

Micro-grids: Best Practices around Technology Challenges

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Panelists Richenda Van Leeuwen, Executive Director, Energy Access, UN Foundation
Matt Orosz, President/Director of STG International
Tristan Kochoyan, Founder of Power:On
Michelle Klassen, Vice President of ZeroBase Energy
Matt Basinger, Founder and Director at Advancing Engineering, Indonesia

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Sean Hello everyone. I'm Sean Esterly with the National Renewable Energy Laboratory, and welcome to today's webinar, which is being hosted by the Clean Energy Solutions Center in partnership with the United Nations Foundation Energy Access Practitioner Network. Today's webinar is focused on showcasing the panelists' respective organization experience around various technology challenges and solutions pertaining to micro-grids and to discuss and contrast the specific geographic contexts along with providing collective best practices.

One important note of mention before we begin is that The Clean Energy Solutions Center does not endorse or recommend specific products or services. Information provided in this webinar is featured in the Solutions Center's resource library as one of many best practices resources reviewed and selected by technical experts.

I just want to go over some webinar features; you do have two options for audio. You may either listen through your computer or over your telephone. If you do choose to listen through your computer, please go to the audio pane and select the "mic and speakers" option. If you choose to dial in by phone please select the telephone option in the audio pane and a box on the right side will display the telephone number and audio PIN you should use to dial in. Just a reminder, panelists we ask that you please

mute your audio device any time you are not presenting. If anyone is having technical difficulties with the webinar, you may contact the GoToWebinar's Help Desk at the number displayed at the bottom of the slide. That number is 888.259.3826.

We encourage anyone from the audience to ask questions at any point during the webinar. To do that simply type your question into the question pane and we will receive it and present it to the panelists during the Q&A session at the end. If you are having difficulty viewing the materials through the webinar portal, you will find PDF copies of the presentations at cleanenergysolutions.org/training and you may follow along as our speakers present. Also, an audio recording of today's webinar will be posted to the Solutions Center training page within about a week of today's broadcast and we are also posting to the Solutions Center YouTube channel where you will find other informative webinars, as well as video interviews with thought leaders on clean energy policy topics.

Today's webinar agenda is centered around the presentations from our guest panelists Richenda Van Leeuwen, Matt Orosz, Tristan Kochoyan, Michelle Klassen, and Matt Basinger. These panelists have been kind enough to join us to showcase their respective organization's experience around various technology challenges and solutions pertaining to micro-grids, discussing context and geographic context and collective best practices.

Before our speakers begin their presentations, I will provide a short informative overview of the Clean Energy Solutions Center Initiative. Then, following the presentations, we will have a Question and Answer session moderated by Dan Schnitzer. The panelists will address questions submitted by the audience and then finally closing remarks and a brief survey for the attendees.

This slide provides a bit of background in terms of how the Solutions Center came to be formed. The Solutions Center is one of 13 initiatives of the Clean Energy Ministerial that was launched in April of 2011 and is primarily led by Australia, the United States, and other CEM partners. Some outcomes of this unique initiative include support of developing countries and emerging economies through enhancement of resources on policies relating to energy access, no-cost expert policy assistance, and peer to peer learning and training tools, such as the webinar you are now attending today.

There are four primary goals for the Solutions Center. The first goal is to serve as a clearinghouse of clean energy policy resources. Second is to share policy best practices, data, and analysis tools specific to clean energy policies and programs. Third is to deliver dynamic services that enable expert assistance, learning, and peer to peer sharing of experiences. Lastly, the Center fosters dialogue on emerging policy issues and innovation from around the globe.

Our primary audience is energy policy makers and analysts from governments and technical organizations in all countries, but then we also strive to engage with the private sector, NGOs, and also civil society.

One of the marquee features that the Solutions Center provides is the no-cost expert policy assistance known as the Ask an Expert program. The Ask an Expert program has established a broad team of over 30 experts from around the globe who are available to provide remote policy advice and analysis to all countries at no cost. For example, in the area of Energy Access we are very pleased to have Ellen Moore, the President and Founder of Sustainable Energy Solutions, serving as one of our experts. If you have a need for policy assistance in energy access, or any other clean energy sector, we do encourage you to use this valuable service. Again, it is provided to you free of charge. To find out if the Ask-an-Expert service can benefit your work please contact me directly at sean.esterly@nrel.gov or at 303-384-7436 or you can visit the Solution Centers website. We also invite you to spread the word about this service to those in your networks and organizations

Now, I'd like to provide brief introductions for our distinguished panelists today.

Our first speaker we'll be hearing from is Richenda Van Leeuwen, the Executive Director of the Energy Access Initiative at the UN Energy Foundation. And then following Richenda we will hear from Matt Orosz. Matt is President and Director for STG International. Then following Matt our third speaker of the webinar is Tristan Kochoyan. Tristan is the Founder of Power:On, a social enterprise supplying electricity to rural communities in developing countries. After Tristan, we will hear from Michelle Klassen. Michelle is the Vice President of ZeroBase Energy. Then our final speaker today is Matt Basinger. Matt is the Founder and Director at Advancing Engineering Indonesia. Then finally joining us today to moderate the question and answer session today is Dan Schnitzer who is the Founder and Executive Director of EarthSpark International. Dan focuses on fundraising, partnerships, and promotes the development of countrywide clean energy supply chains.

And now with those introductions I would like to hand the webinar over to Richenda.

Richenda

Thank you very much and good morning everybody. Just for clarification, I work with the United Nations Foundation. Next slide please.

We work very closely with the United Nations on the Sustainability for All initiative. I hope by now many of you are familiar with this initiative, which among its three objectives is focusing on helping to bring the benefits of energy access—both including electrification as well as clean cooking solutions to the almost 1/5 of the world who still today do not have access to electricity. As a part of that in order to address this the UN

Secretary General in 2011 launched an initiative called Sustainable Energy for All focusing on achieving universal energy access by 2030, doubling globally the rates of improvement in energy efficiency and also encouraging doubling the share of renewable energy in the global energy mix. In order to support this initiative and to advocate on these issues with UN member states the Decade of Sustainable Energy for All was also declared. This year was the first year in the decade and we are also looking very much closely towards having Sustainable Energy for All adopted, we hope, as one of the new sustainable energy goals by the United Nations next year as well. Next slide please.

In support for the Sustainable Energy for All initiative, if the UN Foundation in 2011 also launched the Energy Access Practitioner Network, which is a broad based global network of 1,900 members focusing primarily on delivering market-based solutions to addressing energy access. Collectively you have delivered over 230 million solutions reaching about a quarter of a billion people around the world since your membership collectively started in terms of your organization. Last year reported back to us about 21 million people served with bringing electricity to their households. One of the areas of focus for this network is specifically around mini-grids as well as other decentralized solutions. Next slide please.

