Mibawa unveil their vision for the future in the form of a product package known as the Solarpack 3.

The design of the Mibawa Solarpack itself is revolutionary, for incorporating such compact and flexible design into such an affordable unit. Including a 3-watt solar panel alongside a 4,000mAh battery and two 0.9-watt bulbs, with a total of 12m of cable, it has proven dramatically popular among Kenyan villagers with smaller properties and less space to light up.

The Solarpack's components are specifically designed for consistent high performance in the Kenyan sun, using the latest technology that solar panels have on hand to extend battery storage and remove potential issues; the environmentally friendly package offers an eco-friendly solution that eliminates the need for paraffin. Michael realises that a one-time investment in a long-lasting product is far more cost-effective than the constant, regular purchasing of paraffin. In rural areas of Kenya, where disposable income is less available, this difference can be expected to make a dramatic impact on not only the general lifestyles of Mibawa's clients, but also upon their health.

This does not come without its challenges, though. "In the off-grid solar kits, we faced high default rates on the Pay-As-You-Go platform, because the product's security features were weak."

However, the mark of a great innovator is the ability to rectify faults and use that experience to end up with a radically better product. This is certainly the case for Mibawa, as this initial challenge "led to a change of strategy in terms of seeking and introducing a better product."

While their work in supplying renewable energy to over 20,000 off-grid households is a large enough feather for most caps, Mibawa has also become central players in the ongoing effort to provide rural communities with water equipment solutions. Access to clean water remains a huge challenge to rural Kenya, but with interest in clean solar energy on the lips of eager investors across the globe, the prospects of expanding their enterprise look promising for Michael and Mibawa.

Being involved in projects alongside international organisations and government agencies, Mibawa have constructed water treatment plants in addition to conducting hydrological surveys of vast swathes of Kenya. To date, Mibawa have equipped over 100 boreholes with pumping systems, including some that utilise solar power. Extracting water from up to 200 feet below the ground, to be pumped into vast storage tanks, is a fully automated operation that, Michael believes, is destined to transform the way that many rural Kenyans live their lives, from Dadaab to Wajir to Turkana.

With a future plan based around continued sustainable growth injected by increased foreign investment, Michael suspects that increased competition in the market is on the not-too distant horizon. As to the ambitions of his company, Michael states humbly that hitting the USD 1,000,000.00 sales turnover by the end of their financial year would be a major milestone.

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# We Share Solar Suitcases Light up Schools in Kenya and Uganda

By We Share Solar

A rapidly-growing, award-winning program is bringing solar light and power to youth in Kenya and Uganda, and will be entering new partnerships to expand its reach.

We Share Solar has been providing light and power to schools, orphanages and community centres in Kenya and Uganda since 2013 through its award-winning We Share Solar Suitcase®. We Share Solar is the education-focused program of We Care Solar, an NGO based in the United States. We Care Solar works to improve maternal health outcomes in regions of the world where there is not reliable electrical access. To date, We Care Solar has installed over 1,500 Solar Suitcases in health clinics and medical facilities in over 27 countries. We Care Solar also provided solar suitcases for disaster relief in Nepal, the Philippines, and Haiti.

The We Share Solar Suitcase® incorporates design principles and components from the We Care Solar Suitcase®. Like the We Care system, it is a self-contained, portable, and largely “plug and play” 12 Volt DC solar electric system that provides LED lighting and charging for mobile phones and other devices. It can remain mobile or be installed permanently, as it is housed in a watertight and dust-resistant high density polyethylene case built for harsh conditions. When the system is permanently installed, the case is mounted to a wall and functions as an electrical cabinet. The system is rugged, durable and built with high quality components. The maximum solar input is 250 watts with a maximum current of 15 amps and an operating voltage of 11.4 to 14.4 volts. Typical Solar Suitcase systems are installed with a 100 watt solar panel and a 24 to 40 amp hour sealed battery. The Solar Suitcase was designed by Dr. Hal Aronson (co-founder of We Care Solar) and Brent Moellenberg (We Care Solar engineer). Hal has taught students, electricians, and technicians about solar energy for 20 years. The We Share Solar Suitcase is similar to the We Care Solar Suitcase except that the wiring is designed to maximize student learning of solar electric circuits. The We Care Solar Suitcase is yellow in color and the We Share unit is blue.

We Share Solar is a hands-on education program that gives youth a chance to link technology with service learning. We Share Solar provides a project-based curriculum for secondary students in the

United States to improve STEM (Science, Technology, Engineering, Math) skills, solar energy knowledge, and awareness of energy poverty in the developing world. Teachers trained in the We Share Solar Curriculum create rich learning experiences for their students, who assemble Solar Suitcases from a kit of high quality parts. Solar Suitcases are put through a rigorous professional quality control inspection before deployment. The final stop of the Solar Suitcase journey is deployment to an energy-scarce region of the world with placement at a school, orphanage, or community centre. We Share Solar has deployed 230 Solar Suitcases worldwide since 2013; 40% of these in Africa. As the program expands, it is focusing on partnerships in Kenya and Uganda.

In April 2016, We Share Solar and its partner organisation, Change Mtaani, provided 19 Solar Suitcases to 11 schools in Machakos County, Kenya through a collaboration with the Machakos County Ministry of Education. Change Mtaani, a CBO based in Kibera, has led installations for We Share Solar for the past three years. Founder Brian Inganga and a team of youths from Kibera were trained by We Share Solar on solar suitcase installation, site assessment, project monitoring, and end-user training. Hon. Faith Wathome Kithu, Minister of Education for Machakos, helped select and make arrangements with the primary and polytechnic schools in her district that were most in need of electrical access. Each Solar Suitcase comes with four to six 5 watt LED lights that can light up to three rooms from one system, as well as charge e-readers, tablets, mobile phones, projectors, and laptops. Brian Inganga tells of a memorable interaction during the Machakos installations, “our best moment was at Uuni Primary School when the caretaker told us how challenging it is getting light in the classrooms. We were told when it is dark (during daylight), kids go outside where you can see the blackboards to learn.” Uuni School now has a Solar Suitcase to provide lighting inside the classroom. Teachers and students from Machakos schools will benefit from the Solar Suitcases by allowing teachers to prepare lessons with light and power, giving pupils better conditions for studying, and making the schools safer. Over 1,600 people will benefit this year from the 19 Solar Suitcases recently installed in Machakos.

We Share Solar aims to maximize sustainability





# Solar E-Cycle – An e-mobility innovation for Africa



**T**he Solar-E-Cycle is a new transportation device powered by renewable solar energy aiming to provide competitive low-cost accessible transportation to fast growing populations in Africa. It uses off-the-shelf parts (PV panels, batteries, bicycle frames and ebike motors) to create the lowest cost 4-wheel transportation device that does not require fuel.

This solar light electric vehicle takes advantage of upward trends in performance of solar and electric vehicle technology, downward trends in costs and increased global concern with both global warming and economic disparities, especially on the African continent where most of the world's population growth will occur during the next century.

The product has a proven daily range of at least 50km using only the sunlight falling on the vehicle. It can comfortably carry 3 people and baggage for a total of 100kg. The product is also a power generator on wheels with 3000Wh of daily generation and storage capacity. The product performance, safety and location are continuously monitored using advanced GPS/GSM technology for power management and vehicle tracking including driver supervision and geo-fencing. The company calls upon low cost Asian manufacturing using off-the-shelf parts to avoid capital-intensive investment.



40 billion hours of labour each year are spent hauling water, 71% by women and girls. 84% of households are without piped potable water risking waterborne preventable diseases one of the world's most urgent health issues. In 32 Africa countries more than 50% of the population earns less than \$2/day. Less than 3% of individuals have access to bank loans. Greenhouse gas from petroleum fuels in power generation and transportation contribute to global warming. With 4 billion more people on the planet by 2099, mostly in developing countries such as in Africa, power generation and transportation will increase global warming.

As a transportation device it will empower women by reducing the toil of fetching water and get children to school. It can be a medevac with solar fuel that is always available. With very low maintenance it is not

a burden to be left by the wayside because of lack of cash to pay fuel, lubricants, mechanics, etc.

The intermediate outcome of the project is:

- i) Reducing the workload of women and girls;
- ii) Increasing the time available for education for rural children;
- iii) Improving access to potable water;
- iv) Creating economic opportunities in rural areas;
- v) Increasing family revenues

## Market situation

Lack of power infrastructure in off-grid communities hinders the economic development of families and small businesses in rural areas. Around 1.5 billion people, or more than a fifth of the world's population, have no access to electricity, and a billion more have only an unreliable and intermittent supply. Of the people without electricity, 85% live in rural areas or on the fringes of cities. Extending energy grids into these areas is expensive: the United Nations estimates that an average of \$35 billion-40 billion a year needs to be invested until 2030 so everyone on the planet can light their premises, and have energy for productive uses such as schooling. Despite major efforts, on current trends, however, the number of "energy poor" people will barely budge, and 16% of the world's population will still have no electricity by 2030, according to the International Energy Agency. International donors, national and local governments are not able to provide infrastructure to populations in off-grid areas and private financing has barely reached the energy poor. Energy-poor also lack mechanical means of transportation and ways to finance it. Even buying a bicycle is near impossible and involves years of savings.

Three market segments are targeted. Personal transportation needs of individuals, enterprises and communities through a monthly lease equivalent to \$1 a day, the ecotourism sector through daily rental via tourism operators and direct sales.

A 10 year target for this project is a fleet of 70,000 bicycles generating 25,000 leasing days, revenues of \$12 million. Over 100 MW of power installed, 100,000 tons of CO<sub>2</sub> emissions avoided, 1.5 million jobs.

