CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

Energy Efficiency for Energy Access: Latest Trends and Innovations

—Transcript of a webinar offered by the Clean Energy Solutions Center on 24 April 2018—
For more information, see the clean energy policy trainings offered by the Solutions Center.

Webinar Panelists

Sam Grant clasp
Jem Porcaro UN Foundation
Maja Gajic fosera

This Transcript — Because this transcript was created using transcription software, the content it contains might not represent precisely the audio content of the webinar. If you have questions about the content of the transcript, please contact us or refer to the actual webinar recording.

Katie — Hello everyone, I'm Katie Contos and welcome to today's webinar which is hosted by the Clean Energy Solutions Center in partnership with the United Nations Foundation Energy Access Practitioner Network. Today's webinar is focused on the Energy Efficiency for Energy Access: Latest Trends and Innovations.

Before we begin I'll quickly go over some of the webinar features. For audio you have two options. You may either listen through your computer or over the telephone. If you choose to listen through your computer, please select the mic and speakers option in the audio pane. Doing so will eliminate the possibility of feedback and echo. If you choose to dial in by phone, please select the telephone option and a box on the right side will display the telephone number and audio PIN you should use to dial in. If anyone's having any technical difficulties with the webinar you may contact the Go-to Webinar's help desk at 888-259-3826 for assistance.

If you'd like to ask a question we ask that you use the questions pane, or you may type it in. The audio recordings and presentations will be posted to the solutions center training page within a few days of the broadcast and will be added to the solutions center usage channel where you'll find other formative webinars as well as video interviews with thought leaders on clean energy policy process.

Finally, one important note to mention before we begin our presentation 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 resource library as one of many best practice resources reviewed and selected by technical experts.

Today's webinar agenda is centered around the presentations from our guest panelists Sam Grant and Maja Gajic, who have joined us to discuss the latest trends in innovations and appliance efficiency and their role in increasing access to clean, reliable and low-cost energy. Before we jump into the presentations I'll provide a quick overview of the Clean Energy Solutions Center, and Jem Porcaro from the United Nations Foundation will provide a quick overview of the Energy Access Practitioner Network.

Then following the panelists' presentation we'll have a question and answer session where the panelist will address questions submitted by the audience. At the end of the webinar you'll be automatically prompted to fill out a brief survey as well. So, thank you in advance for taking a moment to respond.

The Solutions Center was launched in 2011 under the Clean Energy Ministerial. The Clean Energy Ministerial is a high-level global forum to promote policies and programs that advance clean energy technology, to share lessons learned and best practices and to encourage the transition to a global clean energy economy. Twenty-four countries in the European Commissions are members contributing 90 per cent of clean energy investment and responsibility for 75 per cent of global greenhouse gas emissions.

This webinar is provided by the Clean Energy Solutions Center, which focuses on helping the government policy makers design and adopt policies and programs to support the deployment of clean energy technologies. This is accomplished with the support and crafting and implementing policies relating to energy access, no-cost expert policy assistance and peer-to-peer learning and training tools such as this webinar.

The Clean Energy Solutions Center is co-sponsored by the governments of Australia, Sweden and the United States with in-kind support of the government of Chile. The Solutions Center provides us several clean energy policy programs and services including a team of over 60 experts that can provide remote and in-person technical assistance to government and government-supported institutions, no-cost virtual webinar training on a variety of clean energy topics, partnership-building with development agencies and regional and global organizations to deliver support and an online library containing over 5,500 clean energy policy-related publications, tools and videos and other resources. Our primary audience is made up of energy policy makers, analysts from the government and technical organizations in all countries, but we also strive to engage with private sectors, NGOs and civil society.

The Solutions Center is an international initiative that works with more than 35 international partners across a suite of different programs. Several of the partners are listed above, including research organizations like IRENA and

IEA and programs like SEforALL and regional focus entities such as ECOWAS, the Center for Renewable Energy and Energy Efficiency.

A marquis feature that the Solutions Center provides is no-cost energy policy assistance known as Ask an Expert. The Ask an Expert service matches policy makers with more than 60 global experts such as authoritative leaders on specific clean energy finance and policy topics. For example, in the area of appliances and equipment we are very pleased to have Christine Egan, executive director of CLASP serving as one of our experts. If you have a need for policy assistance in appliances and equipment, or any other clean energy sector we encourage you to use this valuable service. Again, this assistance is provided free of charge. If you have a question for our experts, please submit it through our simple online format: cleanenergysolutions.org/expert. We also invite you to spread the word about this service to those in your networks and organizations.

Today's webinar is co-moderated by Jem Porcaro, who's a senior director for Energy Access at United Nations Foundation.

Now I'd like to provide brief introductions for today's panelists. First up is Sam Grant. He joined CLASP as the Africa Regional Lead last April with ten years' experience working in energy access. He lived and worked in Papua New Guinea, Mongolia, Ethiopia, Uganda and Kenya. Sam previously held leadership roles at the Equality Group Foundation and Micro Energy Credit.

And our final speaker today is Maja Gajic, who has joined us—who has just been awarded her PhD in engineering on the topic of designing hybrid solar collector. She will be soon traveling to Liberia to work on the Light Up Liberia project, working for Fosera.