The reason for a focus specifically on mini-grids within, and micro-grids within, the work of Sustainable Energy for All goes back to projections, that in fact, to bring universal energy access by 2030 about 40% of the required installed capacity is likely to be provided most economically through micro-grids in one way shape or form. We'll come back to that later.

So the work within Sustainable Energy for All also has a special focus area called a High Impact Opportunity area that's driving the establishment [second voice speaking in background] of an enabling ecosystem for investment, deployment, and replication of clean energy mini-grids. I'm sorry, could someone mute their microphone please. I'm struggling to present right now. Next slide please.

The objectives of the mini-grid's High Impact Opportunity Area at the United Nations foundation is the co-lead for the Secretariat together with the Alliance for Rural Electrification is really focusing on five specific areas, some of which relate to policy and some relate to market barriers and increasing financing. We're really strongly focusing on ensuring that many micro-grid solutions are particularly appropriately represented within national and international energy planning as well as supporting the appropriate regulatory environment to help, whether it's looking at interconnection of mini-grids into a national grid or really looking also at best practices around the technology, the structuring, the policy, the tariffs setting for actually stand-alone mini-grids as well where there is not going to be any planned interconnection as well. Again, we'll hear more about

that from the presenters in a few moments. We are also really looking at focusing on leveraging appropriate investments as well as concessional capital where needed as well to support the strong emergence of this sector going forward. Next slide please.

It's a little confusing at times but the UN Foundation work on micro-grids came out of our working group, which has been led by Dan Schnitzer...co- led by Dan Schnitzer, on mini and micro-grids, which encompasses about 150 members of the practitioner network right now. Building from that, we've grandfathered much of that work now into the broader Sustainable Energy for All clean energy mini-grids high impact opportunity area as well. For those of you that might be interested in learning more about that please just email Sean after the session and he can connect you with my colleagues here at the UN Foundation.

We're delighted that this webinar today brings four members of the Practitioner Network Micro-grids Working Group really to highlight areas of their work and specifically focusing on a deeper dive into some of the technology challenges and some of the solutions that they're employing to address those. Thanks everybody and Sean back over to you.

Sean Think you Richenda and now we will move on to Matt's presentation.

Matt Hey folks, can you hear me?

Sean Yes we can Matt.

Matt Great, this is Matt Orosz from STG International and I am going to share a little bit today about our approach to designing micro-grids.

Sean Matt, just a heads up we are seeing your whole screen—so the timer and notes there. Yep, there you go. That's perfect.

Matt Great. Just to locate us in the discussion around energy access there's a few different discussions and definitions floating around in the field and from our perspective energy access means access to a level of energy that is really indistinguishable from the grid. So whether you are on or off the grid you have the ability to use any sort of electrical appliance or supply any kind of electrical or energy needs that you would have regardless of your location. Energy access to us means you have power 24/7. It's the standard voltage in your country and we do a lot of work around optimizing how to make that possible in remote locations, how to make it affordable, and how to privilege the use of renewable energy in the infrastructure that it's used at. Our goal is to really indigenize the process as much as possible to drive local economic growth.

So, a micro-grid or a mini-grid from our perspective—this is kind of a neat representation from Acumen Fund and from our perspective a micro-grid is kind of situated intermediate between the grid and a household solar

system. The cost structure as well as usually the level of service is usually somewhere intermediate so the costs down below are estimations for what a typical unit of energy costs a kilowatt-hour of energy.

Within dwelling too much on the motivation and the need for micro-grids, which I think really most of the attendees are well familiar with, we particularly want to highlight the importance of energy access to health and education missions. There are a number of important reasons why access to energy is an important driver of quality service from remote institutions that provide healthcare and education. Also, I like to point out that from this picture in the background that this Lesotho country that we do work in is that contrary to some expectations, there are parts of Africa that get actually very cold in the winter. That is snow on the mountains and if you are talking about building energy needs, so heating or cooling a building, micro-grids are really the ideal infrastructure to start to consider those types of loads.

So we have our own perspective on what some of the limitations are with current approaches. We can get more into this in the question and answer but really it centers around the limitations in terms of the amount of power that you can achieve using a solar home system or solar products and the sustainability of the business model—the affordability to the end user of electricity of a kilowatt hour.

Our approach attempts to overcome the limitations of the, you know, solar products and micro-grid designs. Our approach is mainly reliant on solar energy because it is a relatively predictable resource that we can tap into in a variety of locations but we do still use a small amount of backup fuel in a backup generator and that is how we get our availability up to close to 100%. The way our systems work, and I can talk more about it, but it is a little bit similar to a Toyota Prius. It's a hybrid in the sense that we have two different modes of solar collection—CSP, which is solar thermal, and photovoltaics, PV. We have these two modes of solar power generation coupled with a backup generator. That is kind of the hybrid approach on the technology side, whereas on the business model side are hybrid approaches that our services are provided to institutions through power purchase agreements, so health clinics and schools operated by Ministry of Health and Ministry of Education, whereas electricity services in general are provided to the community through mobile money platforms, which is M-Pesa, which is in Africa a common way to pay for things using cell phones.

Once you've articulated a commitment to try to supply power all of the time it's really important to try to understand what that demand curve looks like in time. So this is a representation of the average of what a typical community in Africa would consume, averaged over a year. The cost of supplying this power, and notice it is a different amount of power during the day and during the night. The cost of supplying this power if you were to just go out and buy a diesel generator is close to about a US

dollar per kilowatt-hour. As soon as you add a solar panel unit you really cut the cost down of the power you are supplying during daylight hours. However, the solar doesn't work at night unless you start adding batteries to the system. Unfortunately batteries, lead acid batteries, are an expensive technology so the cost of the unit that you just added at night is higher than the cost of the units you provided during the day. Because they are displacing fossil fuel burning the overall average cost, that's shown off to the right there, is decreasing as you add solar panels and add batteries and supply power throughout the night. At some point you reach this sort of break-even point where it's really not cheaper to add more batteries and more storage and more PV panels. You might as well just run the diesel just from a purely cost perspective. That is where our hybrid approach with the solar thermal has an advantage because the storage mechanism for the thermal, the thermal energy storage, is relatively inexpensive when compared to batteries. So you cut down on the amount of battery storage you need and also the amount of PV panels that you need.

Cutting down on storage is very important because the dynamics of load really affect your ability to optimize your generation structure. You have to I guess keep in mind that if you are trying to supply power throughout the day and the night and through different times of the year, different seasons, you have to balance the dynamics of the solar resource. So the fact that the sunlight is there at varying times of the day, there are times that the sun goes behind a cloud, and meanwhile the load is constantly changing. So we have an approach that enables us to use statistical representation of the load using data sets from communities that are on the grid to represent what communities that are off the grid would consume if you give them access to grid-like power.

