

State of Play for End-of-Life Recycling for Off-Grid Solar E-Waste

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Webinar Panelists

Luc Severi	United Nations Foundation
Declan Murray	University of Edinburgh
Federico Magalini	SOFIES-UK
Athina Kyriakopoulou	Phenix Recycling
Prajna Khanna	Philips Lighting

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Stephanie Hernandez Today’s webinar focused on the state of play for the end of life recycling for off grid solar e-waste. Before we begin, I’ll quickly go over some of the webinar features. For audio, you’ll 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.

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Finally, one important note to mention before we begin our webinar 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 focused around the presentations from our guest panelists, Declan Murray, Federico Magalini, Athina Kyriakopoulou, Prajna Khanna who have joined us to discuss the current state of sector for the end of the life strategies in recycling for electric waste for off grid products in particular solar PV. Before we jump into the presentation, I'd like to provide a quick overview of the Clean Energy Solutions Center.

And Luc Severi from the United Nations Foundation will provide a quick overview of the Energy Access Practitioners Network. Then following the panelists presentations we'll have a question and answer session where the panelists will suggest 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 learning and best practices and to encourage the transition to a global clean energy economy. 24 countries in the European commission are members covering 90 per cent of the clean energy investment and 75 per cent of global greenhouse gas emissions.

This webinar is provided by the Clean Energy Solutions Center which focuses on helping government policy makers design and adopt policies and programs that support the deployment of clean energy technologies. This is accomplished through support in 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 cosponsored by the governments of Australia, Sweden and the United States with in kind support from the government of Chile.

The Solutions Center provides several clean energy policy programs and services including a team of over 60 global experts that can provide remote and in person technical assistance to government and government supported institutions, no cost virtual webinar trainings on a variety of clean energy topics, partnership building with the development agencies and regional and global organizations to delivery support and an online library containing over 5,500 clean energy policy related publications, tools, videos and other resources.

Our primary audience is made up of energy policy makers and analysts from governments and technical organizations with in kind countries. But we also strive to engage with the private sector, 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 and include research organizations like IRENA and the IEA and programs like SE4ALL and regional focus entities such as ECOWAS, the center for renewable energy and energy efficiency.

A marquee feature of the Solutions Center provides is a no cost expert policy assistance known as Ask an Expert. The Ask an Expert service matches policy makers with more than 60 global experts selected as authoritative leaders on specific clean energy finance and policy topics. For example, in the area of off grid solutions, we are very pleased to have Hugo Lucas, head of the energy department at Factor CO2 serving as one of our experts. If you have a need for policy assistance and off grid solutions 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 Luc Severi who is the manager at UN Foundation's Energy Access Activities focusing primarily on the energy access gap in the health sector. And now I'd like to provide brief introductions for today's panelists. First up today is Declan Murray who is in his final year of a PhD in international development at the University of Edenborough. His research looks at the repair of off grid solar products by users, independent repair technicians and companies. Following Declan, we'll hear from Federico Magalini who is the managing director at SOFIES-UK. In the past 15 years, he's focused in his research and consultancy on e-waste management and industry efficiency.

Following Federico, we will hear from Athina Kyriakopoulou who is the CEO and founder of Phenix Recycling, an integrated waste management company offering solutions to industries such as off grid solar. And our final speaker today is Prajna Khanna who is the head of corporate social responsibilities at Philip Lighting. And with those brief introductions I'd like to welcome Luc to the webinar. Luc?

Luc Severi Thank you so much, Katie.

Stephanie Hernandez Absolutely.

Luc Severi Let me open up my presentation. There we go. Good morning, good afternoon and good evening everyone. My name is Luc Severi. I work at the UN Foundation working on our energy access portfolio. I'd like to welcome you all to our final webinar of what has been another positive year for energy access and –

Stephanie Hernandez I'm so sorry to interrupt. My apologies for interrupting. We're able to see the Go to Webinar bar if you just want to minimize that with the orange button. Perfect. Thank you very much.

Luc Severi Thank you very much. So welcome again to our final webinar for what has been a very positive year for energy access for renewable energy, for energy efficiency, for everything that sustainable development global seven stands for. Today we're going to dive a little bit deeper into what to date has been I would say somewhat underserved and under highlighted topic, namely that of end of life strategies and recycling for off grid energy products. And we are

very fortunate to be joined today by four excellent speakers. We really wanted to touch on this topic this year still because we feel like there's been a growing awareness of the potential impacts both environmental and on health that e-waste can have in rural communities and that includes both the e-waste that we're all aware of, the ICTUS but also on the off-grid energy products in particular looking at lead acid batteries.

