CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

The Future of Energy Innovation: Applications for Off-grid Energy in Developing Countries

—Transcript of a webinar offered by the Clean Energy Solutions Center on 19 January 2016—
For more information, see the clean energy policy trainings offered by the Solutions Center.

Webinar Panelists

Richenda van Leeuwen	Executive Director, Energy Access, UN Foundation
Nancy E. Pfund	Founder and Managing Partner, DBL Partners
Mateo Jaramillo	VP of Products and Programs, Tesla Energy at Tesla Motors
Susan Kennedy	CEO, Advanced Microgrid Solutions

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Sean Esterly — 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 Foundations Energy Access Practitioners Network.

Today's webinar is focused on the future of energy innovation, applications for off-grid energy in developing countries. One important note of mention before we begin the webinar 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.

And before we begin, I'll quickly go over some of the webinar features. You have two options for audio; you might either listen through your computer or over the telephone. If you do choose to listen through your computer, please select the mic and speakers option in the audio pane to help eliminate any feedback and echo. And if you choose to dial in by phone, please just select the telephone option and a box on the right side will display the telephone number and audio pin that you should use to dial in. If anyone's 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.

And if at any point during the webinar you have questions for our panelists, we do encourage you to submit those questions through the question pane in the GoToWebinar window. We will address those questions following the presentation. And if you're having difficulty viewing the materials through the webinar portal, we will be posting PDF copies of the presentations through the Clean Energy Solutions Center website and you may follow along as speakers present. Also a video recording of the presentations in the webinar will be posted to the Solutions Center training page within about a week of today's broadcast and will also be added 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.

And we have a great agenda prepared for you today which is centered around the presentations from our guest panelists, Richenda Van Leeuwen, Nancy Pfund, Mateo Jaramillo and Susan Kennedy. These panelists have been kind enough to join us to showcase several leading innovations in the renewable energy industry and potential applications for off-grid energy in developing country settings.

Before our speakers begin, I just want to provide a short informative overview of the Clean Energy Solutions Center initiative, and then following the presentations, we will have the question and answer session where panelists will address questions submitted by the audience, followed by some closing remarks and a very brief survey.

This slide provides a bit of background in terms of how the Solutions Center came to be formed, and the Solutions Center is 1 of 13 initiatives of the Clean Energy Ministerial that was launched in April of 2011, and it's primarily led by Australia, the US 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 that you're now attending.

There are four primary goals to the Solutions Center. Our first goal is to serve as a clearinghouse of clean energy policy resources; the 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, and then finally the fourth goal is to foster dialogue on emerging policy issues in innovation from around the globe. And the primary audience is typically energy policymakers and analysts from governments and technical organizations in all countries, and then we also strive to engage with the private sector, NGOs and civil society.

This slide gives a brief overview of one of the marquee features that the Solutions Center provides, which is the no-cost Ask an Expert policy assistance. And the Ask an Expert program has established a broad team of over 30 experts from around the globe who are each available to provide remote policy advice and analysis to all countries at no cost to you.

So for example, in the area of rural electrification, we're very pleased to have Ibrahim Rehman, director of the social transformation division at the Energy and Resources Institute, serving as one of our experts. So if you have a need for policy assistance in rural electrification or any other clean energy sector, we do encourage you to use this valuable service. And again, it is provided to you free of charge.

So if you have a question for our experts, please submit it through our simple online form at cleanenergysolutions.org/expert, or to find out how the Ask an Expert service can benefit your work, please feel free to contact me directly at Sean.Esterly@NREL.gov. And we also invite you to spread the word about this service to those in your networks and organizations.

And so now I'd like to provide introductions for today's panelists. Our first speaker today is Richenda Van Leeuwen, executive director for energy access with the UN Foundation. She founded and leads the work of the Energy Access Practitioner Network and also works on the secretary general's Sustainable Energy for All initiative.

And our second speaker today is Nancy Pfund, founder and managing partner of DBL Partners. She will present key aspects of financing innovation, providing a venture capital perspective on renewable energy solutions, and how commercial viability, specifically concerning the off-grid sector, can be determined from a financier's vantage point.

After Nancy, our next speaker will be Mateo Jaramillo. Mateo head Tesla's stationary storage business and will talk about Tesla's new home battery, Powerwall, its potential application in developing country contexts and other innovations Tesla is working on that could have relevance for off-grid.

And then our final speaker today will be Susan Kennedy. Susan is the CEO of Advanced Microgrid Solutions, who has been at the center of many of California's groundbreaking environmental policies, including the carbon reduction mandate and cap-and-trade program, will present AMS' suite of energy storage solutions, including their hybrid electric building fleets.

And so with those brief introductions, I'd now like to welcome Richenda to the webinar.

R. Van Leeuwen Thank you very much, Sean, and thank you very much to everybody. I'm just dealing with a technical issue right now, I can't see my own screen, so please hold on one moment.

Sean Esterly Richenda, we'll go ahead and show your slides for you, if that's all right.

R. Van Leeuwen Yes, because I can't see them, so if you could show my slides, thank you very much, now I can see them, so next slide, please.

So to all who work in technology issues, even with great IT, great technology, there are always glitches, it's always something to remember. So the issue and the challenge that we are still seeing with energy access is one of last-mile

distribution particularly, which is that we have struggled as a sector to be able to bring the benefit of energy electricity to the world as a whole.

So today, about 1.1 billion people around the world still do not have the benefits of electricity. At the UN Foundation, the reason that it is of particular importance to us, not only in and of itself, but is with the recognition of the development benefits that come from having access to electricity, both in terms of affordability of electricity and reliability, but really in terms of driving developmental improvements in terms of education, kids being able to study in the evening, better health outcomes, being able to actually offer more health services, whether through the clinics and being able to perform surgery after dark, or even just a woman being able to give birth by light, not having to bring a candle to a clinic, and so on.

We see also many benefits of people being able to operate home-based businesses into the evening and improvements in income. So we are seeing—having been in the sector now for well over a decade, first as the—as an investor and now working much more on policy and advocacy, we have seen a sea change in addressing energy access, particularly with the scaling of and emergence of a whole new class of companies that are able to now work in the off-grid sector, particularly through minigrids and decentralized energy solutions.

And over the last ten years, we've seen a lot of innovation already driving change in this sector, in terms of technical innovation, with the advent and the uptake of things like LEDs at scale and the improvements that we've seen over time, with cost innovation, if you will, with the financing coming down for solar PV particularly, but also other aspects, as well. Energy storage, where we know that there is a lot of innovation happening, but it's not always been that fast to really be able to enter into a developing country setting, so we're really keen to hear Susan's presentation looking at energy storage and how—and Tesla, as well, for that matter, how we see that going to be able to drive change and opportunity in the coming years.

The financial innovation we've seen in terms of really being able to bring energy solutions and services to communities who really hadn't been prioritized previously because they didn't necessarily have the income level where it was believed to be necessary in order to be able to pay for your energy service, and I think Nancy will probably touch on that in her presentation, as well.