We use this data to inform our infrastructure models and optimize the amount of power that we are able to produce and to allocate the generation infrastructure in a way that minimizes the cost of storage and minimizes the tariff that would need to be charged to the end user.

So asking the question, where are mini-grids likely to be economically viable, we start with the kind of planning documents in the country where we would work and Lesotho is where we have historically done most of our work and from their planning document you can see where the grid is, where the grid is intended to be going and then there is all of these white spaces where there is no plan for the grid to go there. So in those regions if you have a household or a business in those areas you really have two options for getting power and one is a solar home system and the other is, if you live close enough to other potential loads is, the micro-grid.

And we try to rationalize the decision of where micro-grids should go and where solar home systems should go using a variety of design tools, some of which are satellite image processing based. The image on the upper left is a community that's in the white space that is on the planning document. This is Lesobeng in Lesotho and a group here at MIT that we work with

called Grid Forum was able to look at satellite images and pull out the size and the shape and the distributions of buildings in this community. Then we followed up with that with a site visit to actually determine which of those points on the map are households, how many people are in the households, which points are small enterprises, which are health clinics and schools. So then we can ascribe, based on our load data, we can ascribe a load for each one of those points on the map so we know how much current needs to flow to each one of those points so we can optimize the network of distribution wires and minimize the amount of wire that's needed to connect all of those houses.

Again we overlay that with the solar resource. We understand both the dynamics of the load and the dynamics of the solar resource and we use that to feed into a model that we've developed that designs the hybrid infrastructure that allocates between the different modes of generation so that we optimize in terms of how much storage there is and how much generation capacity there is.

When we roll out these systems the process involves first finding the points on the map, determining what those points represent, and creating an idealized topology for distribution network where we would find the economic breakeven between the micro-grid and solar home systems. However, if there is a sort of a reason to try to universalize access in the community, so there aren't some "haves" and "have nots" in that community, and there is a subsidy mechanism then we would simply redesign the grid to connect 100% of the folks in that particular village. Everybody would be on the same sort of mobile payment platform. There would be a smart meter in each dwelling, in each business and health clinic and school and we would use that to streamline the payments and minimize the transaction costs as well as feed data into the design process so that we are continually updating our ability to update the infrastructure.

I'm about to wrap up here but I just wanted to mention that the design of these micro-grids is actually very sensitive to the type of project finance that is available. And if you are financing these projects with debt, the interest rate is actually not very important but the tenure of the debt is. So if you are trying to get payback on micro-grid infrastructure on the short-term, it ends up equating to a very high tariff that you have to charge consumers and also it favors the fossil fuel generation fraction of the micro-grid. Whereas, if you can have a longer payback period, 10 or 15 years, then that means you can charge a minimum tariff, close to about 25 cents per kilowatt-hour, and you have also maximized the fraction of renewable energy on the micro-grid.

This is just a representation of our commitment to indigenizing the process so it's manufacturable to catalyze local Independent Power Producers to operate in remote areas, to own the assets, and to have the right incentives to keep them up and running and maintain them. We do a lot of work to

support that with technology transfer and training with our partners in Lesotho.

This is who we are and I think I will turn it back over to the organizers.

Sean Think you Matt and we will now be turning it over to Tristan. Tristan you should be unmuted now.

Tristan Yeah, hello. Can you hear me?

Sean Yes we can and we have your slide up as well.

Tristan Okay, thanks. So go to the next slide please. Let me begin with an introduction about what we know or what we don't know about electricity access. The two big challenges in this field are how to make electricity cheaper and how to convince people to pay for it. To simplify there are some technology challenges, which are how do we design more efficient systems, and business models challenges, which are how do we operate the efficient systems that we design in a sustainable and profitable way. The simple answer to these questions is we don't really know for sure and that's why we are having these webinars to get a sense of what works and what doesn't based on experiences from different companies that are implementing their own solutions in several locations around the globe. So a couple of months ago we had this webinar about business models from commercially viable micro-grids and today it's about the challenges in micro-grids. What I am going to do here is to try to put things in perspective and share some of my thoughts about how to tackle these challenges and give examples of what we do at Power:On. Next slide please.

So the main technology challenge in micro-grids would be to get systems more efficient and generate cheaper electricity. As it has been said before this is usually done by optimizing the system design and answering questions such as what generation technology do we use, what storage, what size, etc. In the end this has very limited impact to the final cost of electricity compared to things that we have no control over because when optimization will help us to generate 5-10 cents cheaper kilowatt-hour, it will remain marginal when compared to the renewable energy technology over the past decade or the fluctuation of diesel fuel in hybrid systems.

On the other hand the other interesting fact is that while we struggle to optimize the systems, people in other areas are currently paying extremely high prices for energy. They pay, for example, no less than \$100 per kilowatt-hour when they have to charge their mobile phones, which of course is way way more expensive than what any half-decent micro-grid could offer. Next slide please.

Maybe we are looking at this the wrong way. Maybe the goal isn't to get micro-grids more efficient. The problem isn't to pressure people to buy

electricity because they will happily do it because micro-grids are already so much cheaper and more efficient than what they are currently relying on. In my opinion the real problem is to prevent what I heard in a previous webinar. When someone from a company operating micro-grids in developing countries said for a particular project that they stopped paying as soon as they heard a mere rumor of a future grid connection, national grid connection. The actual challenges are how to keep users happy over time to keep this from happening and the solution is to shift focus from the supply side to the demand side. Next slide please.

The tech challenges in a micro-grid are not the technology challenges that are already there and how we optimize the supply side. It is about the technology that can be developed to address this user challenge. The challenge here is to offer value here to our service so the customers will see, acknowledge, and never want to back away from. This is about the other barriers that allow micro-grids to operate. It's not about price. It's about how do we make the service easier to use. It's about how do we improve the user experience. And it's about what innovations we should implement that can go beyond what the customer expects and make them love it and stick with it over time. In that sense I think the bottom of the pyramid offers an amazing opportunity because it's a blank page that is allowing us to leapfrog the next technology generation without having to cope with obsolete infrastructure. Next slide please.