## Current status

The EEP support has been instrumental in undertaking a pilot project in Kenya to test the field performance of the Solar-E-Cycle. Solar E-Cycles Kenya Limited (SECK) has been formed as joint venture between OFGEN Limited and STEINRICH CYCLES S.A.R.L to promote the SEC activities. The pilot phase of the project is estimated to last 24 months with 70 vehicles assembled locally and tested in various locations (both urban and rural) of Kenya. The company intends to scale-up the vehicle assembly plant in Kenya and operations into East Africa after the successful pilot phase. A 10 year target for this project is a fleet of 70,000. Over 100 MW installed of PV capacity, 100,000 tons of CO<sub>2</sub> avoided, 1.5 million jobs created and 30 million people empowered.

In collaboration with Strathmore energy Research Centre, a prototype has been built. This is for purpose

of testing the components procured before finally putting the order through with the manufacturers in china.

## Innovation

The Solar-E-Cycle is an integrated solution from hardware to institutional design. It is a three-in-one solution to provide energy for rural families, small businesses and communities. It is an off-grid power system, a solar powered transportation device and a hybrid financing mechanism for the forgotten "energy-poor". The photovoltaic panels of the Solar-E-Cycle are a least cost solution to bring power to off-grid areas, without the high cost of distribution. The innovative advantage of the Solar-E-Cycle is the multiplying effect brought about by fuel free mobility and power in the same device. The financial barrier to access the Solar-E-Cycle is removed by leasing the vehicle while delegating the management of the lease to existing local micro-finance institutions minimizes distribution costs.

The ultimate outcome of increased mobility and providing power consists in economic empowerment of families and small businesses in off-grid areas. The value of the electricity generated has an economic value 10 times the investment in the Solar-E-Cycle.

The product itself is made up of least-cost components with very little manufacturing. Lead-acid batteries are the least expensive energy storage device. The vehicle is nearly entirely recyclable as it is mostly steel, copper and lead. Use of proven technologies ensures reliability and low maintenance costs almost anywhere.

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Initial public financing establishes core capital for the first five years. Future cash flow streams over a long life-cycle are attractive to private investment guaranteeing long-term sustainability. Without manufacturing facilities the organization is very light relying on experienced microfinance institutions for commercial operations.

## Challenges

In Kenya, specialized solar equipment and accessories are classified as exempt from import taxes (customs duty, excise tax, VAT, Import Declaration Fee and Railway Development levy). We need the support of regulatory agencies to ensure that our vehicle is regarded as a "specialized solar equipment" and as such exempt from import taxes.

Further, the Traffic Act, Cap 403 has no classification for such vehicles in Kenyan roads which would be considered as Light Electric Vehicles (LEV) under which the Solar E-Cycle would fall into.

The Kenya Climate Innovation Centre is providing us with the policy advocacy support to overcome the above challenges.



# NESELTEC LTD.....

**N**ESELTEC LTD, a Rwanda based company with a well established reputation in Off-grid electrification through Solar Lanterns and Solar Home systems is piloting a 30 KW Solar Mini Grid in partnership with EEP. We also supply, commission and maintain thermosiphon solar water heaters in Rwanda.

One in five people around the world, approximately 1.3 billion people, lack access to electricity. NESELTEC LTD propose a new approach to end energy poverty that is founded on a clean energy model of delivery and reflects real world investment opportunities and needs. Taken in sum, we believe this approach—Solar Mini Grid —represents the easiest, most effective means of delivering on energy access goals, and we urge public and private financiers to align investment priorities accordingly.

The Rwandan Government is working to achieve 70% of electricity access of which 48% of the households will be connected to the grid by 2018,

while at the same time supporting the development of a range of off-grid technologies like Solar Mini grids which will connect 22%.

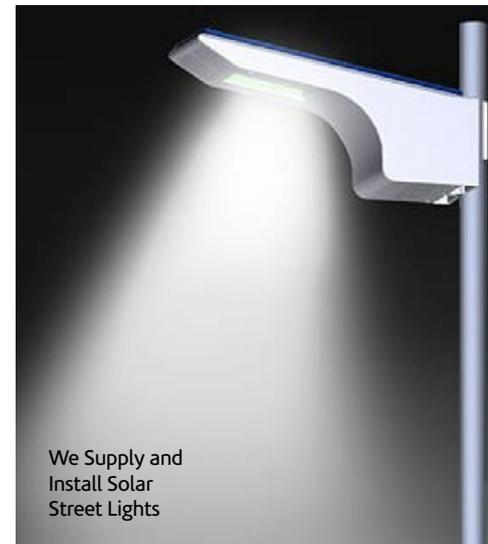
In its RWA9083 project, EEP supports NESELTEC LTD to develop a 30KW pilot Solar Mini Grid in Eastern province, Kirehe district, Mpanga sector, Rubaya Cell, Rushonga Village at Rushonga local market place. The latter is surrounded by than 400 homes and 40 Small businesses.

The project will make 200 connections by the 2 first weeks of June 2016. Other homes will be served in future after increasing the capacity of the Mini grid.

To scale up the RWA9083 EEP financed project, NESELTEC LTD is seeking to develop more than 35 Solar Mini Grid of 30KW minimum each in Rwanda. These Mini Grids will provide electricity to more 20000 rural families. Investment requirements for scalup is \$9,758,873



RWA9083 EEP project site



We Supply and Install Solar Street Lights



We supply, Install and maintain Solar Water Heaters



Poles for Mini Grid distribution network



# Azuri Technologies Overview

**A**zuri Technologies is a commercial provider of PayGo solar home systems to rural off-grid households. With the widest reach of any provider in sub-Saharan Africa, the company is addressing the problem of energy access that affects 600 million people who lack access to the grid. Azuri has combined solar and mobile technology to allow customers to access power on a pay-as-you-go basis, providing affordable, clean and safe renewable energy for as little as half the cost of the fossil fuels being replaced. Azuri is at the forefront of new technology innovation, providing a reliable service alternative to the grid for rural households, delivering lighting, phones, radio, and TV in affordable packages.

## Smart Solar Lighting takes off first in Rural Africa

### HomeSmart™ intelligent solar home systems set to transform rural energy access

In recent years, small solar home systems have brought power for the first time to millions of off-grid consumers in sub-Saharan Africa, thanks to technological advances in LED lights and mobile payment. The systems store power during the day and provide light, phone charging and other services at night. But all solar home systems have the same problem: on days where there is insufficient sunshine, the systems turn off early at night time, leaving households in darkness. It is difficult for customers to have confidence that the light will work all night – a

situation rather like the “range anxiety” often found in electric car users.

Azuri Technologies’ HomeSmart™ is the first use of intelligent automation in small solar home systems, designed to provide light every night even in cloudy daytime conditions, and effectively eliminate “solar range anxiety”. HomeSmart™ first works out a performance target by monitoring the customers’ typical power usage. This becomes the performance the system aims to achieve under all conditions.

At night, if sufficient stored power is available, the system operates like normal. However, if the stored power is reduced, (because there was insufficient sunshine during the day), the system automatically adjusts the brightness of lights and the rate of phone charging in order to meet the duration of light that the customer is used to. These changes are normally imperceptible to the eye. In this way, HomeSmart™ brings anxiety-free “permanent light” to consumers for the first time.

Conventional solar home systems work well in full sun but on cloudy days, most will turn off early at night, leaving households in darkness. This uncertainty is one of the reasons distributed power is often not considered “proper energy”. Customers require certainty that when the light is switched it will come on, irrespective of whether the previous day was sunny or cloudy. It is possible to manually dim systems but few people do. The challenge is to have a fully automatic system that delivers just the right quantity of power all through the night. This is what HomeSmart™ does.

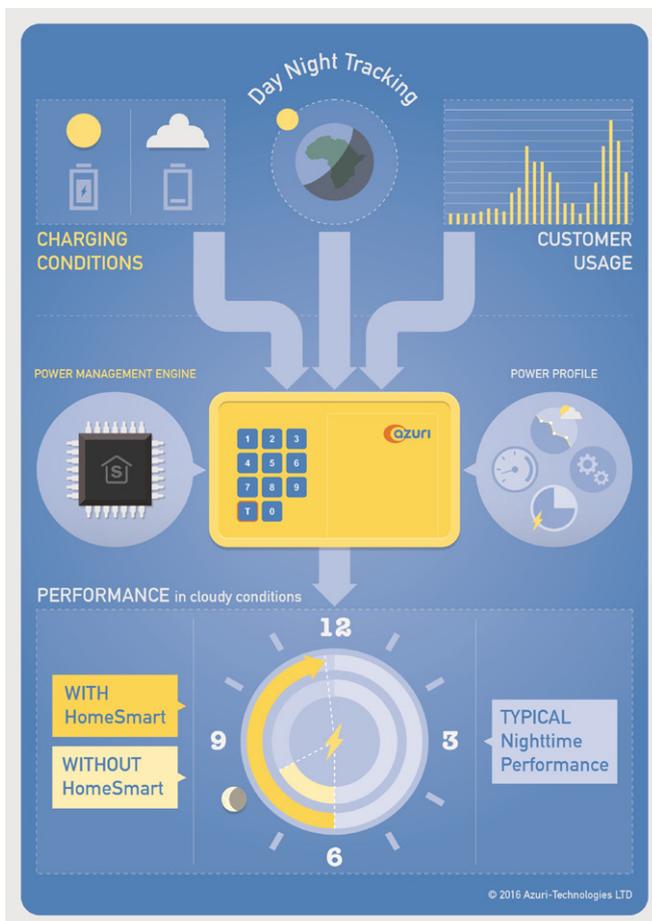


The system actively monitors customer usage to determine a typical expected performance. Then, by accurately monitoring the climatic conditions, the system automatically adjusts the light brightness

to meet the user's expected lighting duration. This active optimisation of light brightness, battery charging and load conditions ensures the system delivers the best possible match to the customer's typical daily requirement with the available power. For example, if a customer typically uses power morning and evening, the system will automatically slightly dim the lights in the evening on days when there is less sunshine to ensure power is still available in the morning.