And then also process innovation, we've seen a lot of process innovation in terms of really being able to prioritize the way that processes are streamlined so that, in fact, it works on the customer side and it works on the delivery side more in terms of the customer financing that you make that work, the delivery financing that you can bring the products to the markets, and then also just really looking at boutique applications, as well, where you're able to align the technology, the financing, the process, to be able to scale a particular solution, whether on the agricultural side, let's say, with solar-powered irrigation or in terms of being able to support the development of a microgrid using clean energy technology that hadn't been able to be done at scale

previously, as well. And, of course, the policy innovation, as well, that really makes that happen in terms of ensuring that the regulatory environment is supportive for those solutions.

So particularly today we've been focusing on off-grid and really seeing that something like 60 percent of new electricity solutions, according to the IEA's best estimate, will be likely provided by some type of off-grid solution, particularly minigrids and also distributed generation like solar home systems as well as larger grid-tied systems, as well.

Next slide please. So many of you, if you're coming from this sector, will recognize this slide really just showcasing that the innovation goes all the way from the very basic entry level lighting solutions that help to allow a family to switch away from the use of kerosene or candles or dry cell batteries and have access to some sort of renewable energy solution. Again, the software is also key in enabling the optimization of the light and the solar panel and the battery combination there.

And then we see it all the way on through, through standalone solar home systems, nano and microgrid solutions, all the way through to grid-connected solutions, as well. Innovation is happening across the whole space. As I mentioned, we've really seen a sea change, particularly in the last five to ten years on the first and the second tiers, we've always had solar home systems, but really were not affordable in the past to very low income families, and now through some financial innovations such as pay-as-you-go and mobile money payments that have made people have a lower barrier to entry in terms of paying over time or on a weekly or monthly basis, that we are seeing that these solutions are now more available to very low income families, although not available to everybody, which is why still these initial small-scale lighting solutions are such an important part of the solution set, as well.

Next slide please. Next slide please. So at the UN Foundation, we operate the Energy Access Practitioner Network, where we have more than 2,000 members, primarily businesses and social enterprises, many of which are small and medium size enterprises, but also some large corporations, as well, that are really focused on helping to promote and support the uptake of new technologies, new solutions, innovative financial and business models, also on the—at the same side advocating to ensure that we have the right regulatory framework in the countries where these solutions are needed to help drive more rapid solution uptake for energy access over time, again, across a range of different solution sets. But clearly looking to help people at least get their foot on the energy access ladder and then move up over time as the solutions allow and also according to their own affordability and their capacity to pay for them.

So we are really focused on driving primarily market-led, decentralized energy applications. We focused primarily on what's already out there in terms of utilization of existing technologies, looking at quality standards, looking at really trying to drive a more uniform approach to quality. But we're also very, very interested to see what is coming down the pike, particularly in the venture space, also from hubs like Silicon Valley and elsewhere, where

there are new technologies coming in with Tesla, the Powerwall. What are the implications of some of these technologies in a developing country setting? Do they have immediate or potential future applications for the off-grid sector? And how can we best and most rapidly help to match them and utilize them where they do that applicability and help to drive the uptake more quickly across markets where perhaps it would be much slower to—and more risky for them to be tested if it were just left to sort of the usual market channels without additional supports.

We're also very much focused on trying to disseminate this information, because as an entrepreneur working in let's say rural Cameroon, it's very difficult to be able to track what's happening in these other markets on a real-time basis, particularly where you may have even limited access to the internet yourself or are getting the internet over your mobile phone.

So we're also really trying to bridge this gap with webinars like this one to help showcase what's happening and then look at and ask the questions around how can we see whether this is applicable, is it applicable today, are there opportunities for us to pilot or showcase the uptake, or is it something that we just need to be aware of and track for potential future applications. Next slide please.

So just to say something about the scale of what we're seeing with the companies that we're working with. Last year alone they reported providing over 30 million people with clean energy products and services in the last year. They work—based in and work across 170 countries. So first of all working on those countries like India which have still several hundred million people without the benefits of electricity, and then also in some smaller settings where the majority of the population may have access to electricity, but there are still communities and applications where they've not yet been able to bring electricity to everyone. Countries like Argentina, where in the north there are still some communities that don't have access to electricity.

So it's a very wide suite of solutions that some much more tailored to smaller community applications, some really trying to seek to get scale across a wide range of households and community applications, as well, schools, health clinics, also agricultural processing and small business and the like, as well. Next slide please.

So one of the things that we do see on the innovation side is it's an extremely rapidly evolving marketplace. Many of our members have only be in operation for under five years. They are driving, they're bringing innovation to the marketplace but many of them are still small and so don't really have that internal R&D capability to really necessarily look at what's happening in the market and to be able to test that and try that out as quickly and as at scale as they would like to inherently.

So it really is dependent on others still to be able to do that R&D and then help to look at how we can be bringing that back into the existing marketplace. The need is there for technical solutions, but again, the primary need that still remains is really to look at the financing architecture, so the

innovation is still needed in terms of access to finance for companies. Some of them are doing very well, and Nancy I'm sure will talk about some of the recent transactions, including one of the companies she's involved with for off-grid electric.

But we would say the majority of the sector still do struggle somewhat to be able to fulfill their own financing needs and also really to be able to look at aligning the financing for the customer solutions together with their company financing needs, as well. So there is a need for additional financing. There's an additional need for derisking and bringing in those financial minds who can help to look at this more systemically across the sector, beyond an individual transaction level, as well.

Last slide please. So I'll stop there, we have some amazingly innovative companies already that we're working with very closely. Some of them are referenced on this final slide. What we see as the innovation really is being able to drive that affordability, that sustainability of the solution, tailored to the needs and the wants of the communities and the households, and I'm delighted now to be able to pass over to Nancy from DBL and then Tesla and Mateo and Susan to really talk about both financial innovations, but also how they see the technologies that they're working very closely with potentially or even today having this applicability, particularly in the off-grid sector for developing countries, but also as well more broadly.

From UN Foundation, we are technology neutral, we're approach neutral. Grid is great where you can get it, where you can do it very cleanly, affordably, and also where it really is able to be accessible to all. So thank you all very much.

Sean Esterly Thank you Richenda. We'll turn things over now to Nancy.

Nancy Pfund Thank you, Richenda, great intro. And just mentioning the Clean Energy Ministerial, we—the folks in the Bay Area on this call maybe don't know, but the meeting—the annual meeting is going to be in the Bay Area on June 1st and 2nd of the Clean Energy Ministerial, so we're super excited about that.

I want to talk about the off-grid opportunity for microgrids and solar and storage. I want to spend just a few seconds just telling you what DBL is and then we'll launch into the topic. DBL stands for Double Bottom Line, we are a double bottom line venture capital firm headquartered here in San Francisco.

What it means is that we invest for both top-tier financial return as well as social return, we believe those two goals enhance each other rather than anything else. And we spun out of JP Morgan in 2008 after getting started there in 2004, and for the past 11 years, we've had some great portfolio companies and successes and so we've helped to melt away some of the biases about mission-related investing and in fact, the field is getting so much more popular with every year that we've been in it. So we're very excited and investing in Africa is important and generally, more generally, off-grid

countries, developing countries, is a very important new facet of impact investing's growing reach.