I want to illustrate that by giving examples of what Power:On does in that area. We use smart meters and mobile phones, which are already widely adapted living in the most remote areas in developing countries. We develop user applications that will make our system more valuable and easy to use. So the first kind of application is obviously for payments with mobile money, which is now a classic thing among startups that are working in this field. Our apps also allow customers to monitor and control consumption and receive alerts when the credit is running out. Everything is on the phones where they can act on it really quickly and really easily. This can also be used to send customized tips on energy efficiency to help users lower their bills because we have to remember they have never had electricity access before and they don't know how it works so they need help about their understanding what energy efficiency is. We can also promote special offers and also promote deals with efficient appliance retailers to encourage responsible usage. This is a new relationship with users, with service, which offers a whole other level of user engagement. This is very important because classic electricity supply should not apply here. We should consider that it is over because once we offer this kind of services to users they will not back away from that value and look at what the national grid is doing in big cities nearby with regular blackouts and etc. Next slide please.

This new strong relationship with users in turn allows to impact back on the supply side because applications for load management, for example, can be managed as well. We can, for example, set alerts when a demand

spike occurs. That permits customers to help us reduce stress on the system in exchange for an award. For example, we can ask them to turn off their device for one hour and then have another hour of free use the next day or we can do data analysis and forecasting to improve the systems behavior based on data from smart meters. These improvements will lead to lower electricity price that will benefit the users but it all started and was made possible thanks to user focus, not supply optimization concerns. Next slide please.

Now I will pass quickly over the slide. Just to pose questions about the future of the electric supply business because in my opinion this is only the beginning. Loss of innovative services can be implemented and this can be done very quickly and that's what we're doing at Power:On. The other question is about the implication and effects that these innovations will have in developing countries. An interesting fact is that the bottom of the pyramid and the off-grid areas are now driving the innovation in some technologies in mobile banking, which was born in east Africa in those smart grids. I think this is a rather interesting turn of events. Next slide please.

Now I want to emphasize the pain points, which is innovation needs funding. I want to talk about a couple of problems I feel are threatening the ecosystem. The first one is funding mismatch. Huge amounts of money are made available from big organizations to fill the electricity access gap nowadays. It is largely due to the SE4ALL initiative so hats off to you guys. These organizations are willing to invest several million dollars at a time to fund scale ups or already proven projects. On the other hand most startups driving innovation in this field are barely past the pilot phase and they are only looking for a couple hundred thousand dollars to get approved concept of their innovations. There is a major mismatch here. This should not be a problem because a lot of grants and subsidies are also made available by public or private foundations and they should fund social innovation in this field if it's deemed too risky by regular investors. The problem is they don't and as a result they are kind of working backwards because they are looking to fund problem models except there are none or very few. If a model has proven an attraction then it should be able to scale without subsidies and if not it should not be funded any further because it would not be good enough. In the end, these type of systems risk funding the wrong companies and not the innovative startups that are going to solve this. As an illustration I just want you to remember that [inaudible 37:16] Systems, which is for me one of the major success stories in this industry. Half of our systems would not have existed if the founders did not have \$400,000 in savings to start the company. In that sense they were very lucky because usually start up funders do not have 400k in capital from their own bank accounts. I think I have reached the end of my 10 minutes here. Just to conclude, I think there should be more funding for innovation because innovation is what

will solve the challenges I talked about. Once this is done we can focus on scale-ups.

Michelle

Hi Sean, should I go ahead and start?

Heather

Yes, please do. Thank you Michelle.

Michelle

No problem. Hi everyone. I'm Michelle Klassen. I'm the President of ZeroBase Energy based out of Detroit, Michigan. In 2009 ZeroBase was beginning a dialogue about hydropower, renewable energy, and requirements riding within the US Department of Defense. Many new technologies have been adopted first by defense industries, think mobile phones, photovoltaics, GPS. We will walk alongside the trailblazers in the defense industry collecting and publishing what we learned as sustainable power transitioned from what was then an experiment to what is now the future of power for the Department of Defense. Next slide please.

Five years ago the Department of Defense was only using diesel fuel generators for power. Today they are fielding hybrid power management systems that supply fuel and power critical operations. ZeroBase walks them through these operations. While organizations are innately resistant to change, there is a path paved for new solutions by early adopters. Typically early adopters are challenged by the realization of a current solution as an inhibitor to operations. Then these inhibitors become large enough hurdles that the needs assessments get pushed up the chain of command. Next the needs assessment reveals another paradigm with where to proceed with a different set of solutions and the organization either chooses to change to fit within the new paradigm or chooses to remain at status quo. If they choose to change, however, this data gets changed into requirements that can be published for competitive bidding. This step suggests where we currently are within the micro-grid space. As you can see on this slide, the failures of fuel generators, at what is called tactical edge, has led the adoption of battery based hybrid systems. These systems became the very foundation for micro-grids today. I want to point out here though that the system of adoption is historically slow. If the process moves too quickly the organization ends up buying something that it cannot understand, nor can it process. This is happening all over the world and puts at risk the larger market adoption. Next slide please.

Many organizations and end users are just now attempting to get requirements for power out that go beyond the typical year one budget cycle. These budget parameters often eliminate the option for hybridization or renewable energy centric solutions. What we see now in industry is an attempt to get it right. We see ministries of energy, via their rural electrification authorities, and agencies making an effort toward long-term sustainable solutions. As is the case in any technology adoption, there are a lot of misconceptions and a lot of new learning that needs to take place. This new learning will come from the aggregated experiences—successes and failures of industry and will only be passed on

to the requirements by clear dialogue like this webinar today. The biggest barrier that we see is the year one budgeting cycle. This will always favor fuel generators because procurement does not take into account the cost of fuel over the life of the generator. Fuel is typically another budget altogether. A couple years ago I traveled all over the Liberia and South Sudan conducting site assessments at UN funded hospitals and clinics. While the need was ever apparent, the reality was that there was no way for agencies, who operated these hospitals and clinics, to solve their fuel problem with procurement of a smarter system. They were given a budget by the UN for their two or three year contract that included capital expenses and did not incentivize decreased O&M during that term.

The second barrier is the random requirements often written around incomplete understanding of a product, rather than a desired outcome. Because this is a paradigm shift for many beneficiaries of the technology, it's often evident that there is a gap between requirements writing and the reality of best in class long-term sustainable solutions.

Because there is no real governing authority designating best practices among micro-grid technologies and integrators, it's often left to someone very far removed from technology to write the requirements as it will be adopted by end users. This typically results in a hodgepodge of specifications and leaves the door open for technologies that will operate for a limited timeline mostly because they met a checklist but will not be sustainable or easy to maintain over any period of time.