And with those brief introductions I'd like to welcome Jem to the webinar.

Jem Thanks, Katie. I'm going to just try to show my slides; I just have a few. Can you see my slides?

Katie Yes, they look great.

Jem Great. Thanks Katie, and thanks to everyone for participating today, especially Sam and Maja. Really looking forward to this webinar on energy efficiency for energy access. I hope most of you are familiar with the Practitioner Network but if not, the network is an initiative of the UN Foundation that was established roughly seven years ago as our contribution to Sustainable Energy for All. Our overarching aim is really to support the development of market-led decentralized energy access solutions and businesses. And so, in many ways we are kind of the field—the network as a field-building initiative.

We kind of carry out our mission by helping unify the sector by accelerating learning amongst stakeholders within the sector and by trying to elevate the distributed energy access sector within international development agenda. We have a number of schools that are doing that. Amongst them are creating

market intelligence through surveys and contributing to other research, convening the sector, sharing knowledge through webinars like this one, communicating news through newsletters, our website and through promoting the sector.

We started off with about 20 members in our network about seven years ago; we have now about 2,500, representing roughly 1,400 organizations working in almost 200 countries around the world. The network is predominantly comprised of SMEs and NGOs and corporations, but we also have a good mix of development partners, CSOs, academia, government and investors.

So, today's webinar is more specifically focused on looking at the latest trends and innovations in appliance efficiency and their role in increasing access to modern energy services. For that I'm really excited and lucky to have Sam and Maja with us. This is the fourth webinar in a series of webinars looking at kind of best practices more broadly. And as usual you can always follow us on social media.

Before I pass things off to Sam let me just tee things up by saying how important we think energy efficiency and super-efficient appliances are to expanding energy access, especially to higher tiers of access. I think as we all know, the global market for clean energy technologies, including solar *[audio static]* and solar home systems have grown significantly over the past few years, but it's important not to forget that these markets have largely provided basic levels of energy access, typically power to charge a mobile phone, maybe a few lights, and while the growth of this market is a huge achievement in itself and kind of as a critical first step to get on the energy access ladder, achieving greater socioeconomic benefits really will require the provision of higher levels of energy services to off-grid consumers.

This is where off-grid appliances are really important, as appliances are really what help bridge or convert energy supply into energy services. After all, no one really cares about electrons themselves; they really care about the energy services like lighting, entertainment, information, communication. However, a major challenge in delivering these higher levels of access is the fact that traditional appliances and end use technologies consume too much power to be cost-effectively bundled or supported by available off-grid energy technologies.

The good news is, which hopefully we're going to hear quite a bit about from Sam and Maja is that there's kind of a new class of energy efficient appliances coming online that are becoming more available in off-grid applications. So, that's really the crux of this webinar to kind of dive into what are those new class of technologies, what are some of the latest innovations and trends to look out for. And so—sorry, I meant to press my button there.

With that I think I'm going to hand it over to Sam to take it over. Sam? All yours.

Sam

Thanks Jim. Thanks for that introduction. Hello everyone. I've got a lot of slides, a lot of information. And so, I'm just going to jump into it. If you could engage in assisting me with moving the slides …? Thanks, Katie.

Yeah, off-grid appliances, as Jem mentioned are kind of the *[audio static]* link between energy _____, energy _____, _____ everyone wants electrons, they want light, refrigeration, entertainment, water pumping. A good off-grid or _____ grid appliance is designed with consumers in mind, kind of suitable for use with a solar home system or a mini grid. And it's designed with thinking not just about energy efficiency but also quality and reliability. It's so important for energy efficient appliances to be affordable, easy to operate and easy to maintain.

Many times, these different attributes are tradeoffs—and we'll jump into some of those tradeoffs a little bit more *[audio static]* later on in the presentation. So, energy services are evolving for the off-grid sector. Next slide please.

There's growing demand. This is from a 2016 Global LEAP market research study that has found that _____ household currently _____ over $600 million on _____. Many of these products are not efficient, inappropriate. I think *[audio static]* much higher quality appliances. *[Audio static]* close to $4 billion _____. But *[audio static]* products will require innovation, market development and significant scale-up by new and existing suppliers. Next slide please.

So, energy efficient *[audio static]* appliances are important. They reduce the overall cost of the total system. Here in this slide we see a 2015 analysis from Humboldt State and Berkeley National Laboratory. This study found that the upfront cost of the typical off-grid energy system can be reduced by as much as 50 per cent *[audio static]* super-efficient appliance _____ if solar PV and batteries are used, while delivering equivalent or even greater energy services. Efficient appliances can rapidly reduce the solar and PV, fundamentally changing the life cycle costs and the *[audio static]* consumer space *[audio static]* the savings from avoided energy supply *[audio static]* more than make up *[audio static]*.

Efficiency designs are just as important as *[audio static]* systems, where supply is constrained and consumers have the same expectation for quality and appropriate design. Many of the people I speak with here in Nairobi who are on a prepaid meter, for instance, they have a very tight budget for how much they spend and put on that meter each month, and they know exactly how many times they can iron their kids' clothes or turn on the water kettle. So, energy efficiency is really important for both sectors. Next slide please.