And in the last few years in big workshops whenever we have a lot of distributors and retailers in the group I've always tried to bring up this issue where I always make the same statement, mainly that lead acid, lithium phosphate batteries, lead is one of the most toxic metals in the world and acid is not a party drug. So, we definitely need to find better solutions to take care of what is potentially an environmental and a health disaster. But before we dive in, let me just provide you with a quick introduction to the Energy Access Practitioner Network which is housed here within the United Nations Foundation.

The EAPN was established in 2011 to support the global momentum to achieve energy access for all as it is now also captured under sustainable development goal seven. We do this by connecting our 2,500 members who now collectively represent about 1,350 organizations all active in the energy access space by connecting them to information, knowledge, resources, tools and probably most importantly to very powerful partnerships. And in doing so we are aiming to unify the sector to accelerate learnings across actors, countries and technologies and lastly also to elevate the issue of energy access on the global agenda for example as a key supporter of sustainable energy for all.

On this slide you see, you have an overview of how we work. But let me just highlight of work we've done this year. So firstly, in recent years we've been carrying out annual survey across our membership to capture market intelligence, to capture sector trends. And you can expect the results of our last survey which we carried out over the summer months earlier this year in the first part of 2018 so definitely something to look forward to. Secondly, this year we organized and supported several country level events. For example, in June we organized a last mile distribution workshop for distributors and retailers of off grid products in Tanzania in particular which is where this issue of last mile distribution, we tried to start the conversation of turning it around and talking about first mile recovery, first mile logistics as it relates to recycling and end of life strategies.

And just two weeks ago we were part of the organizing committee for the safe workshop which looks at safe access to fuel and energies or in other words the intersection of energy access and humanitarian responses. And during this workshop we also organized a side event looking specifically at the appropriateness and the opportunities for mini grids and hybrid energy solutions in refugee camp settings which really brought together both the energy community and the humanitarian response community. But enough about that. Back to the topic of the day, end of life strategies and recycling for off grid energy products.

We encourage you all to follow the conversation, to contribute to the conversation on social media. We're using the hashtag #PNwebinar which stands for practitioner network webinar and definitely follow our Twitter handle @energyaccessPN. Again, the PN stands of course for practitioner network for both live updates of this webinar but also following the webinar we'll do a quick recap in terms of what the main lessons learned have been or what we're taking away from this webinar and beyond. So, without further ado I would like to first of course pass controls back to Katie and then I believe Declan Murray will kick off the presentations.

Stephanie Hernandez Wonderful. Thank you for that overview, Luc. Yes. We will be now hearing from Declan Murray. Declan? Declan, I believe that your phone might be on mute.

Declan Murray Oh yeah. Sorry about that.

Stephanie Hernandez Wonderful. Thank you so much.

Declan Murray So hi everyone. Thanks Luc and thank you, Stephanie for the introductions and also for your hard work in putting this together. I know that for Luc especially this has been something he's wanted to get a webinar together on for a while. Really looking forward to the discussion and then hopefully for some good questions after the presentations. So, over the next few minutes I just want to make one point really or try to and that is that repair is a form of waste management. Not only that but I would argue it's a quicker, lower cost and less energy intensive strategy than recycling. Although I do want to stress that even repair needs that final safety net that recycling offers particularly for batteries. And I'm looking forward to hearing what Athina can tell us about that.

So, since 2014 I've spent 18 months in Kenya collecting the data for my PhD. And in that time my field work split over three sites drawing on three main research methods. First, I worked in an independent electronic repair clinic observing how the existing electronic repair economy works in the country. Secondly, I surveyed users of solar products and asked them about their understandings and attitudes towards e-waste management at home. And the third site of my research was the offices and warehouses of various manufacturers and distributors of off grid solar products. There, I interviewed employees about the company warranty and disposal practices.

But rather than bombard you with all of that, I'm going to tell you just one story of a customer who came to the repair clinic where I was working and he brought in the panel for his Niwa solar lantern. It was the Niwa Multi 300. So, in February 2016, the panel that charges Martin's Niwa. Martin was the customer who came into the clinic, was blown off of the roof of his house in high winds. Afterwards he noticed that his lantern was no longer working. He could see that there was no visible damage to the panel itself, so he concluded that the problem must be in the cable connecting the panel to the lantern.