This is an example of "reverse Innovation", where the latest technology is delivered first in emerging economies. Azuri aims to deliver a simplified, highly accessible service that delivers tailored benefits and peace of mind for each customer. The service aims to invisibly integrate into the customer's lifestyle so that they can enjoy the experience that the technology enables.

Azuri is the only company to have developed adaptive smart metering applied to small solar lights. Most solar home systems run until the power is exhausted and then switch off. In poor weather, this may mean lighting time is reduced to just a few hours, forcing customers to revert to traditional means such as harmful kerosene. While we are beginning to see the idea of self-learning intelligent automation appear in high end households in developed countries, this is the first time that such intelligent technology has been applied to entry-level solar home systems. In a developed nation, intelligent automation may save around 25% of energy costs. Whereas, in off-grid communities it's the difference between being able to see at night and not.



# Takamoto Biogas brings modern lifestyles to Kenyan farmers through clean, reliable cooking fuel

## Summary

*Takamoto Biogas in Kenya provides collateral-free biogas and other farm tool loans to Kenyan farmers. The reduced up front investment in a bio-digester enables more Kenyans than ever before to transition from wood based cooking fuels to clean, renewable biogas, saving them time, money and keeping them healthy. While biogas is the ideal technology for farmers who have waste and require energy, it has been a challenge to find a reliable biogas company to provide the service they are looking for. Takamoto Biogas has worked to develop partnerships with key farming stakeholders in Kenya to bring biogas to the villages where farmers have already been desperately looking for biogas for years.*

By Laura Schutter

**T**akamoto Biogas provides Lease-to-Own Biogas to farming families in Kenya. Unlike typical investments in renewable energy, Takamoto Biogas is an affordable, reliable and renewable energy solution to any farmer with cows and the spirit to try something new.

The majority of rural households in Kenya cook with wood based fuels - specifically firewood and charcoal - which are causing deforestation in the long run, but in the more short term, they are wreaking havoc on the lungs of rural women and the walls of their kitchens. 4.3 million deaths per year are attributable to indoor air pollution from cooking fuels (WHO, 2014). At the same time women using firewood and charcoal are twice as likely to suffer from cataracts in their lifetime compared with women using clean fuels like biogas (Case-control study of indoor cooking smoke exposure and cataract in Nepal and India).

Takamoto Biogas founder, Kyle Schutter, initially launched Takamoto Biogas to provide a lifetime of free biogas for a one time fee of KES 100,000 (approx. 1,000 USD). During a farmers' meeting in Central Kenya Schutter recalls, "I was in the middle of my presentation when a farmer from the group stood up holding the sample contract I had passed around for a biogas system installation and announced, 'I want one, when can I get it?' He had already signed the sample contract."

While the enthusiasm for biogas was quite clear, it was rare that any farmer could produce the necessary financing to install a biogas system. This experience was not unique for Takamoto Biogas. Overall, Kenya has drastically lagged behind other nations in investing in biogas.

One of the main barriers to an even greater outreach of domestic biogas in Kenya are a lack of financial capital as well as lack of awareness. However, two other include 1) low utilization of

newer, pre-fabricated digester technologies and 2) a lack of business model innovations.

The opportunity for biogas in Kenya is significant as there are 2 million families raising dairy cows or pigs who could benefit from a biogas system. To make a comparison, in Nepal, the biogas penetration is 49% of dairy and pig farmers while in China it is 15% and Vietnam is 7%. Currently the biogas penetration in Kenya is only 0.5% (Energy for Sustainable Development 15 (2011) 347–354).

In order to begin to approach the penetration levels in other parts of the world, Schutter developed Lease-to-Own Biogas. Lease-to-Own Biogas enables a farmer to purchase a bio-digester in a way that matches her income by making payments over a period of time. Farmers make a small initial investment for the installation of the biogas system after which they pay a monthly fee which is equivalent to what they were previously spending each month on firewood, charcoal and/or LPG gas for cooking. Once they have fully paid for the biogas system, they will have free, reliable cooking fuel using only the waste from their cows.

The biogas system is an 10 cubic meter "one size fits most" that can be installed in a single day by a trained team of biogas technicians. The biogas system is installed on the farming family's property and the biogas is stored in the system itself until its time of use when it is piped directly to the kitchen for cooking. What the farmer now has, is a power generating facility right on their own property. They are no longer plagued by the changing prices of wood based fuels, or the blackouts caused by the electricity companies or even the shortages that often occur in rural areas of cooking gas. A biogas system empowers a farmer to control their own energy in a sustainable cycle that allows them to focus their energy on income generating activities on the farm.

Takamoto's 10 cubic meter digester is the ideal size for a typical family in rural Kenya producing six hours of cooking fuel everyday which is enough for preparing three meals a day and heating water twice a day for milking the cows. To produce this amount of gas per day, the customer needs to have 2 cows, which is one of Takamoto's specific eligibility criteria for new customers, and which all of their current customers also have.

Although biogas can be used for chick brooding, water heating and lighting, the highest energy need in rural Africa is cooking. Biogas is the perfect fuel for cooking as it burns with a high temperature and is easy to control with an on off switch so no energy is wasted. The bio-digester itself is made of a PVA "bag"

digester that has experienced a lifespan of over 20 years in China.

Takamoto's digesters are made of a PVA bag-digester that has experienced a lifespan of over 20 years in China. Since the bio-digester is prefabricated, it is the ideal loan product that requires no collateral from the farmer. If the farmer defaults on the loan, the digester can be removed, and the farmer will not lose any of his/her cows, her house or any other possible collateral that they otherwise had to put up for a conventional biogas system.

For payments, Takamoto Biogas makes use of the popular mobile money, M-Pesa, which allows a farmer to make her monthly payment from anywhere at any time from her phone.



Takamoto Biogas sales team with biogas digester (Source Photo: Frontier Marketing)

Takamoto is developing another payment model through which a farmer can request that a monthly deduction be made from her milk payments from her dairy cooperative called a "checkoff". This ensures that the loan will be paid automatically every month, and the farmer faces no risk of the biogas system being removed. This payment model offers nearly unlimited opportunities for the farmer to access other necessary products for a farm on a monthly payment basis. Through a study of their own customers, Takamoto Biogas found that on average a household with a biogas system reduced their energy expenditure by 13%, saved over 40 minutes per day, and reduced deforestation by 2.7 trees per household per year. Finally, as women are the primary users of biogas,

it is important to note that now 43% of Takamoto clients are women as compared to only 3% when they provided biogas at a single fixed cost.

The reduced cost of Lease-to-Own Biogas empowers women to make decisions about the energy they use and the health of their families. According to Schutter, when Takamoto Biogas recently arrived at a homestead to install a biogas system and found out that the customer had not paid the full installation fee yet, the woman of the household immediately picked up the phone to call a few friends and within 10 minutes the whole fee had been paid and they started installation. "You could see there was no way she was letting this opportunity to have biogas slip away!" he says.



Women biogas training (Source Photo: Laura Schutter)

Due to the nature of micro financing and the high demand in Kiambu County (a single dairy cooperative in the region has over 10,000 members), this affordable biogas product has only been available to a limited number of farming families. But with over 200 families now using (and making monthly payments for) Takamoto Biogas, developing partnership in

Kenya and abroad is the next critical step for the company. "There are millions of women right now cooking with dirty fuels and wasting their precious time trying to light a charcoal stove or firewood, and it is truly unfair to limit biogas to only those who live in a single village due to the capacity of this start-up company," emphasizes Schutter.



Woman cooking over biogas in Githunguri, Kenya

Takamoto Biogas has already begun working in partnership with financing institutions including a grant from the Bill and Melinda Gates Foundation and the Climate Innovation Center in Kenya that financed the first pilot project of their affordable biogas. Additional funding from EEP (The Energy and Environment Partnership Programme), AECF (Africa Enterprise Challenge Fund) and National Geographic Great Energy Challenge have supported the launch of the company's scale up. Today, anyone can become a financial partner by lending as little as \$25 to a farmer towards their purchase of a biogas system on the Kiva website ([www.kiva.org](http://www.kiva.org)). As the burden of financing the digesters now lies on Takamoto, these partnerships are critical.

In addition to financing, Takamoto Biogas is developing installation partnerships enabling the company to more quickly educate farmers about biogas and provide their services in new regions of

Kenya. For many women, this is the first time they have ever cooked over gas in any form so local staff who share both the culture and the local language of the biogas user provide trainings and follow up visits ensuring a smoother transition for the farmer to the new fuel.

With a high demand for biogas across Kenya, and growing success in Kiambu County and its environs, Takamoto is not in lack of potential customers. Furthermore, Takamoto is in the process of creating partnerships to replicate its business model in other regions of the country where there are eligible customers for whom the switch to biogas would make financially good sense.