So in terms of a backdrop, while there's a huge opportunity, Mateo Jaramillo: we've heard, today only four percent of the world's total climate finance ends up in Africa, so we've got a long ways to go. As Richenda mentioned, there's over a billion folks without access to electricity and 640 million of them are in Africa, and yet the potential on the continent is huge.

The African Development Bank has said 11,000 gigawatts of solar, 350 gigawatts of hydropower, 110 gigawatts of wind, there's—it's really a continent rich in resources for making this transition. And this slide shows you what that transition is going to be like and in venture capital, we're always looking at pattern recognition to help us kind of guide our way to investing in the future, and there's a very bright pattern here.

And that is what happened in developing countries with the cell phone, where basically we skipped there the—in many ways the generation of the landline and went straight to distributed cell phones. In 2002, for example, only 3 percent of people in Africa had mobile phones, and by 2010, that was up to 48 percent and last year it was 70 percent and climbing.

In Nigeria, they only had 100,000 landlines in 1994 for 100 million people, now Nigeria is the leading African country for mobile phone usage, with over 100 million active mobile users. Along with the growing use of mobile phones, mobile payments have become extremely popular. This is a key attribute that makes distributed power very easy to pay for in developing countries, and so mobile payments are expected to reach 101 million users by the end of this year.

So energy presents a very similar leapfrogging opportunity and ability to leverage the thriving mobile payments market. So that's a really important part of the story. In terms of our—well, Richenda went over this fact very clearly, so I'm not going to spend a lot of time on it, but there is—there are a lot of—there are 15 percent of the population in our world without access to grid power and over half of those are in sub-Saharan Africa. So that's why Africa is such a focal point for investment, although obviously not exclusively so. There are all kinds of opportunities across the globe.

I want to tell you about our investment decision regarding off-grid electric as an example. There are many great companies out there that Richenda mentioned some of them. M-KOPA, Mobisol, BBOX, Powerhive, so what's important is to realize that there is a cluster of companies developing that are getting financing, and this is very reminiscent of when in our—in the United States we moved from just moms and pops in the solar industry to very well-funded technology-and-finance-driven national companies. And so this is a little bit of déjà vu what we see here.

So when we looked at the opportunities to invest in off-grid, the thesis really had various elements. Obviously we need large markets, the kinds of numbers we just talked about are large, the total available market in Tanzania is 40

million, 640 million in Africa. Because of costs coming down, as Richenda described, as we'll hear more about, decentralized solar is often cheaper than the centralized grid, especially when partnered with storage. And you can get to cost parity with kerosene and phone charging options now, which wasn't the case even a few years go.

As I mentioned, mobile money, cheap smartphones, decreasing costs really make a base of the pyramid consumer business model possible, and when we looked at off-grid and saw the amount of money that it generated from a lease very similar to leases here in this country, about the net present value of that being right now at about $290 per lease, if you just figure out your millions of leases, this would allow OGE, off-grid electric, and others to be valued at very significant levels, looking at that billion-dollar valuation, at some point.

And in the case of, as Richenda described, in the case of rooftop small systems with storage, there's already some great traction. OGE, for example, has 45,000 installations to date. Now, as impact investors, and it's important to mention this because impact investors are playing a big role in developing countries, we really love the economic upside of this.

Because it's not just that we are solving an energy problem, we're helping to create a middle class in a region where only six percent the population is middle class. And the employment opportunity already off-grid has 800 employees, projected to grow to over 10,000 over the next few years. There's an academy that off-grid has created and others are doing similar work where they're getting really good graduates from universities and it's becoming one of the most—these types of places are becoming the most exciting places to work in Africa. Creating the ability for "solarpreneurs" to proliferate, starting with solar charging kiosks for cell phones and migrating all kinds of solar-powered businesses.

So in sum, when we looked at the impact opportunity, company like OGE both creates jobs that build access to the middle class as it creates its own multiplier effect by catalyzing entrepreneurs' business growth. So those were some of the appealing aspects of the deal for us.

Now, looking at just getting into some of the specifics, we—Solar City had been an investor in off-grid, along with the Omidyar Network and Vulcan Capital and Serious Change. So folks that we know and had experience with, so this always gives you comfort in terms of being able to take something small and make it big.

That was helpful to us, the focus on sub-Saharan Africa was very important to us as we—as I described, given its attributes, and the pay-as-you-go service model at parity with kerosene and cell charging is a huge aspect of kind of robustness as a model.

In terms of where the company is now as it relates to Richenda's chart a few minutes ago, they have an entry kit, which is a 12-watt solar module, a 30-watt-hour lithium battery, 3 bright LED lights, a phone charger and a

rechargeable portable LED light. Then there's a next level up, which adds a portable radio and an optional efficient television.

Now, the company will evolve to include microgrids in areas that are amenable to that, and we'll hear more about that from Mateo and Susan. But this is a great place to start and it's very current in terms of addressing the needs of the population.

Another—in impact investing, you always need to look at policy, and we spend a lot of time on that. Another encouraging aspect is that the Tanzanian national government has sort of took a playbook from California and has its own one million solar homes initiative, which is a big percentage of that country's population, ten percent.

And so they have a goal to provide 1 million homes with reliable solar electricity by 2017. This will generate 15,000 jobs and transfer 86 percent of Tanzanians from kerosene and candles. So that's—that kind of a policy boost is super important to everyone. On the financing side, what this combination of opportunity has allowed for, I think we'll see more and more of this, not only with off-grid electric but with the other players, is now we're getting equivalents of the solar lease funds that we all know about here in our country, because they've been around for several years now, that allow people to avoid the up-front expense of solar and pay more like a monthly lease.

And so this—the first model for this off-grid announced right before the end of the year, raised a $45 million loan fund with impact investors. The Packard Foundation, Ceniarth and the Calvert Foundation, along with some unnamed family offices, have put together basically a solar lease fund for Tanzania. Very precedent setting, never been done in a developing nation at this scale, and 45 million goes a long way in the developing world and just for reference, the first Solar City solar lease fund was only 50 million. So this is just a really heroic achievement and this kind of a model will proliferate and allow investors to reap low-risk returns as we build distributed clean energy and the economic opportunities that go with that in the developing world.

So just to close, I want to—this chart just shows you what a tremendous opportunity exists in Africa and we could do similar charts in India and other parts of the world, but we're starting here. The availability of impact finance migrating to more traditional finance to get this scaled is a very good sign and extremely pivotal, and the fact that we already have a big customer base, we've proven the model, it really is an exciting combination of technology and finance innovation. Very reminiscent of Solar City and the other rooftop solar players' early days, and it will benefit the entire region's health, economic potential and quality of life, as it helps the world transition to a more sustainable energy future.

And the companies that join off-grid like M-KOP and Mobisol and BBOX and Powerhive and the others are really building the 21st century energy and economic development infrastructure for the developing world. And the opportunity for return and impact is huge, and the time is now. So with that, I'm going to turn the baton to Mateo and of course, happy to answer questions

at the end. Thank you so much for the opportunity to tell you about this—about off-grid.