That previous slide was a little bit older information and many of you know that the decrease in system cost has been driven largely by a reduction in PV prices and even more recently in battery sources prices. So, here's more recent information.

The market is moving quickly, and based on performance is improving, which is encouraging. So, we refreshed the previous slide's analysis with just two years later and found that in 2016 a small solar home system appliance package using conventional appliances as opposed to a solar home system that was using the most super-efficient appliances that we've tested and found on the market we found about a 20 per cent cost reduction or benefit. So, 20 per cent is significant, but we think there's a lot more work to be done and we think that there's opportunities even greater with additional appliance efficiency improvements. Next slide please.

So, over the past few years a variety of off-grid market stakeholders would occasionally ask a set class if they thought refrigeration could ever be viable for small-scale or off-grid energy systems. And I think based on the previous slides and your knowledge of the market you can agree that not only is off-grid refrigeration potentially viable, but it could potentially play a crucial role in the future of the off-grid market if we build refrigeration to match the system sizing that can be foreseeably afforded by the majority of off-grid customers.

So, in order to understand kind of the potential impact of the refrigerator on an off-grid energy system _____ in the slide we've added a refrigerator to the set of appliance that we used for the modeling earlier. The green icon shows the amount of PV and battery capacity needed to run an off-grid appropriate refrigerator as part of a load that also included four LED lights, radio, phone charger, a fan and TV. The orange icons show the amount of PV and battery capacity needed to run an average conventional on-grid refrigerator product with the same load and the same bundle of other appliances.

The results are pretty stunning. As you can see pretty clearly the off-grid appropriate refrigerator can be run with an 80-watt peak PV array and a 35 _____ power battery, both of which are well within the range of many of the leading solar home system companies than the systems that are commonly available on the market today. However, you would need almost nine times the amount of PV and battery, and almost eight times the amount of battery capacity if you were to use kind of conventional refrigerator that's sold for the on-grid market.

So, the cost of the system size would be a non-starter for most off-grid customers if they were to use a conventional refrigerator, just would never be possible, and one of the primary reasons why the Kenyan market less than one per cent of rural households own a refrigerator. It's just not within their reach. Next slide please.

So, there are many barriers in _____ kind of the scale-up and development of appropriately-designed off-grid appliances in the off-grid appliance market. Product design and development—many off-grid solar companies struggle to identify or develop great appliances and appliance manufacturers are typically unaware of the off-grid market design needs. They're largely two separate communities that don't communicate with each other, so really a large information gap there.

Many of the appliance manufacturers are just not aware of the off-grid market opportunities. They don't see a potential $4 billion market, they see—they really don't see anything at all. And those that are aware kind of struggle to find a clear path to the market and see just too many risks to take the time and effort that would be required to really move into it aggressively.

Many of the off-grid solar companies they offer _____ financing to expand their appliance product offerings, or switch to different appliance vendors. There's definitely a searching and transaction cost associated with _____ _____ into China and engaging with manufacturers and testing those appliances in the market with their systems. All those costs have really led to I guess a very timid introduction of appliances so far by solar home system companies. Next slide please.

So as briefly mentioned before there's kind of a sweet spot of value for an off-grid, appropriately-designed appliance. We tend to evaluate off-grid appliances with four key criteria: energy consumption, or energy efficiency, price, size and service delivery. So, efficiency alone doesn't make an appliance off-grid appropriate, and price doesn't either. There's typically tradeoffs within these four parameters, and we work with a lot of manufacturers to try to find the best balance between the four. Next slide please.

So, one way in which we've tried to—CLASP has tried to enable the market to better understand the off-grid appliance landscape is new product testing. So, this has all been under the Global LEAP awards. So, the product testing component of the Global LEAPs is based on test methods and consultation with leading international technical and market experts. Typically, the test methods are based on the International Electro Technical Commission's standards, and then we add additional tests to address performance requirements and environments that are typically found in off-grid households. And so, these battery of tests are done in laboratories in the Netherlands, India and China. To-date we've developed off-grid appliance test methods for fans, televisions and refrigerators. This acts as the core foundation of most of the work that we do in the off-grid space. Next slide please.

So, we follow this testing. We've developed an off-grid appliance data platform which provides easy access to appliance test and market data. Hopefully systemically it acts kind of that gap in market intelligence, so both solar home system companies or people that would wish to procure off-grid appliances and manufacturers and designers.

So, we procure and test, we share the data with anyone who asks us, and we hope that this helps the market make smart appliance choices. We currently are building out a web platform for this database that we hope to launch later in the year. At the moment all of our testing data resides on a giant Excel sheet which I'm happy to share with anyone interested and are participating on this call. Next slide.

Here's some of the testing results from fans. It's crucial to keep in mind that there's a significant difference out there in the market with respect to any given off-grid appliance in terms of energy efficiency. This is data from our off-grid fan testing efforts—shows a significant spread in terms of how much airflow a given fan delivers per watt between the highest-performance products and even the average in the market. These differences have a huge impact on the energy—in the energy cost required to deliver the service that an off-grid family or business expects, and deserves, really, because you don't have that information. It's not testing for these very real kind of performance and energy efficiency differences. Otherwise accounting for them somehow—you know, you're not equipped to make a decision. And yeah, to me the air delivery differential and energy consumption difference in fans is personally one of the most striking data points that shows the vast discrepancy in the market. Next slide, please.