While ZeroBase has prided itself on being the lowest cost/best quality for our partners, the reality is that anyone can bid lowest and check the box to present requirements in order to win a project. This is especially true with companies that are not playing by the same rules of the game that we are here in the US. While we must be profitable we must also put it at a price threshold that makes the investment easy to bear for early adopters. This has been the teeter-totter approach that we've learned to navigate so that the best in class technology can be adopted. In the case, however, that bids require lowest cost solutions as the primary indicator for acceptance the incentive for failure is usually excessive. What we have seen is equipment without sustainment and without a local party who can fix and maintain equipment. Much of this equipment is not standardized by US or European agencies and do not have sustainment manuals. So the need is met for a few months. The lowest cost investment is implemented and then there is very little restitution if the system and when the system fails. The bottom line here is that industry often sees requirements that cannot be met or will fail due to poor quality and thus do not compete on poorly written requirements. Next slide.

As I've had the privilege of educating partners on these topics over the years, the best solution that I have found is one in which industry Subject Matter Experts are brought into the discussion before and while requirements are written. SMEs know what works and what does not. Our

warranties require us to back up components as well as system solutions. Best in class components should be specified and backed up with quality control certifications while not excluding emerging technologies. Individual components as well as the complete micro-grid system should be reviewed under the qualification of fielded experience. They should be a much heavier significance weighted toward field use and longevity than there should be towards price alone. Technology that meets a desired goal should be backed by warranty and performance records. Then their qualifications should prioritize field experience rather than lowest cost. Cities should be called on to discuss lessons learned on installed systems, technology, and sustainment challenges as well as the ability to train laymen of the usage of the system.

The field is no place for R&D. The requirements should be written around proven solutions that local partners can install and maintain. The broadest path within any worthwhile venture is of course to learn from our failures. There are more than enough to point to. I have a long list of my own but these failures are inevitably the cobblestone streets that lead to the desired end state of power security. Next slide.

ZeroBase has had years of experience in preparing the hybrid power management systems with an existing generator onsite. In these applications there is an inverse relationship between the amount of fuel consumed by generator run time and the amount of PV penetration and battery stored availability. Hybridization is thus a sliding scale with relationship between investment in solar/PV and fuel saved.

Since most of the sites where micro-grids will inevitably be landed are operating on diesel only, micro-grid technologies that integrate existing generators regulating differing voltages and managing remotely will be the superior solution. The purpose of generator management is to get a specific outcome—less generator run time, more power surety, and more continuity. While targets can vary widely, it's helpful for baseline production target is identified to start. Doing this will show the end user how much of one is sacrificing for the other. How much PV, for instance, he is sacrificing to fit into an upfront budget, which the difference will inevitably be spread over the life of the project in fuel procurement.

In many cases the end user is not clear in what they are trying to accomplish. Often times there is little or no power to begin with. This means that successful outcome is often fuzzy and does not reach a model of duplication. If, however, targets are set from the start success results can be captured by monitoring and can be replicated. An example of this is the EarthSpark International project in Les Anglais, Haiti. This project was properly specified from the start but still allowed for dialogue around the micro-grid technology. EarthSpark started with the current demand and slowly walked from these other solar and planned transmission, distribution, and production around the inevitable expansion. Their local

training and sustainment plan will prove to be a replicable model for years to come, even as the core technology advances and changes. Next slide.

Micro-grid adoption does not revolve around current technology. Technology evolves but outcomes remain the baseline that should be standardized. The prioritized solution is the one that can be sustained and supported when fielded. The key components in a micro-grid system— inverters, renewable energy, generators, batteries—these are all commoditized now. While there are a few approaches to the same end, the thing that needs to be prioritized is the support and commitment of the end result, which is power security. Micro-grids are able now to move from a project approach to a productized manufactured solution. This enables standardized practices, which are the baseline for standardized document controls, training, and sustainment. Requirements must also always include a training and sustainment plan that can be properly documented and priced into the total cost of ownership. Solicitations must waive these lifecycle costs—think replacing batteries over the life of the system and capability of upgrading components as technology grows smarter. Every site should not be an ad hoc project and installation and so the market has grown such that pre-packaged solutions, specifically on the power management side, can be dropped in as a pre-manufactured pretested preauthorized solution. This eases installation and project cost and enables a more turnkey system warranty rather than component-by-component warranties but business partner, Jared Warren, often tells a story of homes years ago that wanted refrigeration capability. These were cold rooms in the basements of old homes in Detroit. Each one was different sized based on footprint until one day someone began manufacturing a turnkey refrigeration system that did not require the installation overhead that it once did. Prices thus came down and supply increased for everyone. Micro-grids are ready to take that leap today as well. Next slide.

As a summary, requirements should be written, number one, with an eye towards economies of scale. If the system is not replicable it probably won't work the first time. Ask yourself, would commercial banks finance this, because this is where the industry is heading. Does the price go down if we scale up and validate that model? Number two, requirements should incentivize quality, not punish it. Ask yourself, why do eight organizations buy things that commercial customers would never touch? Will it really work? Prove it. Who do we call when it breaks and how will it get fixed? Number three—don't allow engineers to reinvent the wheel with each and every project. There is no need to design around a specific vendor's technology or specifications. Instead, design around the desired outcome and replicate. If you can only get the solution from one source, the technology is probably not yet mature. Industry will innovate if the desired outcome is clear. Industry will solve problems but organizations can require proof. And number four, technology and best practices are evolving. We must publicize both our success and our failures. Our goal should be more competition driving down the cost and having a pool of

high quality industry partners committed to success. Success in this field will change the lives of billions of people who are currently living without energy access and power security. Thank you all for your time.

Matt

Hello, my name is Matt Basinger and I am excited to get a chance to talk with you for a few minutes from the perspective of the micro-grid developer. So, just to take a second position and to qualify the piece of the discussion that I'll have for the next two minutes is primarily in emerging markets from the perspective of Southeast Asia and Africa, is where I will draw most of the examples that I'll give. And with the type of micro-grid that I pull examples from over the next few minutes will be primarily PV based micro-grids and those that are sub-megawatt so tens or a few hundred kilowatt peak of installed capacity. So, just to qualify as we go to the next slide please.

There are many, of course, technical issues that a micro-grid developer faces—a new micro-grid developer. A lot of these issues have already been touched on in one form or the other through the other speakers, which is great to just continue to develop this story that my colleagues have presented. There are three broad topics that I'd like to touch on though briefly, which are standards, synthesis, and scaling. We can move on to the next slide.

First standards, what I mean by standards is of course things like electric code, things like best construction practices. Often times these are largely missing depending on the specific market, the specific context we're looking at. As a new micro-grid developer this can be very problematic. Even when these standards are in place in one fashion or another often the accountability, the inspectors that would be dispatched to qualify a site as safe, that it would be meeting a particular standard or code, don't exist or largely unavailable. This of course presents huge issues for micro-grid developers. This picture here is from Lake Sentani. This is a community just about 10 kilometers from where I live in Papua, Indonesia and though this is a very stark example, and fairly extreme, I wish that I could say this was isolated. This type of a situation, which we could spend a whole presentation assessing what is going on here, is unfortunately something I see far too often in Southeast Asia and East Africa where I've been a part of developing micro-grids. Next slide please.