Sean Esterly Great, thank you very much, Nancy, and we'll go now to Mateo for his presentation.

Mateo Jaramillo Thanks very much. I've just attempted to share my screen.

Sean Esterly Yep, we're seeing that, and you'll just—perfect.

Mateo Jaramillo Fantastic. First of all, thanks very much for inviting Tesla to join the conversation. I think Tesla is, of course, well known for the cars in the United States perhaps, and in northern California in particular more than anywhere else in the world. But we are growing our presence worldwide, and with the launch of Tesla Energy this past year, in April, we're sort of—have started to chart a new market force, which extends beyond the areas where even the car is at present today. So I'll talk a little bit about that and Nancy, thanks for the setup there.

It's a very good introduction when we start talking about grids, because that's really the focus of Tesla Energy here. But to just sort of take one step back anyway, the mission of the company for Tesla overall is to accelerate the world's transition to sustainable transport, obviously that means focusing on automotive technology and transportation technology overall and moving to electric mobility.

That—it is a more efficient means of transportation and so that's why Tesla has made a very big dent on all the technology going in there. We're only committed to electric transportation, there's no hybrid aspect to it on the car side for us. However, if all we do is focus on the automotive applications and we ignore the grid that is charging those applications, then we've left at least half of the opportunity on the table, because ultimately, of course, electric vehicles need to come back and charge onto some kind of grid.

And they're charging from some form of resource. Obviously, we think the trends are moving more and more towards a renewable resource and to even beyond that, a distributed renewable resource. And so that's where our battery-stored technology comes in. Cost is by far and away the most important driver on the electric grid. That's true in the United States as well as it is in any emerging markets where grids are being developed. And in sort of an unusual was, Tesla's focusing on the high-end markets and selling the volumes that we think we can do there on the vehicle side really allows us to go into other very cost-sensitive markets, as well.

Just a brief history of Tesla, of course we're a very young company relative to the markets in which we're operating. The automotive industry is 100 years old, the electric grid industry is similar. And so by comparison, we're just over 12 years old, sorry if I got my math wrong, little more than that. And in that time, though, we feel we've come a pretty long way.

The first car we introduced in 2008 and that was a very small, very high-end roadster, a sports car. Model S, which was our—is our sort of flagship sedan we launched in 2012 and then in 2015 we added a vehicle to that same platform, the Model X, which is a crossover vehicle. We also launched the Tesla Energy Effort.

And the Tesla Energy Effort, as I mentioned, it's sort of a new path for us overall. But the automotive products that we've developed over those past 12 or so years have incorporated more than just our own cars. We have developed power trains for other car companies, as well, and this was sort of a—the confirmation that Tesla has best-in-breed technology overall, but it also reinforces the idea that Tesla really is a systems developer for batteries.

Batteries, of course, all by themselves don't do much, they need to be able to interconnect with the grid and feed the right kind of power to the right kind of devices in the right context in which they're operating, and so this mentality of delivering complete systems is very much a part of the Tesla engineering approach overall and very much informs the direction that we're taking on energy storage.

I also highlight the fact that we're very interactive with the grid through our superchargers, as well. So these are our high-powered DC charging stations, I've put just two of the maps up here, for Europe and for the United States, we have similar maps for parts of Asia, as well. And it just highlights the nature, too, of Tesla to really interact with the grid and to be very engaged in the development of that grid.

In the process of deploying both our cars as well as our infrastructure, our charging infrastructure, we've seen just about every kind of grid commission there could be. It's probably not surprising to most of you, but in many of the developed world, in fact, the grid has reliability issues and has other sort of unique characteristics that one needs to be aware of that sort of sets the stage quite well for going into some of these newer markets.

Collectively, Tesla's delivered nearly 100,000 cars into the world right now, we think of that as a collective fleet. And when we sort of take that perspective, that means that basically we've got more than six gigawatt hours of deployed energy storage out there, which makes us the largest battery manufacturer in the world.

We also have more than 27 gigawatts of bidirectional three-phase AC inverters, which is basically the grid connection point for the vast majority of the world, three-phase AC power, different voltages of course, and collectively those cars have driven, at this point it's more than one and a half billion miles.

And so that really sort of informs the way that we approach our interaction with the grid overall, and also the scale at which we're attempting to solve these problems. Of course, in order to really work at very high volumes, which is what our intention is, not just with our current car but with a

forthcoming car in a couple of years, the Model Three, we have to scare on supply.

Lithium ion batteries have really taken a hold in the market, we think they're the clear winner for the next ten years or so at least. But right now, there's not enough supply in the world, to be perfectly frank. And so that's why Tesla has taken the steps to develop what we call the giga factory. This is our first giga factory, we've contemplated additional ones beyond it, and it's under construction right now in the state of Nevada in the United States.

And this will supply enough batteries for both our vehicle side as well as for the Tesla Energy side. This plant, as currently envisioned, essentially would double the world's supply of lithium ion batteries. So the current world supply for all chemistries from all manufacturers in all regions would be equivalent to this individual factory operating for Tesla.

And so this is one of the major drivers for cost, and this is what allows us to really step into new markets where cost is, of course, the most important issue. So this is, as I said, very much underway and already supplying batteries for the Tesla Energy side.

As I mentioned, the—we are sharing technologies between the car and the Tesla Energy side of things, and the reason we're able to is because of the architecture that we take into the battery packs. So we start with a small cell, those blue cells there, about the size of your thumb, and from that individual cell we create what we call modules, groupings of hundreds of cells and then those modules, depending on how many we need per battery pack, are going into the different battery packs.

But that allows us to essentially utilize a common form factor at the cell level and as well a common form factor at the modular level, and on top of that, all the engineering work that goes into developing the architectures and building the robust systems, and then of course the supply chain and the manufacturing side of things, which supports the massive scale at which the company will be operating.

And so that's what really allows us to take some very concrete steps into these new markets without requiring a massive re-engineering effort or supply chain effort to really hit the low cost targets that we need for both markets, frankly, the car side as well as the grid-connected side of things.

And so this is how we start to see the benefits from working in the automotive scale going over into the grid-connected side of things. It's a very big lever, there's a lot of energy that goes into transportation and once we start to convert a relatively small portion of that energy to electric energy, then the levering effects back into the electric grid are very, very big.

And so that's why we're able to address all these different applications. I've listed all the applications here that are able to be addressed by both the Powerwall, which is the Tesla home battery, and as well as the Powerpack, which is the Tesla commercial utility-scale battery, because one nice thing

about batteries and the particular architecture that we've taken is that these are very scalable solutions.

And Nancy mentioned the 30-watt-hour battery, we're not going down quite that small at this point. We're still in the single digits of kilowatt hours and we'll probably remain there for some time, but nonetheless, you can address everything from a microgrid all the way up to transmission distribution support either at the centralized level or at the distributor level.

We see very big opportunities in microgrids in emerging markets, we have already started up our efforts in Africa, in fact, we have an effort underway currently in South Africa and we'll use that as sort of a launching pad for the rest of the continent.