So, when we evaluate or look at kind of the drivers to increased efficiency in the off-grid fan space we look at a few key technologies. One of the obvious standout ones is brushless TC motors. They're lighter, they're more durable, longer-lived and notably more efficient than traditional brush motors. Given the low economies of scale, though, they're currently more—usually way more expensive and really increase a fan's retail price. But they're super-efficient and their longer life can dramatically improve kind of the lifetime cost of owning and operating the fan, especially when you're using expensive energy. Motion and occupancy sensors, this is something that we've experimented with quite a bit and the Bangladesh and the India market, you know, fans typically are just left running and then they burn through any battery charge built up from the solar panel. So just building in different features that really optimize the life of a battery charge can be really important in an off-grid context. Next slide please.

So, what you see here on this slide is data from our TV testing efforts. And again, I won't harp on, but you see significant differences in the energy efficiency that's currently out there on the market. And that energy efficiency makes a big difference in the system sizing. Next slide.

And again, there are a lot of ways to make an off-grid TV more efficient [inaudible]. And you do it cost-effectively, most importantly. One of the most innovative things that we saw in the early days of this market was an off-grid appliance specialist responding to the stresses in terms of energy consumption that loud speakers place on off-grid energy supply. So rather than using traditional TV speakers they started using an array of iPhone speakers. The decibel level was just as loud, the sound was very good, but the energy consumption was a fraction of what those other, more traditional TV speakers were consuming.

One of my favorite anecdotes about TVs is a chat I had with an executive at a prominent disco. We were talking about off-grid TVs and he told me, "We're always working with suppliers on efficiency of their products. There are cheap, easy things manufacturers can do to make an appliance more energy efficient. But when I asked them why they haven't done so already

they say nobody's ever asked them to. So, the Samsung CLGs of the world, in many ways they're just not building to this particular market. It's just not an important market segment for them.

One of the things that we're trying to do is to really tease out what features would be required by those larger, multinational conglomerates to make it really affordable for efficient _____. We're not there yet; still working on that. There's a lot of work to be done. But we think it's important to do. Next slide please.

So, this slide compares the energy performance of the off-grid refrigerators tested as part of the Global LEAP market baseline testing efforts, and the rated energy performance of products nominated for the most recent Global LEAP awards for off-grid refrigerators. You can see energy performance for products nominated in the Global LEAP awards competition is generally much better than the Samsung that we've been able to do out in the market. The graph shows watts per liter, so that's a metric that allows us to control for product size when _____ energy performance in refrigerators. And the energy consumption metric displayed in the spider graph earlier was more of a kilowatt hours per day and had a rough correlation with product size. But larger products tend to require more energy in aggregate, as you would assume. However, you can see here the relative energy efficiency of the refrigerator product actually tends to increase along with the product size because there's a minimum threshold energy required to start a refrigerator really than any energy end size based on the energy consumption of powering up the compressor.

The main takeaway here is there's widely-divergent levels of energy consumption even _____ consumer sizes and as you can see the 23-liter product was called out here, runs on just a little more than a third of the energy compared to the 25-liter product. So that's a huge difference. Next slide please.

So yeah, so refrigerators are interesting. We've very recently been really trying to dig deep into advance refrigeration technology and understand what kind of—you know, what progress can be made to make refrigerators more affordable and decrease that percentage from one per cent of rural Kenyan households to a much higher number in the near future.

What parts of a refrigerator drive energy consumption? And what are some of the levers that can move a refrigerator from an inefficient 25-liter product to a highly-efficient 23-liter product that we saw in the previous slide?

The largest single driver refrigerator energy performance is the compressor which is the component that enables the actual cooling of air inside the chamber. And the compressor efficiency has improved pretty significantly in mature on-grid markets in the recent past, resulting in roughly a 10–15 per cent improvement in overall refrigerator efficiency over the course of the last five years. And while we're starting to see some of these advancements cascading to the off-grid refrigerator product market the most immediate

opportunity to increase off-grid refrigerator efficiency really continues to be increased adoption of the more efficient compressor design.

Further innovations in compressor technologies are these variable speed compressors that enable _____ to consumer greater or lesser amounts of electricity depending on the actual temperature of the internal chamber, and whether it needs to be lowered by say two degrees or five degrees. This type of compressor could radically reduce the amount of energy consumption. By our calculations by as much as 30 to 40 per cent.

And then obviously cabinet insulation, you know, is an important determinant of refrigerator energy consumption. Most products developed for on-grid market have about 1-1/2 inches of polyurethane foam insulation, but if that's increased to 4 or 4-1/2 inches refrigerator efficiency can improve by as much as 30 per cent. Advanced insulation technologies could further drive improvements, but many of those types of materials are just too far away from being commercially viable in a price range that off-grid customers could afford.