If you want to get involved with Takamoto Biogas as they propel farmers into the new age with cycles of quality products and affordable financing, get in touch: [info@takamotobiogas.com](mailto:info@takamotobiogas.com)



# Ecowaste to Energy

**B**y the year 2100 the world's population will be producing over 11 million tonnes of waste per day – three times more than it does today. Urban areas are going to face significant consequences – physical, fiscal and environmental – unless, city managers implement policies that transform consumption and, more importantly, waste disposal. Changing how people use and reuse materials is in many ways beyond the control of city management; however they are able to ensure that, through municipal policies and projects, the disposal of solid waste is done in a manner that benefits the city, its people and the environment.

## A local context

The eThekweni municipality serves the City of Durban which is the largest city in the South African province of KwaZulu-Natal. It is the third largest metropolitan municipality in South Africa and it provides municipal services to nearly 4 million citizens and approximately 1 million households. eThekweni municipality is home to, arguably, the busiest port in Africa; so as a result has many important economic sectors (transport, motor industry, tourism and agriculture) that are well established within its region. The eThekweni Municipality has hosted numerous global conferences, world sports events and Durban is the host city for the 2020 Commonwealth Games.

The municipality finds itself in the challenging position that many municipalities in developing nations find themselves: the responsibility of delivering world class facilities, whilst at the same time having to deliver on basic services to a large portion of the population that is without services and unable to afford these amenities. Historically, parts of the city have little to no

infrastructure and the financial and logistical burden of introducing services to these areas falls onto the municipality. The City also has the challenge of using outdated existing infrastructure and at the same time trying to be competitive and comparable with other metropolitan municipalities throughout the world that are using up-to-date and innovative technology. The eThekweni municipality has to balance service delivery with constant advancements in different sectors, whilst all the time being conscious about being cost effective and environmentally sound.

## Waste Disposal

Part of the services offered to the citizens of the Municipality is the weekly refuse removal from over 85% of its households and the receiving of solid waste from local industries. The city is serviced by three landfill sites. One of the sites is Bisasar Road Landfill site and is Africa's largest landfill site and has been in operation since the 1970s. The landfill reached its maximum capacity in January 2016, so as a result is no longer accepting municipal waste at the site. The Municipality is now faced with the added logistical and financial pressure of transporting solid waste to the other landfill sites that are located on the periphery of the city.

The eThekweni Municipality Launched a progressive methane landfill gas project at the Bisasar Road Landfill site. The project is still in operation and has been very successful, however the methane derived from the landfill is approaching its lifespan. This flagship project was highly acclaimed for its innovation when it was started, and shows the progressive nature the municipality adopts in dealing with its waste issues.



## 'W2E'

In response to the imminent closure of the Bisasar Road Landfill site, the Municipality sought different options to deal with the waste that would normally have been sent to the Bisasar Road landfill. The Municipality was looking for initiatives that specifically handled the approximately 40 000 tons per annum of green waste (biomass) that was disposed of at the site. Ecovate was able to identify a solution that would be able to convert the 40 000 tons per annum of biomass into energy, prevent it going to landfill, and thereby also reduce the logistical and financial pressure of transporting the waste to other landfill sites across the city.

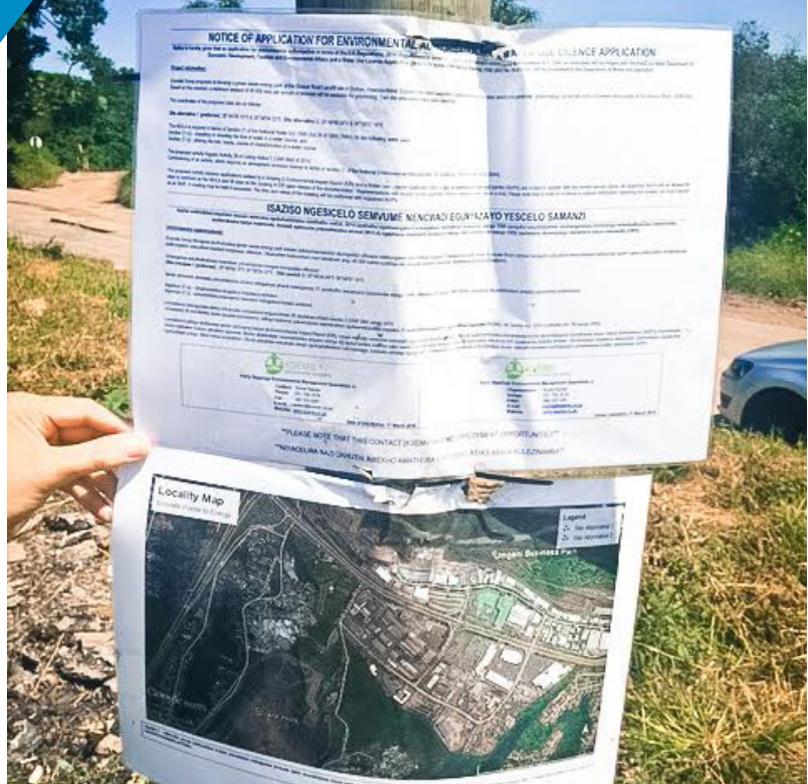
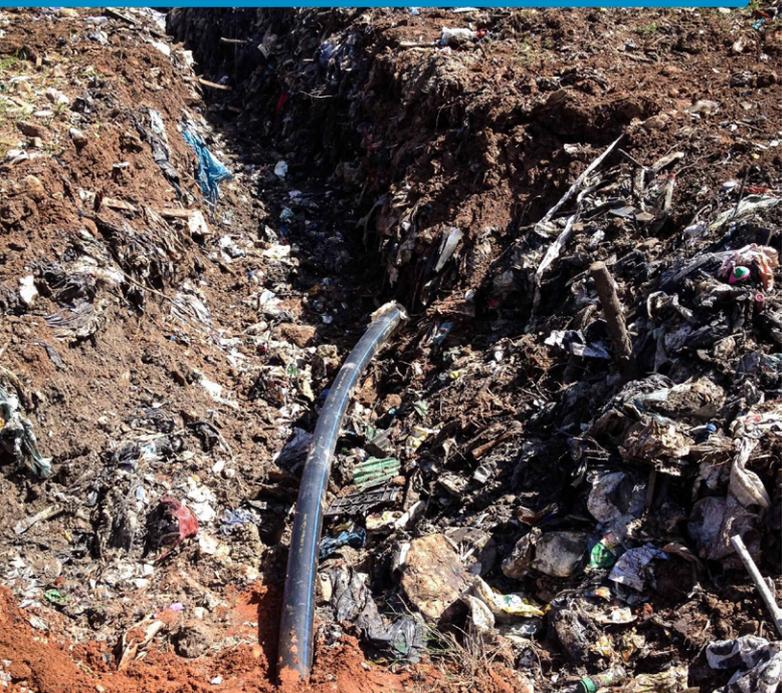
Ecovate proposed the Bisasar Road Waste to Energy (W2E) Initiative, and this has been endorsed by the eThekweni Municipality. At the time of writing, this W2E Initiative is at the feasibility stage where it is being assessed from environmental, financial and engineering perspectives. It is expected to be implemented in 2017.

Ecovate, is a young and creative start-up business in Durban, South Africa, looking at innovative ways of dealing with waste reduction and energy production. Though the company has a footprint in the United Kingdom in the energy efficiency sector, the founders being South African, wanted to return to South Africa with some of the expertise gained from overseas. The founders of Ecovate were, moreover, raised in the city and have returned to call Durban home again. So, coming up with a solution for their home city was obvious. Ecovate is, consequently, in the advantageous position of being able to draw on their experience with new technologies and

projects from their dealings outside of South Africa, and yet also having the local insight to translate that experience into the Durban context. Ecovate was able to understand the unique circumstances and needs of the eThekweni Municipality and was able to find a practical solution to address the challenge specifically of waste disposal.

The Bisasar Road W2E Initiative that Ecovate proposes will convert the green waste (biomass) into energy by using gasification technology. A high pressure thermal breakdown process will break the biomass down into its composite parts and syngas will be produced. The syngas in turn will be fed into generators which will produce electricity that will be fed into the national grid. Initially the project is expected to produce in the region of 1.4 megawatts (MW). Once operating at full scale the plant is expected to have a power generating capacity of up to 4MW. To reach the full scale potential of the project, extra volumes of biomass will have to be sourced. When considering the engineering plan of the project, a focus has been placed on identifying constant volumes of additional biomass waste streams that can feed the project. A possible additional source of biomass that has been identified is the *Eichhornia crassipes* (more commonly known as Water Hyacinth) an aquatic plant which is not endemic to the region but grows prolifically and congests local river systems, impacting negatively on the local riverine habitat. The Water Hyacinth has already clogged the uMgeni River, which flows close to the Bisasar Road Landfill site and this project potentially, with the removal of this alien invader, can help address this issue.

An additional challenge on the engineering plan has been around the preparation of the feedstock,



so that the gasification technology is fed with a homogenous biomass feedstock that is well prepared and contains no foreign waste streams that might affect the efficiency of the system. The engineering plan has adopted an extensive sorting and preparation process in making the biomass optimal to be fed into the gasification system.

The applications for the necessary environmental permits to operate at the site and to use the technology are well under way. Ecovate is still finalising the Scoping Report; however, it is important to note that because of the process of gasification, gas emissions will be produced so an air emission license is needed. However, owing to the nature of the chosen technology the air emissions from the plant are expected to be below allowable levels, and below the Methane Gas Landfill Project that is currently operating on the site. Whilst the environmental approval process is notorious for being lengthy and arduous, due to the nature of the biomass feedstock and the technology that has been chosen, no major environmental triggers are anticipated.