There's a—there, of course, is a very strong interest in surge technology for the very simple reason that energy is not always produced, electricity is not always produced when ideally you would like to use it. So the concept of storage being introduced especially into a more and more renewable grid is a very intuitive one, in many ways. And so that's really what Tesla is aiming to do.

As I mentioned, we're starting at the high end of the market, but we see very, very quickly coming down into that market that really allows for a proliferation of energy access across developing markets. And the products that we're designing are very much intended to serve those markets, ultimately. Right now, some of the form factors are more suited to the developing world, but there is definitely a path to address the global market for energy storage as we see it emerging very quickly here over the next couple of years and into the coming decades.

On top of the applications for the microgrids, of course, ultimately there is still, of course, a lot of interconnected assets and there's a lot of services that still need to be procured in the electricity markets and the energy storage devices that we're developing are fully capable of providing all of those services and increasing the value of the grid, essentially.

Perhaps the best way to think about is these are the warehouses of the electricity grid that to date have never existed. Every industry has inventory, every industry to operate efficiently has warehouses and that's essentially what we're developing and will be deploying here soon.

Just a little more detail on the Powerwall, of course. We're further refining this for the markets and making sure that we're delivering solutions that really solve the problems that are out there, and again, just an example of that, some of the scale that we have going from individual units for very small microgrids all the way up through much larger systems, as well, and then very large, centralized systems, as well, to support the existing infrastructure at the transition or distribution level.

And then finally the complete sustainable future as we see it. Of course, this is a very say let's say developed world home, but we see this as basically

being the exemplar for pretty much anywhere in the world. So ultimately you'll have solar, you'll have a battery to be able to feed your loads, hopefully we'll all be using electro ability, as well.

So this happens to be a picture, of course, of the developed world, but it's quite easy to imagine a developing world version of this, as well. So with that, I'll end and again say thank you and of course happy to answer questions as they come up here in the dialogue.

Sean Esterly Great. Thank you very much Mateo. We'll move right along now to Susan Kennedy for her presentation.

Susan Kennedy Thank you very much, I really appreciate the United Nations Fund and the Clean Energy Solutions Center for putting this together. And let me give you a little bit about my background first. I'm at the—I've been at the policy level both as a—at a utility regulator for the last 20 years. Most recently, I was the chief of staff to California governor Arnold Schwarzenegger. And before that, I was on the California Public Utilities Commission where we regulated the electric and telecommunications and water utilities.

In those positions, we—I helped to draft and implement many of the energy policies that we are working in—with today, including the carbon cap-and-trade system, the low carbon fuel standard, the renewable profile standard, net energy metering, the million solar roofs initiative. So I've been at—working in energy as a regulator and policy person for the last 20 years.

So we started at—Advanced Microgrid Solutions is a developer of energy storage projects. So we don't have our own—we don't build our own batteries and we don't built our own technology, we select the best available technology from around the world and we design projects using energy storage to harness and control building load, and then we use that building load to provide large-scale, grid-connected resources.

Our software platform focuses on two things, integrating distributed energy resources, like advanced building load management systems, solar, wind, fuel cells, cogen, electric vehicles and energy storage, and then aggregating and operating those distributed resources to provide large-scale, grid-connected resources to utilities and grid operators.

So the way we—let me give you a couple examples of the way we are using energy storage and here's—in this case, we—one of the key issues is integrating with distributed resources, including solar. If you look at the red line on this chart, that's a building load that has solar and you—and it's very volatile. During the day, it's producing more solar than can actually be consumed by the building, so it's sending it back to the grid, and then when the sun stops shining for periods and then at the end of the day stops shining, the building load dramatically shoots back to the—to grid resources.

This blue line on the—on top is what the distribution system operator sees and has to plan for, and so you have many resources being spent trying to handle the volatility of the distributed resources on the grid and it's in a very,

very expensive headache for grid operators and utilities to manage for when they—when this load comes back to the grid.

But when you add energy storage, this green line actually smoothes out the—it absorbs some of the solar earlier in the day and then uses the battery to smooth out the consumption pattern so that not only do you not have this volatility on the consumer side, which is a very expensive proposition, but also the grid operator has some control—some—it reduces stress on the grid by eliminating this enormous jump up in demand.

So capturing—at scale being able to capture the benefits of energy storage for both—on the consumer side of the meter, but also at the distribution level is the—is what we're aiming to do using energy storage.

Energy—the single question of why energy storage is because it's the only technology that allows you to integrate these renewable resources and harness the building load in a way that can provide distribution-level benefits. Utilities around the world are going to spend more than a trillion dollars over the next decade trying to manage this volatility in the distribution system. A trillion dollars. In the United States alone in 2014, utilities spent more than $100 billion on the distribution system alone.

So you can see the level of the need for storage at the distribution level is enormous. So storage provides reliability, power quality, integration of renewables, avoids the distribution-level upgrades, and it allows consumers of electricity to harness their load for revenue streams from grid resources.

The key to being able to harness—to use energy storage effectively is to unlock the multiple benefits of energy storage, demand management, integration of renewables, power quality backup, negative demand recapture and providing for things like electric vehicle charging infrastructure, these are all services and uses of a battery that you can—the multiple uses that you can put in one battery system, in many ways.

So the key to cost effectively deploying energy storage is to use as many—use the battery for as many resources as possible. On the distribution level, the same is true at the distribution level. When you distribute batteries behind—controlling customer loads on a large scale, it becomes the most—the cleanest, fastest, most cost effective resource for capacity for load serving entities, for load-following integration of resources, voltage regulation and reactive power, conservation voltage.

So the key will be to provide the technologies that allow those batteries and storage systems to be utilized on—at the customer load for these distribution-level buildings or resources. So what AMS is doing is we are building the—50 megawatts of energy storage systems for grid support in southern California, and so we're utilizing some of this—some of the theories I just laid out for a grid support project for Southern California Edison.

In the last couple of years, a very large nuclear facility, San Onofre, was taken offline in southern California, and so it created an enormous need, 2,500-megawatt procurement for Southern California Edison in this area, and in this area, you cannot—you can't put another peaker plant. You can't put a ten-megawatt peaker plant in downtown Los Angeles or in areas—in very urban—dense, urban areas. You cannot solve their problem with another 500 or 1,000-megawatt solar array in the desert and try and transport it in, because transmission distribution system can't handle it.

So this type—this enormous need had to be handled by harnessing the building load itself, and that's where we saw the opportunity to demonstrate behind the meter grid-scale resources. So we have identified by—building load in this area at a large scale where we are harnessing the building load using energy storage systems, happens to be that we're—our projects are primarily using the Tesla Powerpack, again, I said best available technology and there's no question that the Tesla systems were the best in class.

And so we're using as large a system as we can, inside the buildings or I mean, with—to harness the building load and then aggregating many buildings into a fleet for grid service. And the way it works is similar to the way a hybrid electric car would work in that the batteries go on and off to be able to shift as much of the building load when possible when the utility needs the resource, just to control the consumption.