And I guess one more kind of anecdote: I was at a CLASP colleague's house in Washington, DC a month ago and his refrigerator in his home has a water dispenser built into the refrigerator but it's actually inside the refrigerator. So, you have to open up the door and leave it open as you're filling up a glass of water, a pitcher of water. To me that was a laughable example of how the on-grid refrigerator appliance market is not thinking about the off-grid sector when they're designing these appliances. Next slide please.

So, I'm just going to quickly now run through a few of the programs that CLASP is working on to try to drive greater energy efficiency and energy access in the off-grid market. So, the Global LEAP awards, as I mentioned previously, identify and promote the world's best off-grid appliance, evaluating them on the basis of quality, off-grid appropriateness, energy efficiency and cost. Looking at a lot of the product performance _____ that we just reviewed the awards signal the importance of product performance and quality to the global market, and this helps off-grid energy companies kind of jump-start their search for high-quality appliances, hopefully give the appliance companies a clear point of entry into the off-grid market.

We include the winners and finalists in the off-grid appliance data platform that I mentioned before and circulate an annual bias guide which we hope is being used by manufacturers and off-grid solar home system providers to inform purchasing decisions. Next slide please.

So, we've recently launched the Efficiency for Access Coalition which kind of brings together some of the tools that we're creating for the very first time, specifically to advance the deployment of high-quality appropriate energy efficient and affordable appliances. Next slide.

And kind of the Low Energy Inclusive Appliance program is the latest and most substantial to-date contribution to that coalition. LEIA's ambitious goal is double the efficiency and halve the cost of a range of appliances and

technologies over the next five years. And we've broken out those appliances and technologies into near-to-market products such as TVs, fans and refrigerators, solar water pumps, and we're going to really focus on kind of scaling those markets. And then we'll take a look at more kind of horizon and enabling technologies such as brushless DC motors and electric cooking and hopefully stimulate those sectors with R&D investment. Next slide please.

We've recently launched an Off-grid Cold-Chain Challenge where we're looking at off-grid cold storage containers and this is a pretty nascent market, very developed on the on-grid side of things but very few actors in the off-grid space. And so, we're hoping to bridge technology gaps and kind of reward promising business models in this space. Next slide please.

Finally, we're recently took over management of the Lighting Global Quality Assurance program housed within the World Bank group and eventually the same type of quality assurance that the Lighting Global program is applied to _____ products and plug and play _____ kids, eventually we hope to apply the same level of testing and quality assurance to off-grid appliances: fans, TVs and refrigerators for the development and refinement of the testing methodologies that I mentioned earlier. They're the beginning of this process.

And that is a lot of talking from my end. That's it from me. Thanks so much everyone for listening.

Jem Thanks, Sam. Thanks very much. It's very impressive how much CLASP is contributing to the off-grid appliance market. I think in the interest of time we're going to quickly segue to Maja now to give a slightly different perspective from a practitioner, Fosera, who has been doing a lot of great work providing off-grid appliances. So, Maja, the floor is yours.

Maja Thanks for the introduction. Thanks for the interesting presentation, Sam, and thanks everyone for listening. So, my presentation will be quite a bit shorter, so I think we'll be able to stick with the time.

Fosera is a German-based manufacturer of solar home systems that cover solar panels from 1.5 watts to 50 watts for larger systems. But soon we'll be introducing an even larger product which I'll mention a bit later. Fosera's headquarters are in Germany and our main manufacturing plant is in Thailand. We also have assembly lines in Ethiopia and Kenya and hopefully soon in Liberia.

Apart from solar home systems we also manufacture high-efficiency LED lamps as well as accessories and efficient DC appliances such as fans, televisions, radios, torches and lanterns. And Fosera's vision is to enable people all around the world to have access to the same energy services that we do. And so, for people living off-grid this means that they need to have access to appliances that are low-cost, efficient and easily available.

So, DC appliances have conventionally been used by a limited number of niche off-grid applications resulting in quite a low demand and an immature market not quite reaching economies of scale as mentioned by Sam.

However, according to the GOGLA Off-Grid Solar Market Trends 2018 report, since 2010 there have been approximately 130 million solar off-grid devices sold, an impressive growth that's expected to continue.

And so, there's a huge potential in this market for DC appliances, as we start to see millions of households around the world gaining access to modern energy services and starting to move up the energy ladder. And this occurs as consumers naturally start to seek out more complex energy services after their basic lighting needs have been met.

So Fosera offers DC plug and play solar home systems that are safe and can be easily installed by anyone. And to offer customers low-cost energy services along with the solar home systems we have been focusing efforts on designing highly-efficient and smart appliances. And so, for example our award-winning 12-volt DC TV consumes only 0.5 watts for the 11-inch screen size and only 12 watts for the 24-inch size. And so here the trend can be described as redesigning DC appliances to have both high-efficiency and a low cost.

So, another example of an appliance we have developed is our new fridge. It's called the CoolSun 60 and it has a maximum power draw of 45 watts and 54-liter capacity. And to keep costs low and minimize reliance on expensive batteries, thermal storage in the form of phase-change material has been incorporated into the fridge. And using the latent heat stored in the phase-change material we reduce compressor run time. So, the material freezes at 6° C during the day using solar energy and then in the night any heat absorbed melts the phase change material slowly while maintaining constant temperature in the fridge.