In order to get a new cable, he decided to take the panel to our clinic in town, a 15-minute motor bike ride from his house. When he arrived, Wilson my

mentor and boss in the clinic sent Martin across the road to buy a new cable from a phone accessories shop. Knowing it wasn't a difficult job to take the plug from the original cable and attach it to the new one as we see in this slide here, Martin waited while we connected the new cable and tested it. And so, in the end Martin had paid about \$1.00 US, the equivalent of \$1.00 US to get the cable replaced and to get his lantern working again.

Round about a week later I visited Martin at home where he showed me the roof that his panel had fallen off and I was surprised to see something else on the roof. And he explained how after leaving the clinic he had gone to a friend across town who is a welder and got him to make a steel frame to hold this panel that you see on your screens onto the roof. Martin also showed me a couple of other solar lanterns he uses he charges off of chairs outside his house in order to keep them out of the wind. Although he did say he was worried that his children might knock these ones off.

And then in December of last year I spent a year in the workshop of the distributor of Martin's product in Kenya. So Niwa the company in this particular instance don't have a kind of technical presence in the country and that role is performed by a distributor called Sollatek who are based in _____. So, during my day with Niwa one of the products we worked on was a newer—it was also a Niwa product. It was a Niwa Home 200. So, after some preliminary tests outside Benson decided that again the problem was with the cable connecting the panel to the battery unit you see sat in the shade in that image.

However, unlike Martin or Wilson in the clinic, Benson had access to a stock of replacement cables from the manufacturer, from Niwa themselves. But they still didn't work so then Benson turned up to opening up the panel itself. Unfortunately, Benson didn't have the hex screwdriver that you need to open this panel, so he was improvising with a regular flat screwdriver. Anyway, after multiple other attempts trying new panels, new cables and other things, Benson conceded defeat and said that the customer of this particular product would receive a whole new, a replacement product.

I have dozens of other stories from my research like Martin's and I have no doubt that there are hundreds of thousands of them across Kenya and Sub-Saharan Africa and other countries in the global south. For Martin the repair at the clinic where I was working was possible because all he needed was a new cable. Had his battery been the problem as is most common with these products there would have been little we could have done for him.

In terms of strategies to support repair as waste management, we need to look at providing replacement parts, at least replacement batteries. Also, I should stress that Martin is a bit of an exception. The fact that he knew that the cable was the problem and took it to town and then even went the step further than that, the preventive action to now attach his panel into a frame on his roof really stands him apart from other users that I've interacted and we spoke to in my survey where most people are just holding onto their faulty or broken products at home.

So again, if we're looking to think about strategies for using repair as a tool, as a device in waste management then I wonder if we might look to the existing repair network at Martin did especially to help those users who are less technically literate than Martin was. And then finally, to move from Martin's home to the Sollatek workshop in _____ get it repaired and returned would have taken something like 80 hours at least. That's about three and a half days. But if there are repair clinics with the knowledge and the resources to repair products within 15 minutes of Martin's house to me it's little wonder that he chose to void his warranty and pursue that closer service. Even less so when in the particular instance of reality now with Benson he was the kind of verified or designated technician was unable to repair the product on that day that I was with him.

So just to conclude really as we move through the rest of the webinar and indeed beyond, I'd invite you all to think about product breakdown or failure not necessarily as the end of life but rather as the end of one life. So, in giving things, in giving products a new life through repair like Martin did, I believe we can let our actions defend solar as a green technology and not just our words. Thank you very much.

Stephanie Hernandez Wonderful. Thank you so much, Declan. Next, we would like to welcome Federico to the webinar.

Federico Magalini Ok. Thank you very much. I thank you, thank you all for organizing, Luc and Stephanie for organizing this webinar. Do you see my screen correctly?

Stephanie Hernandez Yes, it looks wonderful. Thank you so much.

Federico Magalini Ok. So, I can start. I will try to stay within these ten minutes. And sorry if I'm speaking sometimes too quickly trying to channel as much message as I can. I think there is no need to recall the large benefit of off grid sort of products in Africa and in Asia. But as Declan said, those products might go through different stages of first life, second life, third light. We know repair is pretty much advantage in Africa and Asia in particular. But sooner or later they are reaching the end of life and then there is mainly no other option than proper recycling. And I think when it comes to the end of life of electronic products, we have at least four areas where we can see certain impact.

Of course, off grid solar, they have an impact on e-waste. They are part of this called e-waste stream. The impact is not major. Of course, we have a lot of off grid solar being spread across African and Asia. But as you can see there also is other electronic products. There is not—products that are having a greater impact. But definitely we are an enabling factor for the consumption of other electronic products like radio, fans, refrigerators, water pumps and so on. So, their contribution, their _____ contribution might be a little bit higher. They have an impact on the environment at the end of life because there are a few elements of environmental concerns.