So it acts like a hybrid electric car, going back and forth from grid to battery, grid to battery, until it's given a dispatch order when it shifts the batteries—shifts the building load to batteries. This is a case of using the batteries with an aggregated load and a large system. It has solar and wind resources, as well. So this is what the load—this is what the building load looks like without batteries where you've got solar that happens early in the day and then goes on and off, goes up and down and then the wind kicks in late in the day, and without any battery storage to harness this, you basically have solar that's very cost ineffective early in the day and you went—and you don't have enough resources for the peak period of the day when it's most costly to be taking from the grid.

So when you add energy storage, the way we're using it is you store it, you use it just to—the solar to charge the batteries wherever you can, and then you use the batteries to basically shape the load and shift the building load, harnessing the distributed resources so that you are optimizing the load shifting during the periods of highest stress on the grid or when it's most expensive to be using grid electricity.

And so what the grid operator now sees is a fully optimized load, where it's very flat, very easy to plan around, this is what the grid actually sees and has to plan for, and then when we—during the on-peak period of the day, the load is reduced using the batteries and the on-site resources, so that you have a very fully optimized load.

Our first project is a fleet of—it's a ten-megawatt, hybrid electric building fleet where it involves 26 office buildings through the use of the very large—

the average system size behind a particular meter is half a megawatt, so these are very large systems. In some cases, it's four to six hours of batteries. We're able to shave peak demand by 25 percent, which is a 20 percent reduction in greenhouse gas emissions for this fleet of buildings. It results in a ten percent reduction in energy cost for the building owners. It provides ten megawatts of firm, dispatchable capacity to the utility. Zero emissions, zero distribution upgrades.

We target the substations in a particular area and we identify what are the—where are the major building loads in that area and we harness specifically the load that is required in order to relieve stress on that part of the grid. We cluster the buildings, we—to get—harness as much as of the building loads as we possibly can in those areas, and then we use the software and telemetry to operate it as a fleet so that the utility can actually drop small clusters at a time or the entire portfolio together in order to provide dynamic load management for the utility.

The key for us in our view is scale. These are—batteries are very expensive, it's very expensive technology, and the key to making it cost effective for either the—for deployment for the grid operator is scale. And so aggregating individual resources into fleets and being able to optimize those resources and provide them in real-time or very close to real-time support for the grid so that you can create distribution-level benefits and benefits for the cost reduction and other services at the host level, at the building level is the key to making energy storage an effective and a cost-effective distributed energy resource.

I think I—that's—I'm going to stop there and I think we should go to questions.

Sean Esterly Great, thank you very much Susan, and thank you to the rest of the panelists for the great presentations. We will move right along now to the question and answer session. We had a number of questions come in from the audience. The first question that we had, I'll just work my way through these, first question's for DBL. It's wondering what the appetite of investors is to invest in manufacturing locally products in developing countries and what also is the path to grow the off-grid lighting sector?

Nancy Pfund Well, thank you. Yeah, local manufacture is a popular topic, it is something from an economic development point of view that is beneficial. For example, the giga factory in Sparks, Nevada that Mateo referenced, that's in Nevada, it's in the United States, it's not offshore. The Solar Cities factory that's going up in Buffalo, these can have huge economic benefits to the region in all kinds of ways.

Now, in the early days of a market evolution, it's a little harder to weave in local manufacturing from the get go, especially when there isn't a—sort of an industrial infrastructure. Doesn't mean it can't happen as the rollout moves and gains volume. But the—you've got to remember as we've been all saying, one of the key themes is the dramatic decline in cost of storage, of solar, and

the ability to get these costs at parity with existing solutions. And a lot of that depends on very sophisticated manufacturing ecosystems.

So while I can't say—of course you can always have local assembly and have a role for part of the kind of later stages of the manufacturing chain, but in the early days, you'd need to kind of rely on the cost production that's happened in other places on the globe, and then eventually you'll see, as you have seen in batteries and solar in our country, roles for a local manufacturing space.

The second part of the question was what?

Sean Esterly Yeah, the second part was asking about lighting. Sorry, let me find it here.

Nancy Pfund Just what's going on there? I mean, there's dramatic increases, efficiency, quality of light, cost per lumen. It's a very good story there. And that's why it's so empowering to see the developed world and the developing world coming together on this. Because a lot of the engineering talent that you have that's built up some of the companies we've been talking about are now able—those same people are now helping to get to the next level of cost performance optimization and take that to parts of the world where they need an even lower price point.

So I think you'll be seeing from companies like the ones we've been talking about second and third generations of these products that are even better at optimizing than we see now.

Sean Esterly Great, thank you very much, Nancy. And we had a number of questions come in for Mateo regarding the use of the lithium ion batteries and about their practical use for off-grid applications. So I'll try to wrap up all these questions into one general question, but basically do you see—is there any potential in the future, do you have a timeline for when possibly lithium—Tesla lithium ion batteries can be used for off-grid applications to power homes?

Mateo Jaramillo Yeah, we already have batteries that are running in off-grid applications, essentially running microgrids unconnected to any centralized grid, so they can be used today, to be clear. The—ultimately which batteries will be used is determined by cost, of course, and so we think that first of all, lithium ion as a category will be very, very competitive. We think it's a winner, as I mentioned, and in particular we think that the batteries that Tesla's going to be supplying into the market will be the leader within that.

So I think the answer is right now today there is a fair amount of microgrid work that's happening in let's call them developed islands, those could be islands unconnected to the rest of the land from a grid perspective within a terrestrial application or they could be real islands in the middle of the ocean, and then we'll continue to see that just be—continue to be more and more competitive in the rest of the market.

So it's today and just an increasing market with every _____ that we hit.

Sean Esterly Going to, thank you very much, Mateo. This next question relates a little bit to Nancy's presentation. They just note that it was great to hear about some of the practical off-grid applications, especially with examples of companies providing relevant services. Are there any examples of those that are using sustainable business models rather than depending on public-sector funding?

Nancy Pfund Sure. Well, I guess I would point out that most energy companies around the planet derive some public funding because it's such an important part of our economy that many countries and states and regions do support energy transitions and we've been doing that here in the United States since the country was started. So I guess in terms of just level setting, it's important to realize that the government plays a critical role in promoting energy transitions, and we just saw a great example of profile and private sector attention to this in Paris last month.

So the notion that a sustainable business model in energy is somehow divorced from the role of the public in supporting these transitions is not one that is really relevant. Having said that, predictably, as business models grow, as Mateo said, Tesla's only 12 years old, Solar City went public 3 years ago, Sun Run went public last year. These are very young companies and the incumbents, of course, have had—had had federal and government support, in some cases for almost a century.

So as the companies grow, the idea is that there is less dependency on government incentives or government policies in the form of incentives. That actually hasn't happened in fossil and nuclear, but it certainly will happen, I believe, in renewables because the cost curve is—and storage, the cost curves are so compelling that over the next—that solar and storage are already at parity in many parts of the globe and that will only increase as we develop scale and improve our financing and technological innovations.