So, we are focusing on maximizing use of energy during sunlight hours to avoid having to increase battery size which is the most expensive part of the solar home system. And the fridge has two modes, a smart mode, so _____ _____ of the _____ system, maximizes the benefits of the phase change material and also a manual mode that can be used with any system for constant cooling to between 2° C and 8 ° C.

Another example of an innovative solution from one of our partners is a hot water system, based on a Peltier semiconducting element. And so, in this case there's no need for plumbing coming from the roof for the solar hot water, just electricity. And solar power is used to heat the Peltier element during the day and the well-insulated tank keeps the heat in at night. And in this way by keeping the balance of system costs down overall cost is kept quite low.

And so, with these two examples we see a trend of using novel energy storage methods to keep costs low by reducing the amount of energy required from a battery and then these types of appliances can be made more accessible.

So, fridges, hot water systems and TVs will always need more energy than just basic lighting, and to power these types of appliances Fosera is soon releasing a new product range called Evo which will have panel sizes up to a couple of hundred watts. And the Evo range is innovative and will consist of

a hybrid lithium and lead acid battery. So, the lithium ion will be the primarily-used battery and lead acid will act as an energy backup.

And the system, coupled with Fosera's appliances will be able to intelligently manage day-to-day power consumption. And then with this system uses we'll have the option to grow and extend the system in several steps providing a power supply similar to Western households but with lower risk of debt defaults.

And so, looking to the future it will become increasingly important to focus on integrating productive use of appliances with solar home systems such as sewing machines and solar water pumps. And these need to be redesigned to be able to be powered efficiently by solar power. And finally, the problem of figuring out how to cook efficiently with solar power still needs to be solved.

So that's all for me. Thanks for your attention. If you have any questions you can email us at this address. Thank you.

Jem Thanks, Maja. That's really great. So, I'm going to take moderator privileges and maybe just ask a couple of questions of Maja and Sam, really just as a way to kick start a longer Q&A session that I think Katie will manage with those who are online.

Let me just jump into it. I think we heard both from Sam and Maja kind of the importance of stimulating supply amongst appliance manufacturers who develop _____ more super-efficient products. I was hoping you could both, or perhaps Sam, say a little bit more about that. What sort of incentives, what do we need to be doing more of to stimulate, to get more appliance manufacturers to develop and pay attention to these markets? Is it more data about what the market looks like, supplies, the demand? Is it more about a better understanding of the characteristics of the actual appliances that need to be developed? I'm just hoping you could say a little bit more about that, just given how important it is for achieving economies of scale. So, I don't know if Sam or Maja, if either of you want to take a stab at that.

Sam Yeah, I mean I think that's a good question. And we definitely don't have an answer to it. We've run consecutive Global LEAP awards since 2014, and we haven't—every year we see more and more interest, more partnerships from larger, multinational with solar home system companies and product designers. I think there's a certain amount of risk in entering the market first that a lot of the large players are just unwilling to do. And so, I think proving out market demand is really important, though the last round of Global LEAP awards for Tegans & Sands in 2017 was accompanied by a results-based financing program where we subsidized the bulk procurement of Global LEAP award winners and finalists.

When we opened up that RBF window in October we sold or committed 270,000 TVs and fans across Africa and Bangladesh within a 72-hour period. And we were blown away by the interests and the demand for these products that that RBF round generated and we're very, very pleased. We're running a similar RBF program for refrigerators; we're seeing a just slower uptake and

there's a lot more caution in the market. But we're hoping that those kind of incentives kind of lower that first mover disadvantage in many ways. We hope that will prove out the market and encourage in the future more companies, larger companies to participate in this space.

Jem Great. Maja, did you want to add anything to that?

Maja I guess I just want to say the market is still really immature and it will take off. And I think once it takes off then everyone else will start to jump on board. So, I think it's just a matter of time.

Jem Maja, maybe this is a question for you. Your TV has got a lot of attention and awards over the years. I was wondering could you say a little bit more about your product offering and where do you see the biggest demand moving forward? As I understand it TVs are kind of a large—represent a large portion of demand for off-grid appliances. What's driving that demand? I'm curious what exactly your customers value and how do they *[audio static]*? Are there other appliances that you see promising in the years to come?

Maja Well I've just recently joined Fosera about a month ago, so I don't have lots of in-depth information but from my understanding the TV is really one of our most popular appliances and I think mostly it goes to East Africa and a lot of other markets too. But we're really excited about the fridge. I think we see huge potential and a lot of interest in the fridge so yeah, I think that's what we're seeing.

Jem I mean speaking of the fridge is that now available on the market?

Maja Yeah, that's right. It's available now. We've been working on that—R&D team has been working on that for a while now and it is available.

Jem And just so people get a sense, if you're comfortable saying, what's the price point for that refrigerator?

Maja Xworks, so without shipping it'll be around US $350.

Jem Okay. And do you—and I recognize you're quite early on but what's the sense of where—what part of the market do you see that demand coming from for the refrigerator, given that price point?

Maja I guess this is something that once solar home systems have been paid off it will be like the next steps. So, you've paid off your system and it could be offered with pay-as-you-go. So, on the Evo system you can add a solar panel and add the fridge and then you would have some time to pay that off. But that wouldn't be for the consumers just entering the market, this would be like to keep moving existing customers into getting more access to these services.