The Bisassar Road Landfill W2E Initiative will be located on a portion of the 'full' Bisassar Road Landfill site, because the proposed site is a previous landfill site its future use and development is very restricted. Therefore this project will make use of land that has restricted or limited future use.

### Community development

The community surrounding the landfill site has had a challenging past. The community has raised objections, at some stages, with formal protests to the developments and, most notably, to the extension of the lifespan of the landfill in the past. Ecovate is committed to engage with the local community by looking at the positive impact this project will have on the local community by uplifting the area. The specific impact of this project on the local community will be looked at during the socio-economic assessment incorporated in to the environmental impact assessment. The project will further uplift the area because it will create in the region of 50 job

opportunities that will require skilled and unskilled labour. Adjacent to the landfill site is an informal settlement. Ecovate has undertaken to fill jobs on the site from the local community and to uplift and, as far as possible, up-skill members from this community from unskilled to skilled job opportunities that will be created by this project.

### A sound business model

The business model of the project is also a challenge that has been addressed in the development of the W2E initiative. The generated power is to be fed into the national grid. The energy supplied by the project is aimed to be taken by an industrial off-taker. With the South African national grid being under immense pressure, problems with disruption of supply and large tariff increases, a supply of electricity that is constant and not linked to tariff escalation should be appealing to industry. Added to that, the benefit of a constant supply is the appeal that the electricity they are using is 'green' and non-fossil fuel based. This allows the off-taker the opportunity to reduce their carbon footprint. An additional benefit of being the off-taker of this energy is the marketing and promotional opportunities of the off-taker using renewable green energy. Investigations into possible off-takers is at a preliminary phase and will become a major focus as we progress further through the feasibility plan of the project. However, interested parties have been identified and have expressed an interest in supporting this W2E Initiative.

The project will be producing energy from a renewable source and will also be helping to build the local green economy and helping with job creation. This W2E Initiative will be one of the first ventures of its nature in the eThekweni Municipality and aims to be a pioneering catalyst to similar projects that look at renewable sources of energy in the local region and extending to the rest of South Africa. The W2E Initiative is also in line with South Africa's commitment to the Kyoto Protocol to reduce greenhouse gas emission. The W2E Initiative also fulfils the requirements of the Clean Development Mechanism

*The project will be producing energy from a renewable source and will also be helping to build the local green economy and helping with job creation.*

(CDM). The CDM allows industrialised countries with emission-reduction commitments to meet part of their commitments by investing in projects in developing countries that reduce greenhouse-gas emissions while contributing to the local sustainable development needs of the host country. The implementation of the CDM falls under the Designated National Authority (DNA) created by Section 25 of the National Environmental Management Act passed by the South African parliament in 2004.

Furthermore, the goals of this project of adopting a renewable energy source, boosting the 'green' economy, job creation, and making electricity available to the population by feeding the generated electricity into the national grid of South Africa, are all aligned with the goals of the Energy and Environment Partnership/Southern and East Africa (EEP). So a natural fit has occurred in trying to deliver this project.

### **The Energy and Environment Partnership/Southern and East Africa**

The EEP has provided grant funding for the Bisasar road W2E Initiative feasibility study; the funds are allocated to investigating the high-level feasibility of the project. The desired outcome of the funding is to produce a bankable project after the completion of a thorough feasibility plan. The funds have allowed the interrogation of the engineering, environmental and financial aspects of the project. The funding is

vital in investigating the technology and to predict its performance in the local, South African and African setting. Whilst, similar projects and the technology have proven track records outside of South Africa, those assumptions cannot be guaranteed with specific South African conditions (biomass, climate, and infrastructure). So extensive investigations into the performance of the project and the technology on the specific eThekweni Municipality conditions have been undertaken due to the feasibility plan and the funding allocated to Ecovate through the EEP. This will help to increase the success of the project and limit risk. EEP has allowed the project to move from a concept to a viable project, with ultimately the development of a bankable project that through which funders will benefit.

### **Looking Forward**

Ecovate, in partnership with the eThekweni municipality, aims to contribute meaningfully - through its Bisasar Road W2E Initiative - to the greening of the city, the uplifting of a disadvantaged community and the implementation of 21st technology in the Gateway to Africa.

For more information on the project or how to get involved, please contact David de Wet, Managing Director of Ecovate on [david.dewet@ecovategroup.com](mailto:david.dewet@ecovategroup.com).





## Solution for municipal waste menace

**B**io2Watt is currently operating the first industrial scale waste to energy facility in South Africa and possibly Africa, it generates 4.4MW of power from waste making use of anaerobic digestion technology. The power is being sold to BMW SA roughly 60kms from the site in Pretoria within the greater City of Tshwane. This plant is also the first of its kind where an Independent Power Producer is selling power to an industrial outside of the government renewable energy program, where the financing is placed on BMW's balance sheet rather than on the fiscus.

Based on our success with the Bronkhorstspuit Biogas Plant Bio2Watt has been approached by large industrial players as well as large cities from across the continent to replicate this model, including Kenya. The drivers for this type of project have been diverse including diversifying energy mix from traditional fossil fuel technologies to labour intensive renewable energy technologies, importantly an improvement in the management of organic waste has been another

draw card. The spin offs are considerable both in terms of a cleaner environment and job creation.

Our company has recently received in principle approval from two major international funders to build a further 5 plants in Africa followed by a further 5 over the next 5 years. Bio2Watt is currently exploring opportunities in a number of large African cities.

It is our view that given the high price of electricity, and the lack thereof, all over the continent, coupled with the problems associated with waste in all major African cities. Waste to energy technologies such as biogas will help preserve the environment while at the same offer a decentralized renewable energy solution in peri-urban areas of the continent where grid power is often unreliable, and thus negatively impacting economic growth for those areas.

Bio2Watt's model requires it to take development risks thus carefully looks at opportunities before committing it's resources to developing a project.



# Biomass gasification

Cummins Cogeneration Kenya Limited is a Special Purpose Vehicle (SPV) of Cummins Cogeneration Limited (UK) (CCL), which was established in late 2012 to pursue the development of a 10MW Biomass based power station in Marigat Sub-county, Baringo County and other biomass based power plant sites in Kenya. The power plant utilizes Biomass integrated Gasification Combine Cycle (BiGCCC) technology which is a best breed technology with the lowest environment footprint.

The primary objective of CCKL is to set up combined-heat-and power (CHP) plants based on producer gas where suitable biomass is available at a viable price. The first project under implementation is in Marigat, Baringo County, Kenya. The power plant is utilising *Prosopis juliflora* (Mathenge) to generate and supply 10 MW (Phased) of power to the national grid under a PPA with Kenya Power. Besides jump starting a local economy by providing employment to a marginalized population, the Baringo project will showcase the producer-gas or synthetic gas (syngas) engines developed by Cummins Power Generation.

There is ample supply of *Prosopis* trees in the area and the company has formed alliances with the locally registered Community Based Organizations (CBOs) or self-help groups (SHG) to supply the power plant with biomass fuel. These CBOs are the biomass supply partners for the life of the project and CCKL is continuously training, assisting, empowering and equipping the CBOs or SHG to harvest and transport biomass to the plant site. This will ensure that the right quality and quantity of biomass required is delivered on a daily basis. Other CCKL owned project within Kenya target to use bagasse, sugarcane trash and other agro-residues to generate power.

## 1.1. Project Concept:

The CCKL project concept is based on the following simple premises:

In several semi-arid areas of Kenya, there is a significant and growing "unwanted/alien" biomass resource, in the form of the introduced and increasingly invasive thorny tree *Prosopis juliflora* commonly known in Kenya as "Mathenge", and more commonly internationally as "Mesquite". The



tree is a leguminous (nitrogen fixing) member of the Mimosa family, which originates from the countries surrounding the Caribbean Sea. The rapidly widening infested area around Lake Baringo is the closest infestation to major areas of population in Kenya, and the location where it is believed to be particularly seriously affecting the indigenous rural population most severely. CCKL therefore believes that the wood produced by removing and/or coppicing *Prosopis juliflora* can form the main feedstock for a sustainable biomass to power electricity generating station.

The exotic tree was introduced into Kenyan drylands in the early 1980s to provide fuel, fodder, stem soil erosion and desertification. However, the tree has since become an invasive weed, threatening, rather than improving local livelihoods. Left on its own, *P. juliflora* replaces native vegetation and takes over rangelands. Dense stands of *P. juliflora* can block irrigation channels, obstruct roads and block smaller trails completely.



As such, *P. juliflora* was in 2008 declared a noxious weed in Kenya under the Suppression of Noxious Weeds Act (CAP 325). Under this Act, the Minister for Agriculture can compel land owners with such noxious weeds to remove them.

However, mathenge's effect has not all been negative. The tree produces strong wood, good for fencing posts, timber, construction poles, charcoal and firewood; pods for fodder and flour; the bark makes strong rope; and the trees prevent soil erosion.

## 1.2. Locally and internationally

CCL(UK) is a utilities company established by Cummins Corporation to commercialize the use of various types of gas, including landfill gas, natural gas, and syngas (produced by gasifiers) to generate electricity. Cummins management in the UK have indicated their strong support for CCKL, which will be their second and larger syngas based generation project. Their interest is such that they expect to duplicate the business model elsewhere in Kenya and other parts of Africa, where invasive bush infestations offer the potential to build a multi-million dollar energy business.