R. Van Leeuwen Sean, if I could just weigh in, Richenda, just to add, as well, to Nancy's excellent answer just a little bit more on the energy access sector specifically, I mean, I would say that subsidy has not been an enemy to energy access companies already trying to really help to take these solutions into markets that are already, from a sort of financing perspective, not even often considered emerging markets.

They're pre-frontier markets in many senses, so there are existing emerging market risks associated with trying to build up companies and solution sets there that can be somewhat offset, but that takes resources, it takes investment to be able to do that. But also in many cases, these are market pioneers really bringing these solutions for the first time to communities. So you also have the cost of acquiring customers, it's not as if that you've already got existing customers that are oftentimes that are just sort of switching out, but you're actually having to educate the consumers about whether it's a solar solution or whether it's the service that you're providing, and there's additional costs associated with building that market as you're trying to run down the road, as well, in building up your consumer base.

And so we've actually seen a range of different types of subsidy, some at the more systemic level in terms of nonprofit groups that have been helping to build new acquisition channels for consumers, as well as subsidy that has been very helpful to some of the companies that are startups and don't necessarily have the VCs behind them in a very meaningful way providing the opportunity for them to burn, so a lot of capital up front. So there's been a lot of boot strapping and particularly I would say that additional financing in terms of a variety of ranges of concessional financing tools has been very, very helpful.

As Nancy pointed out, as the market matures, that may well change, but to date it's been extremely useful.

Sean Esterly Thank you, Richenda and Susan, or I'm sorry, Nancy. And we do have a question for Susan about AMS. You mentioned a ten percent savings in energy costs. What percentage saving is made on mains electricity used?

Susan Kennedy It depends on the type of application that the battery's being used for. In some cases, depending on the utility rate structure, it's on the demand charge, the heavy—the savings really comes from demand charge management. But where you have time of use rate structure where shifting a load away from the rates—away from the high-cost energy, then a big portion of it can come from the energy shifting itself.

Our greatest savings come when you're integrating distributed resources, including solar and fuel cells. Those are the—some of the projects we're working on today where we're seeing some of the best savings by shaping and firming those distributed resources in response to a particular rate structure.

Sean Esterly Thank you, Susan. Next question is for everybody. So whoever'd like to chime in. They're just asking for some general discussion on the life of storage assets, the general cost of replacement and therefore the return of investment on the system, and then disposal of storage assets.

Mateo Jaramillo I should probably jump in on that one, first. But Susan and Nancy, of course feel free to chime in. So the life of the systems, Tesla designs systems which are intended to operate maintenance free for ten years in the field. However, of course, many utility assets are—tend to be longer lived than that, and so Tesla has an approach to basically providing what we would call capacity maintenance over much longer periods, however long is needed, so 20, 30 years.

That may involve replacement of physical—physical replacement of goods, it may also just involve supplementing the existing installation to make sure that the operation is as it was rated in the beginning of life. So of course the battery performance profile is changing, there are improvements coming out every year. It's one of the reasons that we're so optimistic for the future of energy storage is, of course, that you do see costs coming down and with it performance improving.

And so, of course, any market wants to be able to take advantage of that, and that's another advantage to the architecture that Tesla has. It allows us to do that in a very cost-effective manner and really minimizes up-front investment. And so we can tailor our battery solutions to the term that may be required for whatever the application is that's desired.

As far as end-of-life disposition, batteries can be recycled fully and in fact, there are some very good success stories in that regard, the lead acid batteries, at least in the developed world anyway, are recycled at more than a 99 percent rate. And we see for lithium batteries, as well, something similar being able to be put in place.

As a matter of fact, Tesla at the giga factory will have a very significant recycling operation, so we'll take back batteries at end of life, reprocess them and put them back into the material flow. So it's very much top of mind for how we think about these things. We are talking about commodities, there is value there at the end of life of a battery as far as a chemical battery goes in the materials that are in there, and we very much intend to take advantage of that. And we don't think we're going to be the only ones there, with the increase in global market for batteries, of course more and more people would see value to the constituent components there.

Susan Kennedy This is Susan, I'll kick in, as well. Yeah, Mateo covered the return on investment from the system itself. From a project perspective, the replacement cost of the batteries is only one aspect of it. The—we believe that the residual value of a project and the return on that investment is enormous when you consider that after you've equipped these buildings with the—not just the energy storage systems but all the telemetry and the communications technology that operates these and taps into those—the value streams, you have a permanent revenue structure built into those buildings.

And so the—you have to look at a project that utilizes battery storage and the return on that investment in a way that captures the value of having a customer relationship that will span far—much longer than the life of the battery itself.

Sean Esterly Thank you, Susan.

Nancy Pfund This is Nancy, I would just add, I mean, Mateo and Susan have covered this well. It does range in terms of these very small systems, rooftop systems in the developing world, what their lifetime is in the five to ten years, and that will change over time, but certainly the notion of recycling and it's important to view these assets as something that will figure out, that will have a recycled life as opposed to just a—being done when the lease time is over.

Sean Esterly Thanks, everybody. We'll stick on the topic of batteries for just a moment. This question going back to Mateo, what is the average price per kilowatt hour of Tesla batteries and can that be competitive with dominant lead acid batteries for these types of off-grid applications in developing countries?

Mateo Jaramillo Yeah, you typically need at least five different reference points to really understand what somebody means when they give you a price on batteries, so I'll sort of refrain from a specific dollar-per-kilowatt-hour figure. I think in fact a better point of comparison for any grid participation by batteries is what's sort of commonly starting to become known as the levelized cost of energy, or levelized cost of storage, depending on how you want to think about it.

But basically how much energy you get out of a battery over its lifetime into the cost of that battery, again, the total cost of that battery over its life. And so that gives you a levelized cost of some sense per kilowatt hour, I'd say. And so the short answer is absolutely we see our batteries being competitive in grid markets today.

As a matter of fact, there's some projects right now in the United States where it's competitive to have solar plus battery and that total cost, the levelized cost of the storage, plus the levelized cost of the solar is cheaper than the grid energy. And so we see that in certain markets today and we see that—both those prices continuing to go down and being very, very competitive in the broader buyer markets.

The energy markets are where the—frankly where the money is, and for electricity, it's not in power, it's in energy. And so that's what we're after. But certainly within the next couple of years and with the growth of the production out of giga factory, we see batteries plus renewables being competitive with the delivered cost of energy in the vast majority of the market.

Nancy Pfund And I would just add that these small systems that off-grid and others are offering, in terms of what they're competing against, their pricing, very, very low, sometimes eight to ten dollars a months. So you can see there's a huge—from the Powerwall, which of course is a whole different animal with enormous capacity to these little systems, it's a pretty varied landscape, which is good because there's need for all, at this point.

Sean Esterly Great, thank you both. Going back now to Susan, we have a question for you on the relationship between microgrid developers and utilities. Do you envision co-ownership and co-development of microgrids with the utility inside of their service territory, or developing one—microgrid developers developing them for utilities, such that it is owned by that utility after it's been implemented?