Jem Okay. Maybe one last question—it's a little bit more of a technical question related to compatibility and interoperability. And maybe to you, Sam, or both of you. As I understand it, appliances—there's a little bit compatibility across appliances as it relates to solar home system products with kind of proprietary

plugs. And then kind of a related question around what happens inevitably when perhaps a mini grid arrives to communities that are using these DC appliances. Maybe Sam can you say a little bit more about what's clasp's kind of thinking around interoperability and compatibility issues? Are there efforts to move the sector from kind of these proprietary plugs to more universal plugs to stimulate more competition and compatibility? I'm curious if there are *[crosstalk]* efforts around that.

Sam Yeah, it's a great question and obviously in the on-grid appliance sector it's a lot of interoperability using same plugs, plugs into the wall, unless you go to another country. But you definitely don't see that in the solar home system space and that's for a variety of very sound business reasons. And one of the enabling technologies that we'll be investing in them is a layup program, is exactly that: the interoperability and compatibility and kind of the issues and the opportunities surrounding that.

I think just from kind of a personal anecdotal—I think it can be very challenge to get solar home system companies to move away from having unique plugs and cables, just because so much of their business model resolves around the financing of those appliances and you need some kind of lockout mechanism to be embedded within the product.

Possible that this sector will move away from that, but I don't see a clear path forward to make that happen or to entice businesses to do that. Hopefully that's something that we'll tease out over the next five years through some of the research in R&D that we'll be deploying _____.

Jem Okay. Well I'm going to look forward to under LEIA.

Okay, I think I've maxed out my moderating privileges, so I'll maybe kick it back to Katie to manage some Q&A amongst those who are online.

Katie Wonderful. Thank you, Jem, for that interesting question & answer discussion. And thank you, both Maja and Sam, for the outstanding presentations.

As we shift to the question and answer session I just would like to remind our attendees to please submit questions using the question pane at any time. We also keep several links up on the screen throughout for _____ reference that point to where you can find information about upcoming webinars and other previously-held webinars and also to take advantage of the Ask an Expert program. We've had some great questions from the audience.

Our first question is for either Sam or Maja: Sam—I think this is directed but please feel free to comment, Maja: How do consumers contribute data to the platform? And what data are you looking for?

Sam That's a good question, and this has come up a lot more as we deploy those 270,000 off-grid TVs and fans through the Global LEAP award. We have a contractual obligation to verify that those products have ended up in the

households where they have been presumably sold. And in addition to verifying the sale hopefully we'll collect some impacted data.

A lot of the pay-as-you-go companies capture information and know when those appliances are being used during the day and that's really helpful information as far as designing systems to work in conjunction with those appliances.

We recently held a solar power—solar water pumping technical roundtable where there was a lot of discussion around what type of data should be collected from these systems to inform customer service, to help restructure financing arrangements. No one really knows yet. There's a lot of experimentation that's going on across different solar home system companies and providers and it's definitely an area that hopefully we will explore further.

Obviously with data privacy coming front and center of a lot of, particularly in the United States' laws with Facebook; there's also a lot of discussion on, you know, what are the ____ implications of monitoring these appliances with remote sensing and GSM technology. And that's something that the industry is going to have to get out in front of and kind of defy before regulation hits what's the ethical information to collect. And I don't think anyone has an answer to that yet.

Katie Great. Thank you, Sam. And to follow on that what are the ways, the tools, the handheld measurements that consumers can use to figure out the energy that their individual appliances put out?

Sam That's a great question. There's nothing like that that I know of that's available to households using solar home systems here in Kenya or in East Africa. There are a lot of the kind of I guess system indicators are usually in the form of just like light bars that are on the battery or controller face. So that's usually where they'll get information on how much charge they have left. Some build any kind of a bar label, some have the actual hours until the light will run out or the appliance will stop working. So those are the only tools I know of so far.

I believe some companies are looking into, as systems get larger and there are more appliances attached to the same system companies are thinking to do energy management at a household level through potentially SMS messaging, letting people know, giving people some kind of indication that you only have an hour left of TV; you might want to dim your lights if you want to watch the rest of that English Premier League game. So those are going to be important signal to consumers so that they can get the maximum benefit out of these kind of constrained power systems and appliances.

Katie Thank you Sam. Maja—and Sam please feel free to comment as well—what is the level of risk associated for these new efficient appliances from the perspective of the consumer?

Maja Well, I mean I haven't been involved that long with developing these appliances so I'm not sure how to answer that, but I mean I guess there is a

risk with any early adopters of technology. So, I know the one case of—I'm not sure if you remember Equion batteries. There was a salt-based battery, a big plant built by Bill Gates Foundation, like really cool technology got deployed. But then suddenly lithium ion came along and just the whole company went bankrupt. So, there's always a risk being an early adopter of technology and I guess that's all I can say.

Katie Thank you, Maja. Our next question is from a consumer and they want to know, as we shift out of these appliance with more energy-efficiency appliances, or batteries, what are the plans or what do you know of for the waste that's left over, and for these old appliances?