So the second issue, and again to take a quick step back due to time what I want to do with my presentation is really highlight a few issues, these three issues. I'm not going to present solutions. That would be a whole other presentation and actually a lot of the solutions, just like my colleagues presented, are in active development or not yet proven. So this is again, unfortunately, the three topics I'm discussing are more highlighting problems and roadblocks that are occurring and being actively pursued in terms of problem solving. This second problem then is synthesis, just to keep with the s theme. The idea here is technology integration. On this slide before you what you see is a very simplified

communication flow schematic of a solar PV micro-grid and the various communication pieces that are often desired. The key pieces, again, when it comes to communication are how the smart meter and how the end user integrates with the micro-grid operator. This often involves SMS gateways, basically mobile technologies and communication networks as well as how the power system is monitored as well. Now the great thing that has already been mentioned is that mini-technologies they are already off the shelf or widely available in terms of power system monitoring and smart meters. The issue really becomes in how to integrate these technologies into a local market, a new market, a new mobile network that maybe does not yet have established easy to access communication gateways. So if you go to the next slide this just highlights three key points that a new micro-grid developer has to often address, which is the SMS gateways, the communication gateways, how to actually pipe the communication that is happening in the mobile network to their specific monitoring software, control software, both on the power system side as well as the computer messaging side, as well as on the payment side. One of the presenters already mentioned M-Pesa and Mobile Money has come up several times and is a very common point when we talk about micro-grids is the benefit of pay as you go. I would definitely echo that sentiment but the issue becomes for a new micro-grid developer, how do you access that, how do you plug in pay as you go payment services like M-Pesa into a new micro-grid development? You have a smart meter. You have a branchless banking type of service, but connecting these two things is not easy often and is not often established for any micro-grid developer. So, that bottom square, the bottom red square on this slide shows also how you're, as a new micro-grid developer working with multiple pieces of software, multiple pieces of monitoring equipment. On the power side, on the payment side, how these things integrate in with each other, especially at the local level, is an active work for a new micro-grid developer. Next slide please.

The final point I'd like to make has to do with scaling. This issue with, especially with what Daniel Schnitzer and other researchers have shown to be incremental scaling, how do we take the need for expandability within micro-grids and really hit that so that we can scale micro-grids? So, there are just three points I want to briefly touch on and give some examples on that drive a move toward what I would say is really needed at this small 10 to a few hundred kilowatt peak of PV micro-grid size for remote community electrification, which is land issues, security issues, and expandability that are all driving a need for distributed generation and storage. Let's go to the next slide please.

This slide shows a picture of a traditional micro-grid solar PV, a centralized solar PV installation, on a hill overlooking a community. This is again from Papua, Indonesia, where I'm based. The first thing that you see is that the power system is far removed from the community. This often is a necessity because of land issues. The reality on the ground in so

many locations is land acquisition for the installation of a centralized power system is complex, it's difficult, it's expensive. Land rights are very complex in many locations. This is not a great fit for traditional centralized powerful systems. Next slide.

If you zoom in on the bottom left you will quickly notice that there are many panels missing from this installation. This actually happened within the first few weeks of the installation because of these or I would say aggravated by the same land issues that I mentioned. Security becomes an issue. Centralized power systems that are installed away from common community spaces, where there's many eyes seeing what's happening, are also prone to security risks as happened here where about 40 panels were stolen during the first few weeks of this installation. You can imagine a distributed generation network of panels throughout. The demand locations throughout the community could be less prone. There's not one point of failure anymore when it comes to security but you are distributing those points of failure throughout many locations, potentially reducing security risk. Go to the next slide please.

So the last point then that I would say is pushing a need or a move toward distributed generation and storage solutions is expandability of a micro-grid that tracks demand. Demand in a micro-grid in these remote communities often, that I'm addressing here, really changes over time and it doesn't always change in predictable linear ways. So you can see this arrow shows a common movement that happens from end users looking to electricity to provide lighting, then moving to television watching and entertainment, followed by more small industry or productive income generating uses such as refrigeration and milling and grinding. Let's go through a couple pictures quickly. Next slide.

This comes from a micro-grid in Uganda where it was primarily for lighting a school. Next slide.

Here also is a picture from a micro-grid in East Africa where a small kiosk or a store was using primarily electricity for illumination. Next slide.

A picture again in East Africa from a bar in a micro-grid so here, instead of just lighting, they've introduced radios and television for entertainment to drive business in their bar. Next slide.

Here's a picture from Indonesia. An example of what I would call, I guess, daycare. As I passed a house, as I was inspecting micro-grids a few weeks ago, where kids were watching television and had access to a nice speaker system you see there too. Next slide.

Moving up this demand increase or expandability that needs to happen, this is a slide from Shared Solar. This is a picture from a project in BJ Modie's lab out of Columbia did that I was a part of a few years ago where

refrigeration was introduced for income generating activity very successfully in Mali. Next slide.

These next two pictures are from milling that is being done in Papua of a type of tree with just a generator but you can imagine how a motor and electric supply could replace the expensive fuel source here. Next slide and the last picture is of how millers and grinders, in this case a picture from East Africa can really benefit from electricity from micro-grids. Last slide please.

What's needed here then, these three motivating factors of land and security and then expandability I would say are really motivating vendors technology developers to look how to provide distributed generation and storage, even for micro-grids and the need for this, of course. Grid tied inverters have been around for a while but how do we move that same type of expandability from the grid to off-grid or micro-grids? So here are just a few examples of industry leaders like SMA and Enphase are creating new products that could come to bear in this space to really enable distributed generation and storage. I, as a micro-grid developer, am quite excited to see how these and other technology developers are helping to move forward this space and I think that we will see more in coming years that will enable new micro-grid developers. Next slide.

This again just summarizes these three points and this issue if you go to the next slide. There it is, this idea of scaling and how do we get there. That's it for me.

Sean

Thank you very much Matt for that presentation and now we're going to try to bring Daniel on the phone. Dan, if you can go ahead and unmute yourself? He is on travel so I will make sure his audio is working properly for an organized discussion among the panelists. Dan, are you able to hear us? Dan, if you are on the phone still, if you could unmute and come on. It seems that Dan is having some audio issues. I do have the questions that he was going to present to the panelists. I will go ahead and read those for him.