The population around Lake Baringo area have shown willingness and are indeed keen to support the CCKL power plant in the long term, by cutting and delivering biomass, as the land occupied by *Prosopis juliflora* is presently unavailable to them as pasture and crop land due to the rapid blanket infestation of the bush. *Prosopis juliflora* wood cutting to supply the power plant provides attractive cash income to the community which is hard to find, and where traditional methods of earning such as cattle and goat herding are often no longer available due to the lack of accessible pasture and increasing population.

The business has received a lot of publicity and has attracted requests for proposals from various potential clients like CEC in Zambia, Uganda Electricity Generation Company Ltd, James Finlays Tea, the Sugar Cane sector, and Kenya Nut Company. CCKL has also attracted other investors who wish to take part in subsequent projects within Kenya and sub-Saharan Africa. CCKL targets to achieve 120 MW of installed capacity in Kenya in multiple sites.

## 2. Key features of the project

- 10 MW biomass based power plant (8 MW export minimum to KPLC).
- Location: Marigat, Baringo District, Kenya
- Input: *Prosopis juliflora* wood sourced within Marigat
- Hourly consumption: 10 tonnes/hour of chipped biomass
- Output: Sale of power to the Kenya Power and Lighting Company (KPLC) under long term contractual Power Purchase Agreements (PPA)
- 20 year project life
- 330 day operation – 7,920 hours/year.

### 2.1. Gasification

Gasification is the conversion of solid or liquid material such as coal, petroleum or biomass into a gas for use as a fuel. It is a thermo-chemical process that converts solid carbonaceous materials into combustible gases. This is done at high temperatures with a controlled amount of oxygen.

The process of converting biomass into combustible synthetic gas such as methane, carbon monoxide and hydrogen is undertaken through a four stage process of dehydration, pyrolysis, oxidation and cracking and reduction.





## 2.2. Biomass integrated Gasification Combine Cycle (BiGCC) technology

BiGCC is an advanced power generation technology which allows reduction of emissions of nitrous oxides (NO<sub>x</sub>), Sulphur dioxide (SO<sub>2</sub>), and particulate matter and improve fuel efficiency of biomass, coal and other appropriate forms of fuel. It is a combination of two technologies:

- Biomass gasification, which uses mathenge wood to create a clean-burning gas (syngas).
- Combined-cycle, which is the most efficient method of producing electricity from gas commercially available today. Cummins low-BTU, lean-burn natural gas generators generates the electricity.

### 3. P. Juliflora harvesting arrangement:

The harvesting system CCKL has adopted is meant to encourage community organisations (CBOs) and self-help groups, with limited but defined financial and equipment support from CCKL, to organise cutting of the bush by hand and chainsaws, and for farmers to transport the wood, by a variety of methods to local collection centres in each sub-location, using head loads, draught animals and community owned tractors and trailers.



Biomass is then transported to the power plant from the appropriately located collection centres in each sub-location by CCKL own fleet of long haul tractors. Additionally, the project is supported by CDTF funded tractors and trailer for transporting biomass from farm gate to the collection centre.

### 3.1. Soft start

CCKL has been supporting the CBOs with working capital and equipment as well as business management and operations trainings. The community organisations are tasked with the responsibility of eventually accumulating enough working capital from cash advances to sustain own biomass purchasing and harvesting operations. The CBOs are supposed to metamorphosis from CBOs to business enterprises within a year in order to be profit oriented and sustainable.



### 3.2. Benefits Of Biomass For Electricity Production

Biomass energy production is one of the key support areas that the Government is promoting. Unlike other sources of energy, biomass encompasses and tackles socio-economic issues, environmental as well as technology requirements. Details of such benefits include:

- Biomass based power generation is the only form of renewable energy which creates large socio-economic impact as the fuel is sourced from the local vicinity. CCKL's 10 MW plant utilizes over 2000+ farmers and has jump-started the local economy with employment and establishment of support services. The plant has a potential of creating 100 internal jobs and over 2500 indirect jobs.
- Plants can be set-up in any location where biomass and power consumption can be aligned.
- Generation of electricity can be planned based on consumption and has limited dependence on climatic conditions, unlike solar and wind power generation.

- Single or a combination of different biomass sources can be used to generate electricity. The use of agricultural residues like maize cobs, organic briquettes and macadamia shells are such viable alternatives.

**3.2.2. Environmental**

- There is zero-discharge unlike coal, heavy furnace and diesel power stations and the technology has two by-products: i) biochar which is used as soil amendment and ii) heat which is used for biomass drying or thermal applications i.e. heating.
- Only a limited amount of civil work and space is required. Plant can be commissioned within 40 weeks from licensing and funding.
- No fossil fuel is required to start or run the plant.
- Limited water requirement and most of the used water is recycled.

- Charcoal dust or biochar is suitable for soil improvement, as a fertilising agent and for water retention. Also, the biochar might be used as activated charcoal for medicinal applications.

**3.2.3. Technical**

- The product is completely modular. This allows the generation to be scaled up, down or moved, based on requirement. The plant size can start from 100KW and upwards.
- Reliable with longer plant life.
- Low construction cost.
- Good turn-down capability with start/stop flexibility.
- Limited site electricity consumption.
- Gasification technology is able to capture upwards of 70% of the biomass's efficiency as compared to +/- 30% from steam-turbine technology.



**4. Community Financial Benefits In Biomass Harvesting**

Charcoal making is the main commercial use of Juliflora at present. The calculation below shows that harvesting Juliflora for biomass increases the income of locals significantly:

<b>COST BENEFIT ANALYSIS: CHARCOAL VS BIOMASS</b>					
	<b>CHARCOAL</b>			<b>BIOMASS</b>	
<b>Revenue</b>	10 bags charcoal (equiv. 2200 kgs biomass)	<b>4,500.00</b>	<b>Revenue</b>	2200kgs	<b>4,400.00</b>
<b>Cost</b>	<b>Item</b>	<b>Unit rate</b>	<b>Cost</b>	<b>Item</b>	<b>Unit rate</b>
	Powersaw hire	900.00		Powersaw hire	900.00
	Pruning	400.00		Pruning	600.00
	Arranging	400.00		Trans.	220.00
	Covering	400.00		CBO fees	660.00
	Watering	400.00			
	Uncovering	400.00			
	Cooling	400.00			
	Carrying sacks	500.00			
<b>Total cost</b>		<b>3,800.00</b>	<b>Total cost</b>		<b>2,380.00</b>
<b>Profit</b>		<b>700.00</b>	<b>Profit</b>		<b>2,020.00</b>
<i>NB: Days to payment</i>		7			2

Immediate benefits to a farmer include:

- i. Profits of between Kshs. 4,000 and Kshs. 6,000 earned per trailer load after selling at Kshs. 1800/- to 2300/- per ton depending on the moisture content.
- ii. Tools and equipment for harvesting and transportation provided on request
- iii. Less labour and time required to harvest biomass
- iv. No pollution or health risk associated with smoke.

Benefits to the community at large include:

- i. Employment opportunities for both skilled and unskilled labour
- ii. Economic upgrade of Marigat Sub-County through the mushrooming of small and medium enterprises/businesses.
- iii. Control of the invasive menace *Prosopis juliflora* while at the same time protecting indigenous tree.
- iv. Profit accrued by CBOs will benefit community members who do not own any Mathenge trees in the form of welfare projects such as boreholes, cooperative etc.

Other Benefits;

- i. CCKL has partnered with CDTF to provide free tractors and chains saws to assist the CBOs in the harvesting and transportation of biomass from farms to collection centres.
- ii. CDTF and CCKL have also partnered to equip one of the partner CBOs with briquetting equipment for organic and carbon briquette manufacture. This will create additional jobs.

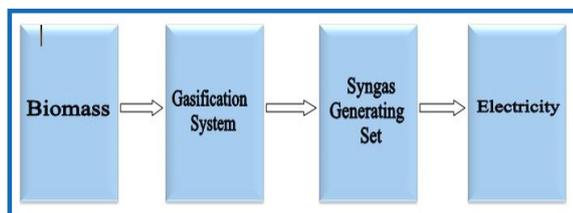


- iii. The CBOs with assistance and training from CDTF are in the initial stages of forming a cooperative society that will incorporate all members of the CBOs. The cooperative will be open to all other community members.
- iv. CCKL has also partnered with Hand in Hand Eastern Africa NGO which is offering free training to the partner groups in business management and accounting as well as in other income generating projects such as bee keeping

### 5. Generation process:

In the last few years, there has been tremendous research in the field of gasification and the use of reciprocating engines to generate power from the gas. Initially, the producer-gas generated in the gasifier was used to partially replace diesel in diesel-generating sets (a 60:40 mix, for example. Later, spark ignited engines that run exclusively on producer-gas were developed.

Biomass is processed and fed into gasification reactors and all the volatile compounds are released in gaseous form including tar leaving behind carbon or char dust. The crude gas from the system is cleaned using scrubbers and filters to produce clean producer or syngas. The gas is condensed and channelled to the gas-sets where it's ignited to run reciprocating engines which in turn rotate the alternator generating electric power. The process is as illustrated below:



Mr Yash Krishna the Managing Director of CCKL is upbeat about the role that biomass-based cogeneration could play in provision of energy in Kenya. He is especially upbeat about the use of *P. juliflora*. "It's a win-win scenario, turning this plant menace into an income generator for local communities."

# BURN Sells 150,000th Jikokoa™ Cookstoves in Kenya

By Ame Igharo and Boston Nyer



**T**he jikokoa™, is a clean burning charcoal cookstove, designed by BURN who also manufactures and distributes the cookstove. BURN produces the jikokoa™ in its first of a kind, modern manufacturing facility for improved cookstoves in Nairobi, Kenya. BURN's factory is the largest of its kind on the continent and was launched through an Energy Efficiency Program (EEP) grant.