Sam That's also a really good question. CLASP has worked a lot on the on-grid appliance space to develop kind of end-of-life management plans both kind of at a policy, governmental level and then also at an industry level. GOGLA, which is the industry association for off-grid lighting recently convened an e-waste end-of-life workshop here in Nairobi last Thursday actually. There was a lot of really stimulating conversation around what companies should do, how they can get out in front of any potential policy that would be put in place. So, there is a lot of concern with disposal of these systems, especially if they're dependent on lead acid batteries because those find their way into the water tables or buried in fields where crops are grown over those. So, it's definitely something that needs to be thought through.

It's challenging, just given the geographic limitations of where these off-grid systems and appliances are being deployed. There's a negative value chain in reclaiming that product at the moment, right? So, it's going to take a very coordinated effort and probably some kind of public assistance to find a responsible way to get those products back at the end of their life cycle.

We've seen—at the workshop we heard of companies who are reclaiming appliances and systems, breaking them down, repurposing them, using them for spare parts, building them into refurbished systems and then putting them back on the market, trying to find a way to switch that kind of negative value chain to a positive one. I don't think any of them are there yet but it's definitely something that the industry as a whole has to get out in front of and—yeah, there's a possibility I think, or an opportunity to use kind of innovation prizes as a way to kind of tease out best practice or to find a method or a process that works very well. So, there's a possibility that we'll see those—we'll see innovation prizes awarded in the future to solve this critical piece of the off-grid appliance ecosystem.

Jem Katie, if I may I would quickly just complement what Sam said. I think he's absolutely right and I think GOGLA is doing some good work in this space. I would also just direct people to our webinar in December of 2017 that actually covered this precise topic. So, for those who want to dig in a little bit more look up our webinar on our website for December and that's dedicated to recycling of off-grid solar products.

Katie Great. Thank you both. And thank you, Jem, for reminding us of that webinar.

Our next question for Sam and Maja is to the best of your knowledge is there anything that is equivalent to these domestic appliances in the power tools or low-energy commercial freezers and packaging machinery area?

Sam There's very little. Maja, you might know of more appliances in that category. I know that Moby Souls deployed a welder who worked with their largest 350-watt system. There are several solar water pump companies that are very early stages of development but are available on the market. There are a handful of solar-powered milling machines that are commercially available but also those companies are very small and just really getting off the ground. There are several freezers that have been developed but there's a lot of room for improvement in freezing and ice production and we plan to run another round of the Global LEAP award for refrigeration and we're hoping that one Fosera will enter their newly-developed TV but along with a lot of other companies—they've seen a lot more people kind of take stock of the opportunities for freezing, ice-making, refrigeration, on a commercial basis in an off-grid setting. So that's all that I'm aware of. It's very limited, I guess, to sum up. It's definitely—I would say it's the focus of a lot of donor and government efforts to focus on developing the market for productive use of off-grid appliances and machinery. It's really seen as the key to moving the whole sector forward.

Katie Thank you, Sam. Thank you all for the informative question and answer session. Now I'd just like to provide each of you with an opportunity for any additional or closing remarks that you've like to make before we close the webinar. Jem, why don't you start?

Jem I just want to thank, again, Sam and Maja for spending the time with us today to talk about this issue, obviously something that we are quite interested in and we'll continue working with on—for those of you who may not know this, we're working with CLASP over the years on a survey that they conduct on off-grid appliances and hope to continue to do that moving forward. But again, just a big thank you to Sam and Maja and to everybody for participating today.

Katie Thank you so much, Jem. Sam, would you like to provide any closing remarks for today's webinar?

Sam Oh gosh. I feel like I've probably talked too much. I guess I would just—I guess just lead with energy efficiency is often an overlooked tool to increase energy access. I think it deserves a lot more attention and focus from _____ manufacturers, donors, NGOs. There's a lot of low-hanging fruit there that has _____ implications for both the on-grid appliance sector and the off-grid appliance sectors. So, I think hopefully we'll continue to see improvements made so that more people can watch TV and cool off with a fan and have a cold drink in the heat of the day.

Katie Great. Thank you so much, Sam. Maja, would you like to close us out for the day?

Maja Sure, yeah. I would also like to thank everyone for listening, thanks Jem and also thanks to Katie for organizing such a great webinar.

Katie Great. Thank you both. On behalf of the Clean Energy Solutions Center I'd like to extend a thank you to all of our expert panelists and to our attendees for participating in today's webinar. We very much appreciate your time and hope in return that there were some valuable insights that you can take back to your ministries, departments or organizations. We'd also like to invite you to inform your colleagues and those in your networks about the Solutions Center resources and services, including no-cost policies for _____ our Ask an Expert service.

I invite you to check the Solutions Center website if you'd like to view the slides and listen to the recording of today's presentation as well as previously-held webinars. Additionally, you'll find information on upcoming webinars and other training events. We are now also posting the webinar to the Clean Energy Solutions Center YouTube channel. Please allow about a week for this audio recording to be posted. Finally, I'd like to kindly ask you to take a moment to complete a short survey that will appear when we conclude the webinar. Please enjoy the rest of your day and we hope to see you again at future Clean Energy Solutions Center events. This concludes our webinar.