The first question that we have for you, and this is for all of the panelists, it asks – [inaudible 1:05:42] tries to prepackage as much as possible before shipping to avoid problems during installation and commissioning and this is a very approach from STG, which utilizes on site labor and manufacturing. I was just wondering how these very different approaches reconcile. What are the conditions for choosing one over the other and how do the other panelists reconcile the ever more sophisticated technology while working in places where installation and maintenance is quite difficult? To address the first part of the question, why don't we go to STG first? How do these very different approaches reconcile and what are the conditions that lead to choosing one over the other?

Matthew

Hi, this is Matthew. I guess my preliminary answer to the question is that if we are talking about a micro-grid that is solely comprised of off the shelf commodities then it makes a lot of sense to pack them down and ship them as efficiently as possible to get them to the site where they can be assembled and integrated and commissioned. Our approach involves, to a certain extent, local content in the manufactured parts of the micro-grid, especially because we do co-generation, which involves the solar thermal collectors. There is a market for commoditized small CSP collectors. You can find them on the market. In general they are bulky and they don't ship as well as say solar PV panels. So it actually makes a lot of sense to manufacture them close to the site and that also is a good clean tech, skills based manufacturing process to have locally, which we think is important in increasing the amount of local content in a micro-grid.

Michelle

This is Michelle with ZeroBase so let me just clarify too because I completely agree with Matt. It's not a one or the other option. I think that it's actually both and it's a transition of time and of scale. So with everything we've done, we've sort of duplicated what the automotive industry has been able to do in terms of picking up plants and relocating them in a regional area to be able to enter that market. That does take some time. The process that we are on now is both. We are doing both local content and pre-manufacturing the highly intelligent core components of the system in the US with the aim of opening our next offices in South Africa next year to service a Sub-Saharan African market, which would be there and we will do a subassembly there. So it is both and I think from the get go, when you are trying to enter a new market, access to local components and local labor is always the challenge and you really have to invest in that local market. The way that we view ourselves is the first few pilots will be done in a pre-manufactured setting from the US, which will hold the controls and the quality that is necessary and then that model can be picked up and then replicated in a regional manufacturing facility like in Johannesburg, like in Tel Aviv when we're serving the Israeli market, and on and on. Basically it's not one or the other—it's always both.

Sean

Thank you Michelle and for the other panelists, Tristan and Matt Basinger, how do you reconcile the use of ever more sophisticated technology while working in places where installation and maintenance is quite difficult?

Matt

So Matt here. I will take a stab at that.

Tristan

Tristan here.

Matt

Oh, Tristan go for it.

Tristan

Okay, you go on. Okay, okay, I was just going to say very quickly that for us we tend to partner with local companies that are used to install, for example, hybrid systems and so we tend to include partnerships with these companies because we feel that the involvement of the local stakeholders is very important to the sustainability of the company in a particular country. So we tend to partner with them and just to adapt to what they are used to install and implement because they are also the ones that we will rely on for maintenance for example.

Matt

Matt here. I think from the perspective of the micro-grid developer and the local operator this is very tricky. I think new technologies can be seductive often and can force our designs to address needs that are felt by the end users, by the developers, but until a technology is really proven and, just like Tristan described, until there's local serviceability or clear service channels, it's very hard to adopt a new technology early at scale at least. I think that what's important to realize too, as has been mentioned over and over again in this panel discussion, is there is no proven scaled model or company out there that has really nailed any sort of universal approach. Of course, there is no real universal approach. We're going to see lots of tailored solutions for tailored markets, for tailored needs, and so being a part of piloting those at this stage over these next few years is something that is needed to move forward technology adoption so that there are local service channels and an opportunity for developers and end users to see those technologies. I would just say it's a very tricky balance that I think is not easy to navigate.

Sean

Thank you Matt and Tristan. Next question. This one is for everybody. It asks, was your business model informed by the fall in a cost of a particular technology and what was it? Was it solar panels, inverters? And is there a technology or component that you're looking at that needs to reach a certain price before you're really excited about it? And then what is that and what price? The first part of that question again was, was your business model informed by the fall in a cost of a particular technology and what was that technology?

Matt

Matt Basinger here. I can jump in briefly. I think for us, there are a lot of lessons learned from mobile telephony, from the success of mobile phones, the technology expansion of leapfrog, technology that mobile telephony has been, mobile networks and cell phones have been around the world. This of course informs micro-grids in many ways and then second, of course, the fall of the price of solar PV has really enabled our business model and the type or flavor of micro-grids we're promoting. The second part of that question, I'm very anxious to see a cheaper and more widely available and more widely serviceable battery technology, at lower cost, come online in coming years. I hope or pray for a battery revolution in this same way that we've seen in the solar PV cost and availability.

Michelle

Yeah, this is Michelle from ZeroBase. I completely agree. For us there wasn't a specific technology that turned the tide. We were actually working to start with a US intelligence agency that did not have price constraints. What they had was critical assets at the tactical edge of the world basically that needed 100% up time of power at basically whatever cost. Within that setting we were able to play, obviously, with a lot of different technologies and figure out what was best in class but none of our equipment was geared toward a DOD centric solution. It was always a commercial off the shelf. Everything that we introduced to them was with an eye on being able to validate it on a very highly specialized, rugged, specific environment and be able to replicate that in other environments around the world. That's what we've done. But the thing that I'm most excited about and kind of unnerved about watching on the horizon is the battery technology. We use chemistry called lithium ferrous phosphate, very widely adopted by the US Department of Defense. We were pivotal in getting that technology adopted. It comes in at a little over a dollar a watt and it can be obviously very expensive in the upfront but over a period of 10 to sometimes 20 years it obviously pays for itself quite quickly so much so that the Department of Defense has adopted it with no constraints. It is lighter. It handles very high temperatures, very high elevations, low temperatures are just as much of an issue for battery storage and it handles that well too. So what I would love to see and we've done this with our micro-grids in Hawaii. Our Hawaii division basically had the ability to capitalize or put that cost over a depreciation period. We've been able to use LFP there. I live for the day when we can take that technology or one that meets or exceeds what that can do at a lower price point in the developing world.

Tristan

Tristan here. I wanted to answer that question by saying that, yes, the cost decline of all renewable technologies is the reason why profitable business models are made possible and this has been the case for I think every company tackling the electricity access problem because the cost of technology has declined over the last decade and basically every company is no more than, in this field, is not more than five or six years old. It wasn't until that point that it becomes possible and could switch from an NGO model where the electricity was not sold but rather given, to a profitable enterprise model. This was definitely for us something that helped emerging. More specifically for Power:On, of course we will welcome further decline in cost of technologies, for example, batteries or distribution systems, rather than because the climate was the creation of new devices, like for example smart meters, from innovative startups. The developing of smart metering is very very recent and that was for us really good news.