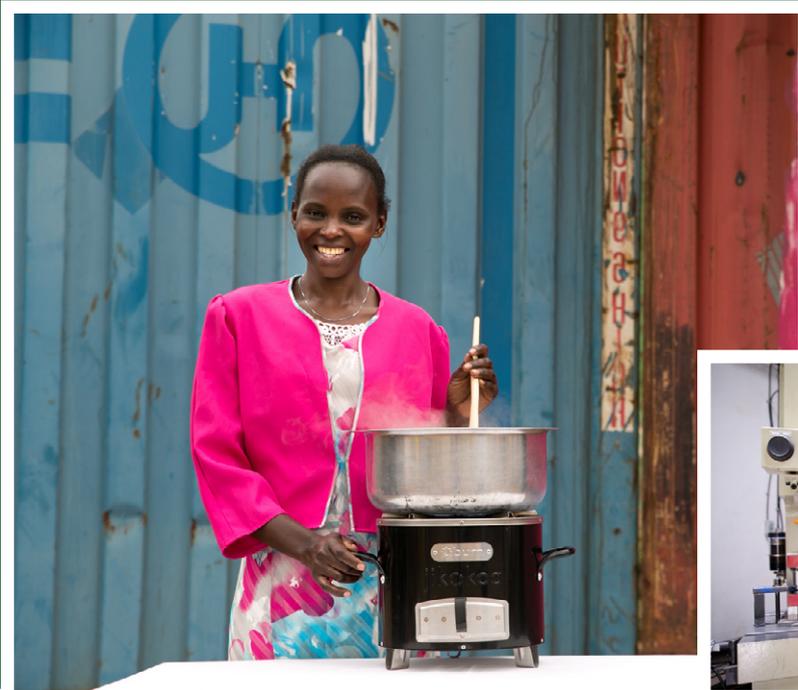
In April 2016, BURN celebrated producing and selling its 150,000th cookstove. The company continues to break records in Kenya in its mission to create clean-energy products that improve the lives of their customers, employees, and all living creatures. BURN intends to sell 3.45 million improved cookstoves over the next 10 years. To date, while creating 407 jobs, BURN has changed the lives of 850,000 people, saving them over \$17 million in fuel costs while also saving 332,000 tons of wood and 587,000 tons of CO<sub>2</sub>.

The jikokoa™ continues to be sold through a number of innovative distribution channels, including more than 400 retail points in Kenya, 100 Equity Bank branches, and through fellow Acumen investee company M-Kopa where the jikokoa™ is their most popular product after solar panels. In

2015, BURN expanded its distribution by becoming a KIVA Field Partner. This partnership has allowed BURN to support its small-scale distribution partners in East Africa by providing them with loans to buy 50-150 stoves at once which reduces their shipping and handling costs, thereby increasing their profits.

BURN is successfully reaching customers and generating retail demand for its stove via a variety of marketing channels including on-the-ground activities, radio, and via product placements on Kenya's number one TV show, Papa Shirandula. As a result, the jikokoa™ is now #1 clean cookstove in Kenya. The EEP funding that BURN received was a critical element in its ability to meet customer demand as its brand awareness increased through its successful marketing efforts and word of mouth from happy customers.

The EEP funding allowed BURN to create Sub-Saharan Africa's first modern cookstove manufacturing facility, thereby reducing the cost of each stove and bringing BURN closer to commercial viability. This led BURN to reduce their gross margin from -35% to +30% within 6 months. The local production model improves upon the typical cost structure of manufacturing in China by 10%. The factory allowed



*"This innovative stove reduces women's exposure to cooking smoke and helps them to save time and money on fuel collection."*



BURN to easily scale as demand increased and the EEP funding was the lynchpin for major investments from US OPIC and the Acumen Fund totaling \$2.25 million USD.

BURN will leverage the factory to expand into new markets with new products. This past December, BURN was announced as the first recipient of investment from Unilever's Enhancing Livelihoods Investment Initiative (ELII), which was established to support smallholder farmers and plantation workers. ELII is a partnership between Unilever, Acumen and the Clinton Giustra Enterprise Partnership. The investment of US \$755,000 in BURN will support the launch of BURN's first product line extension – the kuniokoATM, a low-cost, energy efficient, wood-burning cookstove targeted towards rural communities. Paul Polman, CEO of Unilever said; "By 2020 Unilever wants to have a positive impact on the lives of 5.5 million people across our entire supply chain. This first investment into BURN's newly developed wood burning stove contributes to this target, helping to improve the livelihoods of smallholders, particularly women. This innovative stove reduces women's exposure to cooking smoke and helps them to save time and money on fuel collection. Considering that women reinvest 90 percent of their income into their families this will have a ripple effect creating a brighter future for entire farmer communities."

The stove will be sold to smallholder and plantation workers in tea estates in Kenya and Tanzania. Peter Scott, CEO of BURN, said; "Expanding into other product lines has always been part of our strategic plan, but doing so now in partnership with Unilever will allow us to reach a critical market of smallholder farmers and plantation workers that can truly benefit from this product innovation."

BURN has also been recognized for its business operations. In June 2015, BURN received the Ashden Award for Clean Energy for Women and Girls. This award was in recognition of BURN's gender equality

in hiring, which has been achieved through fair and consistent employment practice, rather than quotas or positive discrimination. As a result, today, women hold more than half of the jobs in BURN's state of the art factory. Based on merit, women have achieved equal employment in production and sale of jikokoATM cookstoves.

BURN is known for a very egalitarian culture where male and females serve in the same positions and are paid equally for the same work. All members of the staff feel free to talk to their supervisors and to the management team if they have a problem or improvement suggestion concerning the work. BURN also offers a maternity leave, an annual leave and opportunities for flexible hours for all the employees. The staff is also offered a lending scheme. BURN recognizes that the impacts of gender inclusion go beyond the factory door and have an impact in Kenyan society. Sylvia, a BURN sales activator said "[my husband] used to make decisions for himself because the money was his; now that I have my money, we make these decisions together. He used to tell me what to do, but now I can see some sense of equality."

The next move for BURN is to expand its impact across the East African region. In both Uganda and Tanzania, urban populations rely more heavily on charcoal than in Kenya due to the high cost of alternative fuels. A recent World Bank willingness-to-pay study in Uganda showed that consumers were willing to pay more for the jikokoATM than any other cookstove on the market or being considered for the market, even more than stoves retailing for three times the price.

*To learn more about the project, watch two videos of BURN: video 1 and video 2.*

*An interview at the manufacturing facility with Boston Nyer (General Manager & Co Founder) and fellow employees. Read here>>Want to know more? Visit the BURN website>>*

# Envirofit Women's Empowerment Program – Improving lives with energy and agency

Global Problem, Local Solutions



## WOMEN'S EMPOWERMENT PROGRAM

As **PRIMARY ENERGY USERS**, the direct involvement of women is needed for renewable energy projects to succeed

After completing the Envirofit **WOMEN'S EMPOWERMENT PROGRAM** women outsold men by nearly

# 3:1



**R**ural Kenyan families live in some of the most remote and, by global standards, poor communities in the world. Because of their isolated location they have been underserved by the clean energy sector, however that doesn't mean they should be denied access to life improving products and technology. At Envirofit we believe that everyone should have access to clean energy, and putting this belief into action has meant adapting our approach to reaching people for each market we serve. Expanding from our initial markets in India into urban markets in Nairobi, Kenya required a complete redesign of our flagship model household wood-burning stove in order to meet customer needs in a new market. Reaching rural Kenyans, however, taught us that clean some clean energy problems require cultural as well as engineering solutions.

Rural Kenyans have few other options for cooking besides inefficient open fires. Women in these households spend hours every day collecting fuel by hand or purchasing it with what little money they have. The open fires they cook over waste 90% of the energy produced by the fuel, and expose them to

deadly smoke and particulate matter, together known as Household Air Pollution (HAP). In Kenya, 95% of the rural population uses solid fuel to cook, and HAP contributes to over 15,000 deaths per year. Globally HAP causes over 4.3 million deaths per year – more than HIV, tuberculosis and malaria combined.

### Reaching rural communities

Envirofit cookstoves are designed with input from urban and rural families in order to tailor them to their needs. Details such as the cooking height, handle placement and stove materials were all adjusted to suit local cooking preferences, so it was surprising when we saw lower than expected rates of sales and adoption in rural Kenyan communities. Looking into the problem further, we discovered that the underlying difficulty was finding people who were well suited to be sales agents, and who were willing to stick with it for longer than a few weeks.

As Kenyan women are the ones who most often collect or acquire cooking fuel, and also use it to prepare meals for their families, they are considered primary energy users whose direct participation is

needed for the successful adoption of clean energy technology such as cookstoves. Through this program Envirofit reached out to recruit female sales agents because they understand the challenges of using traditional and rudimentary cooking methods and could speak first-hand to the common barriers to adoption prospective customers voiced. While female sales agents are better positioned to relate to customers, they often have to overcome different challenges to run a successful cookstove business while trying to fulfill traditional roles as a housewife. To help them overcome these challenges Envirofit developed an agency and skill based women's empowerment training program to be able to improve their ability to run a successful business.

Though the training included basic business and sales skills, it was still based on the implicit assumption that the people being trained believed in their own ability to achieve their goals, to overcome the setbacks inherent to starting a new job or endeavor, and to affect change personally and within their community. However this wasn't always the case, and only after addressing these less considered challenges for our female entrepreneurs did we begin to see success in reaching rural families.