Susan Kennedy I see both markets developing and it really depends on what the regulatory structure allows for in each utility service area. In California, they—it's not barred to own distributed resources. In some areas of the United States, utilities are simply not allowed to own those kind of distributed, customer-sided resources. So we're talking to a couple of utilities right now about exactly the build-own transfer of essentially a microgrid project where they would tap into third parties like us, developers, to design and build the project, and then over a period of time, the utility would take ownership of it and then we would stay on as asset managers.

So I see a lot of collaboration. I think before—there's an interim step to either microgrid or a non-microgrid. There's the interdependence of areas that have island incapability, and I see that as being a more near-term project structure for where utilities are creating the ability to isolate problems in the grid and use energy storage and other distributed resources to be able to self-repair or to repair, remotely repair problems with the grid.

And a lot of these areas that are being—that are capable of islanding tend to be either large campuses or geographically isolated areas or districts such as ports or major transportation hubs and things like that. So I see an interdependence and then island incapability as being a near-term step towards microgrid capability.

Sean Esterly Thank you, Susan. Going back now to Nancy and DBL, assuming that DBL invests in US dollars, who's taking the risk that local currency, which customers in, say, Tanzania, earn and pay under the solar home system rental contract, will depreciate?

Nancy Pfund In any international investment, in the developed and developing world, there—you do have a currency risk, you have—I mean, there is a—there are political risks, and that's the we've thought long and hard about and try to mitigate. There are hedging strategies, there's all kinds of ways that you can approach this, but you're never going to just reduce your risk to zero, and that's okay because that's kind of our job is to be out on the edge there, but do it in a prudent way. So you're right to call it out as a risk, it goes with the territory, and we do feel that this is something we'll be managing actively, not only from a venture perspective but the executives in the company, both here in the states and on the ground in Tanzania are going to be looking at various ways to mitigate this risk.

Sean Esterly Thanks again, Nancy. And this question, again, goes to Susan, but I think anyone could speak to it, as well, if they want to chime in. They're wondering what the base load technologies are to address large loads for buildings and are hydrogen fuel cells a viable future option.

Susan Kennedy I think the main source today for us is either grid, from the grid, or co-generation is widely used here in California for base load. Fuel cells, I think, are a very viable option and it—I think hydrogen fuel cells are one and also other chemistries, natural gas and other biogas fuel cells I think are very viable base load technologies. And we're—I think it's really just about the cost effectiveness of having what is essentially a redundant base load system when you are—when you have grid resources and the regulatory structure that promotes or provides a barrier to deploying those kind of base load technologies.

In the United States, many utilities have already purchased enough base load to cover their entire load and so there's usually an exit fee if you're going to put in a very large base load plant like a cogen or a fuel cell to take—to reduce your dependency on the grid. _____ the cost effectiveness of deploying a base load is really sensitive to what the grid operator—what the market is for those technologies through the grid operator. But I think the—

right now I don't think there's much substitute for co-generation and I think fuel cells are the next one in line for base load.

Sean Esterly Great, thank you Susan. We have time for one more question. So this one, again, is for everybody, and just try to keep the responses brief if we can, as we're running out of time here. But it's—we had a number of questions come in about political instability and just kind of the risk of dealing with government bureaucracy. For energy access markets, political instability of the developing countries presents major barriers to market development, in particular private businesses in investment. Does anyone have any thoughts on or recommendations on methods for overcoming those barriers?

Nancy Pfund Well, I—this is Nancy, I'll just jump in and pass it on to the others. I did refer to it a minute ago in my answer, political risk is something that you need to evaluate and you need to—and that was one of the reasons we really liked the OGE team is that they were very sophisticated about it. Their growth strategy into other nations besides Tanzania has very rigorous political risk analysis attached to it, and so that's what you need to do. It's not something you can eliminate and it certainly is not a reason to say I'm not going to do anything. That's not how u change the world and that's not how you create significant investment opportunities.

You've got to understand that there—these are matters that will come up at one point or another. I will say that the developed world, it's not that different. There are definitely all kinds of challenges going on in various states in the US right now in terms of moving to distributed generation. So it goes with the territory, it's something that I believe that investors need to embrace and sort of get involved and help their management teams do this in an intelligent way. You're not going to win every battle, of course, but you can win a lot of them and move the ball forward towards a global clean energy economy that creates employment opportunities for many folks.

R. Van Leeuwen Can I just add there, as well, that I mean, I think there's two ways of looking at political risk, and Nancy's totally captured it correctly. But we've seen in the mobile telephone center that one person's political risk is somebody else's business opportunity. I mean, there were those who sort of went to all of the markets where they said it couldn't be done and then built up very substantial mobile telecoms companies being able to do that.

I mean, I think there are ways that you can address it financially and certainly as you're looking at developing your business model, building out whether you need some kind of hedging mechanism and building these into your business model. But also recognize the tools that are available now, again, depending on the country, depending on the context, like the African Development Bank's work, like Power Africa, like some of these others that are focusing either at the individual transaction level or are focusing at helping to ensure a stronger and regulatory environment that is actually going to give some additional supports and mechanisms to businesses. So I know, for example, that with support from Power Africa, we've seen some new initial transactions with PPAs, for example, in Ethiopia that had never happened before.

We—one of the ongoing challenges is that there is still a very strong regulatory grey area, particularly for microgrids in a lot of African countries. And to the extent that on the policy side we can have a more normalized operating environment with more clarity around IPPs and how they can operate, how does it work, more support for those who are sort of presenting these groundbreaking transactions, then I think you can offset some margin of the risk.

I think it's really looking at it both on the financing side, but then also how can we, on the policy side, help to just create a more stable operating environment, which of course for business, they love the stability, so I'll end up with that.

Sean Esterly

Great, thank you everybody. And unfortunately that is all the time we have for this webinar, so we'll have to go ahead and wrap up now. I know there's a number of questions that we didn't get to address. We will gather those together and e-mail them along to our panelists so that they can provide brief responses to those.

I would like to move along now to our attendee survey, we have a few questions that we like to ask to help us evaluate how we did and improve for the next webinar. So I'll display the first question, and you can respond directly to the screen and just mark if you agree or disagree with the following statement. The webinar content provided me with useful information and insight.

And second question, the webinar's presenters were effective. Third question, overall the webinar met my expectations. And a yes or no question, do you anticipate using the information presented in this webinar directly in your work and/or organization. And one final question for you, do you anticipate applying the information presented to develop or revise policies or programs in your country of focus.

Great, thank you everyone, we appreciate your participation in the survey, and again, on behalf of the Clean Energy Solutions Center, I'd just like to thank each of our expert panelists for taking the time to join us today and also to our attendees for participating in today's webinar. Very much appreciate everyone's time.

I do invite everyone to check the Solutions Center website, particularly the training page. We have several of the presentations posted already and we'll be posting the rest of those within the next day or two. Also check back within the next couple days for a video recording of today's webinar and please feel free to share that with those in your networks and organizations.

Also just a reminder about the Clean Energy Solutions Center Ask an Expert program, which is free to use. Please check that out while you are on the site, as well. And with that, I hope everyone has a great rest of your day and we look forward to seeing you at future Clean Energy Solutions Center events. This concludes our webinar.