Sean

Thank you everyone and Matt, in relation to that, we did have someone ask a question specifically to you about the components you use and if there was a certain component, technology component, that allowed your costs to be what they are. Matt Orosz.

Matt

Yeah, so we are also highly anticipating the decline in cost of electrical storage, options, and batteries but while we're waiting for that to happen we make use of thermal storage, which is already low cost. So we have, you know, the two components of solar power generation. One is the direct photovoltaic—making electricity on the spot when the sun is shining technology and then we use the micro CSP concentrated solar power technology so we are able to convert some light into heat, store the heat fairly inexpensively, and then generate power on demand through a thermodynamic engine. Then also, having a thermal battery in our hybrid system enables us to, so when we do have a period of time—say it's five days of cloudy weather during monsoon produce when there just isn't that much solar power available and you have to go to your backup power generator. About 60% of the energy in fuel will lose a generator as heat in the exhaust and when you have a thermal battery in a hybrid configuration you are able to recover and recycle that heat that is wasted in the exhaust back into the thermal battery and generate more electricity from that. That is kind of one of the approaches that we use to minimize the cost of the system and to kind of get beyond the fact that the battery storage is a little bit expensive right now.

Sean

Thank you everybody for your responses and moving on to the next question. This one has to do with standards and again it is for each panelist. We often decry standards for being inefficient but they can also be very helpful. What are the most important standards that you have found in your own work? For example, are they metering systems, grid interconnection, or utility distribution systems or some other standards?

Matt

I can jump in here first—Matt Basinger. So this was something that I mentioned in my presentation. The type of standard that I often long for most and is most impactful is on the power generation side and distribution, basically, in terms of inspection and accountability. So this is sort of a sideways way to answer this but the existence of standards is critical across the board, across all the areas that were mentioned in the question. But without enforcement of those standards, the standards do no good. This is what is largely missing. Most markets, most countries, have some form of standard but what's the hardest thing to deal with from my perspective is when those standards are not adequately enforced through dispatching inspectors and accountability of contractors and skilled labor and whatnot.

Michelle

Yeah, and I'll jump in here. Michelle from ZeroBase. I think that there are some really easy baseline standards to hit. Environmental conditions need to be taken into account and you need to create a baseline for standardization. For instance, there was quite a large PV installation that was going to be pushed over into a micro-grid, feed into a micro-grid, that was under development in Mombasa, Kenya. When I visited the site the solar panels were melted. For instance, all of the inverters that were on the PV side were all written in Chinese and there was no sustainment plan to use that. So the system ended up inevitably to be pulled completely out of the ground and started from scratch. That is a basic standard on the PV side that there should be the environmental requirements, tier one compliant, on the inverter side as well. What happens when you don't have these things obviously, there is no interface to be able to use them again and be able to fix them and have a third party company come in and fix the system or to be able to integrate and expand into micro-grid scenarios as capital gets deployed further.

Sean

Great, would anyone else like to add to that, Matt or Tristan? Great, we'll move on.

Tristan

I'm not sure if we understood the question but for me something that will definitely help improve the environmental impacts of the system are the capacity to be able to recycle the batteries that are used in the system that have often dramatic impact on the environment if they are not recycled properly. That would be my concern here.

Sean

Thank you Tristan and we have time for one more question if everyone could maybe provide a quick 30 second response. This is somewhat related to the last questions. What are the top policies that you would like to see at the country level to improve market conditions for micro-grid developers.

Matt

Hi this is Matt from STG. I can maybe jump in on this one. I think a clear policy regarding, first of all, the ability for an independent power producer to exist, as opposed to just having a national utility. Second, the ability for that independent power producer to set a tariff that would enable cost recovery on the micro-grid. And thirdly, a clear policy in place for what happens to the micro-grid if the grid is eventually extended. What happens to the assets and distribution infrastructure? Are they sold to the utility or does the micro-grid purchase power from the utility and redistribute it? Those types of policies, if they can be clearly articulated, on a country-by-country basis then I think that provides micro-grid developers with a good basis for understanding the value that they can bring.

Matt

Matt Basinger, just to echo Matt and his response. I would say that those are exactly in line with what I would articulate and just to add one more would be related to funding. As I think it was Tristan who mentioned in his presentation, a lot of times the financial viability of a business model or micro-grid operator tends to be the required payback period for debt financing. I would say too though if the other knob you could turn is the interest rate related to that. So for policies to be mindful of tariff rates and potentially subsidized debt financing that would allow for either lower interest rates or longer payback periods, taking those three knobs into account and the tradeoff between those three knobs is critical with the policy and the government funding level.

Sean

Great, thank you so much and we are just about...go ahead Michelle.

Michelle

Yeah, I'm so sorry. I was just going to say one thing and underscore those points and say policy doesn't mean anything without enforcement and without the ability to navigate it. What I've seen is that there are a lot of policies and a lot of great banners of doing great work and the ability to do it but without the backing and the organizations like USAID and Power Africa giving backing, private equity isn't coming in and put money into the development of micro-grid on a large scale. Policy, where it has its place and can be beneficial, often times it is there and is not mature enough to actually benefit private equity, debt or equity coming in, or also the developers at the end of the edge of the need as well.

Sean

Thank you Michelle and we are almost out of time so unfortunately I know we did not get to address all of the audience questions but I will forward any remaining questions to our panelists today and hopefully they will be able to provide brief responses through email. So I will take that approach and hopefully get everyone's questions addressed. So in the sake of time I would like to move on to the brief audience survey that we have. This just helps us evaluate our webinar and improve for future webinars so you can respond directly in the GoToWebinar.

The first question is, the webinar content provided me with useful information and insight. The next question—the webinar's presenters were effective. And then the final question—overall the webinar met my expectations.

Great, thank you so much for answering our survey and on behalf of the Clean Energy Solutions Center I would like to thank all of our expert panelists and our attendees for participating in today's webinar. We do really appreciate your time and again my apologies that we weren't able to get to all the questions from the audience but I will forward those on to the panelists and we'll hope to get those responses out to you shortly. I do want to remind everyone that we will be posting. Some of the slides are already posted at the Solutions Center website. We will be posting the reminder of those slides within about the next day or two. Also, within the next week we will have an audio recording of today's webinar posted to

the Solutions Center training page. Just a reminder we are also posting webinars to the Solutions Center YouTube page as well where you can find additional recordings. Last week we held another webinar on micro-grids so you can also check that one out that's there for a related topic. In addition we also invite you to inform your colleagues and those in your networks about our Solutions Center resources and services including the no cost policy support. With that I hope that everyone has a great rest of your day. I hope to see you again at future Clean Energy Solutions Center events. This concludes our webinar.

DRAFT