### Finding the right message

Whether it's solar lighting, feminine hygiene products, water purification systems or clean cookstoves, selling anything to families who live on only a few dollars a day is difficult. In addition, countries with developing economies often lack defined roles and paths for women to participate in income generating activities, and studies show that women often feel less capable and have greater fear of failure when starting new ventures.

The Women's Empowerment Program is an agency-based empowerment training that helps participants examine aspects of their work and themselves. Each WEP training is crafted to reflect existing socio-cultural norms and values by a local certified trainer, and includes material specific to people starting a new business venture. It is inspiring to see women who are

eager to become entrepreneurs but skeptical of their ability to succeed begin to believe in themselves over the course of the weeklong training. Once equipped with both the skills to sell stoves and belief in their ability to overcome obstacles, Envirofit last mile entrepreneurs began realizing success.

### Inspiring results

Working in partnership with Johns Hopkins and ESVAK, The Global Alliance for Clean Cookstoves funded a study to pilot test Envirofit's program titled "Understanding Impacts of Women's Engagement in the Improved Cookstove Value Chain in Kenya.". The study showed that women who have completed the WEP are proven to sell three times more cookstoves than those who have not, and their customers show higher rates of continued clean cookstove use. The success of the WEP in Kenya was also a valuable learning opportunity for Envirofit, as it demonstrated that though there will always be difficulties when expanding into new markets, they can be overcome by understanding and investing in the communities we strive to serve.

Empowering and employing women as a means of growing sustainable clean-energy markets has proven successful enough that the program is expanding throughout Kenya and beyond. Thanks in part to grant-funding from the EEP, the Women's Empowerment Program has recently grown in East Africa, India and West Africa. In each region we have collaborated with regional partners to tailor the content to meet local needs as we continue to reach underserved communities around the world.

*"Empowering and employing women as a means of growing sustainable clean-energy markets has proven successful enough that the program is expanding throughout Kenya and beyond. "*



# iSmart

*Providing slum communities with access to life-changing products through a sales network of youth and women*



Kenya's main source of energy is wood, which accounts for 70% of energy consumed. The demand for wood and charcoal is so high that there is a deficit of up to 60% of the demand. This is depleting forest and vegetation stocks, accelerating land degradation and destroying essential watersheds and natural habitats for Kenya's extraordinary wildlife. UNESCO reports that Kenya's forest coverage has shrunk from 10% in 1963 to only 1.7% in 2006 - an 83% reduction in total coverage. In addition, the carbon dioxide emissions from burning biomass contribute to global climate change. Rising temperatures and increases in severe weather conditions, such as droughts, affect water supply and crop yields.

Beyond the environmental dangers, burning biomass in traditional cookstoves emits carbon

monoxide and particulates. In a health survey conducted in Nairobi's slums, pneumonia was the primary cause of infant mortality.<sup>3</sup> Fifteen thousand premature deaths are associated with indoor air pollution every year in Kenya, exceeding deaths caused by tuberculosis and malaria.

Kenya also faces high unemployment rates, hampering the nation's productivity, potential and prosperity. High unemployment contributes to instability, social unrest, and high poverty rates. Facing extreme economic challenges, the majority of Kenya's urban residents live in slum communities characterized by high overcrowding, insecurity, and a lack of health, education, and sanitation services. The World Bank estimates that Kenyan unemployment is at 40%, with youth accounting for 70% of the unemployed. Only one in five youth at market-

entry age is in full-time employment and in informal settlements, where official statistics are difficult to obtain, the youth unemployment crisis is highly visible, as many young men and women remain idle.

iSmart's mission is to create job opportunities for women and youth in slums so they can work their way out of poverty and realise their potential. To achieve this, iSmart created a dynamic sales network that employs youth and women from informal settlements to distribute life-improving clean cookstoves and other technologies in hard-to-reach markets.

iSmart's vision is a world in which all families, irrespective of socioeconomic status, have access to high-quality and safe cooking technology. Capitalizing on a market failure in retail distribution to low-income communities, iSmart creates sales jobs through the distribution of life-changing products.

### The three key strategies of the iSmart model are:

**1) Recruitment and Training:** iSmart partners with local, community-based organisations to recruit unemployed youth and women to attend a free, two-week sales and marketing training. Upon successful completion of the training, iSmart offers additional on-the-job training and the opportunity to earn an income as a full-time sales agent with iSmart on a permanent basis.

**2) Product Consignment:** iSmart sales agents attend a mandatory, daily morning meeting which consists of ongoing training, goal-setting and a review of the previous day, after which they check out their consignment of €60 worth of products. This consignment model ensures that agents do not take on any capital risk, thereby protecting them from amassing debt or assuming any risk.

**3) Sales:** Currently operating 11 branches throughout the slums of Nairobi, Kiambu and Mombasa counties, iSmart distributes clean cookstoves, solar lamps and other life-changing products through its door-to-door sales force, pop-up marketing events, and bulk orders to savings cooperatives and other organisations. Our market penetration strategy is proactive in order to reach the target market of slum-dwellers and small businesses.

### iSmart is a Proven Model

Since 2011, when iSmart was founded in Kenya, the organisation has opened 11 branches and created jobs for 850 individuals. What started as a project for urban youth in one Nairobi slum has now grown to provide training and job opportunities for women and youth across three counties.

With funds from EEP in 2015, a successful pilot was launched in Limuru, a peri-urban town in Kiambu county. In addition to surpassing the EEP project goals in terms of job creation and clean cookstoves distributed, the project was completed ahead of schedule. Through the EEP-funded Limuru pilot, iSmart brought 5,273 clean cookstoves to low-income households in 2015, while simultaneously improving operations and efficiency across the organisation.

Soon after the Limuru pilot was completed,



iSmart opened its first branch in Mombasa, located 480 kilometres from Nairobi on Kenya's coast. The Mombasa branch was iSmart's first attempt at replicating its model in a new geographic location, not easily reachable from the Nairobi headquarters. The branch has already tripled its performance targets since its first month in operation, and exceeded all recruitment and employment targets.

### The people behind the model

iSmart's model is designed to create job opportunities for youth and women, regardless of education or experience, so they can work their way out of poverty and realize their potential. Compensation is a combination of commission-based payment at the end of the month and weekly team-based bonuses. This structure provides incentives for both learning to budget monthly earnings with expenditures, as well as incentives to increase sales and collaborative teamwork.

Since 2011, iSmart has trained 1,900 youth and women and employed 850 individuals as sales agents. Sales agents earn an average income that is above the international poverty line of \$2 per day, and some earn up to \$10 per day. The sales agents also save 10% of their income that can be used for unexpected emergencies or future investments in property, education, or entrepreneurship. The experience and skills sales agents gain through working in a formal environment can be leveraged for a lifetime of gainful employment.

Francais Owuor has been an iSmart sales agent for five months. "iSmart is my first job. I was on my way to church when I saw the poster on a tree, and asked myself 'Why don't I apply?' so I came on Monday, was interviewed, then started training the following Monday. It was easy to become an agent. Two weeks later I was selling products alone out in the streets." Francis looks young, but he is full of ideas. He is a hard worker but found that when he left school and wanted to find a job, it was impossible to get one without knowing someone. He says, "with iSmart there's nothing like that." Francis sells clean cookstoves, solar lamps and other household products to customers around Kawangware, the sprawling informal settlement that he calls home. As with many agents, the majority of his customers are women, who make

*With the Jikokoa, produced by Burn Manufacturing, the main cookstove product we sell, consumers can save up to 15,000 KES (\$150) a year on charcoal.*

the decision to purchase a cookstove to improve their family's health, save money, or save time.

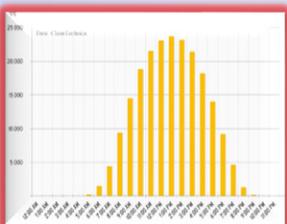
Zachariah recently bought a cookstove from an iSmart sales agent, and explains the motives behind this purchase, and the impact it's had on his family's life. "I bought my cookstove two months ago for my wife, when she was about to have a baby. I didn't want all that smoke around her and the new baby, and I wanted her to have more time with the children, instead of always having to go out and buy charcoal, and having to clean ash and soot from inside the house. It was a headache having to always buy charcoal, and it would fill the house with smoke. Now we use half the amount of charcoal, and there's no smoke. My mother has come to help with the new baby, and she tells me she loves our cookstove, and my mother-in-law too. With the money I save on charcoal I hope soon to buy the same for both of them."

Clean cookstoves reduce charcoal consumption by 50%, saving low-income customers money that can be used on other critical needs such as food, housing

or school fees. With the Jikokoa, produced by Burn Manufacturing, the main cookstove product we sell, consumers can save up to 15,000 KES (\$150) a year on charcoal. The Jikokoa also reduces cooking time by an average of 50%, freeing up time for productive activities or income generation. Reduced emissions of smoke and carbon dioxide emissions can lead to improvements in the health of household members, especially women and children who often bear the brunt of these health problems. The reduced charcoal use and emissions associated with the cookstoves that iSmart has distributed since 2011 have prevented approximately 211,200 trees from being cut down, and avoided carbon dioxide emission equal to taking 31,134 cars off the road.

Thanks to the EEP grant for 2015, iSmart has begun expanding outside of Nairobi, and has continued this growth into several other areas of the country in the first half of 2016, including Mombasa and Thika. Between now and 2020, iSmart will expand to 38 locations across the country, whilst looking to bring the same environmental and employment solution to the wider East African region.



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