We already mentioned batteries, lead acid batteries. But we have also lithium batteries. And they have an impact—they will have an impact on finances because when we move along with policies and based on the standard

producer's responsibility, they are having an impact because we need finance. So, we will see later on how much money we might need to pool or to inject into the system. And definitely they will have an impact on policy and legislation because we will have sooner or later to set up proper legal framework for insuring a proper take back of electronic products including off grid solar products.

Of course, when we compare to the other type of electronic products or other devices as you can see off grid solar has their own _____. They are usually let's say very low in terms of the size and weight if we are speaking about solar portable lighting. And the more we move towards solar home system of course the weight and size is increasing the environmental and their concern when it comes to the end of life I would say is medium, medium to high especially for some proponents. And when we look at the intrinsic economic value of the material contained in these products, it's not that high. Meaning that we might need to as I said earlier inject some money into the system.

But this table shows you or I want to channel one important message with this table. That even if we speak about electronic products in general, different waste streams have different priorities and different _____. In this table I just want to connect together two important dimensions, the economic dimension which is at the vertical axis of these metrics and the environmental dimension. So, we know in this metrics we are there at profit which is the top of the metrics. We are there have losses which is the lower part of the metrics. And we have the environmental let's say gain, so a good thing for the environment on the right and the environmental burden or the bad thing for the environment on the left of the table.

And as you could see if we could just try to visualize the different electronic products on this metrics, you have something like this. And we could put off grid solar, we are more or less in the lower corner of the metrics. Meaning that if you look at the products alone, there is not enough economic value into the products to insure proper recycling. And this is again another way to say if we want to have environmental benefit, if we want to have the proper recycling then we need to inject some money into the system because otherwise proper recycling operation cannot happen.

And of course, when we use the off grid solar again is one word. But behind one word we are very different products. We go from solar portable lighting up to solar home system and sometimes connected to solar home system we have different devices. And depending on the device connected this story, the end of life impact is different. Here you can see the data from a report we did for the FID last year already. You see the baseline of electronic products placed on market in 14 African countries in the blue bar and the red is more or less the estimation of the resulting electronic waste. And then here you see the green on the market is the put on the market of off grid solar and then the resulting waste. But as you can see there is an order of magnitude in this scale.

So, as I said earlier, the impact of end of life electronic products coming from off grid solar is let's say is minimal or it's lower compared to—it's not let's

say it's not main stream. We are ranging between 0.5, which is more or less the same impact as mobile phones up to 3–3.5 per cent depending on the type of batteries used in solar systems. If we're speaking about light lithium phosphorous batteries or are we just thinking about the heavier or lead acid batteries? So that's to give you an idea of the impact in terms of volume. And as I said earlier, depending on the perspective we want to take again the different products or their components are playing a different role.

As you can see we have when we look at the presence of toxins potentially as our components luckily components in lamp containing mercury were phased out because solar, off grid solar moved much quicker to LED, LED lamps but we might have some metals like cadmium, aluminum using MPD models as we might have some lead and cadmium in batteries. But there are also relevant materials from a resource management perspective like Rare Earth using in LED or materials that are having relevant disposal costs like the plastic containing _____ lamp if any containing mercury, the lithium phosphate batteries and so on.

As you can see some metals or some components are in different part of the table and this is also why we need to really look carefully into what we are doing because for instance lead is at the same time _____ but is also having a very high economic value. So proper recycling can happen and can compensate the cost of properly recycling other materials and so on. So again, one of the messages when we look at the end of life, there is not necessarily on single solution or one single perspective we need to take. Sometimes we need to account the different perspectives because there are a lot of interconnections between environment, economic and societal elements.

We know that in Africa we have local markets for some of the fractions that are resulting from the processing of the off grid and are really like when Declan said we need to have a safety net for proper recycling, this is exactly what we need to develop. So, we have local markets for steel, copper, aluminum, in some cases plastic. But we don't have local market, we don't have recycling infrastructure for many of the fractions that are resulting from the proper treatment of end of life off grid solar like the lithium phosphate batteries, like sometimes lead batteries as well, LED plastic containing brominated _____ or printed circuit boards. This is why we really need to develop solutions that are coping with these needs.

And as you can see, this is the best link to my next slides. Some of the key components of the off grid solar products are having a very negative value. Means that if we want to have the proper recycling we need to pay. Now we did back in 2016 the first report. There are other two reports we have done recently, one focusing on Kenya, one focusing on Rwanda, but they have not yet public domain but the methodology, the results of the first study has been used in the second one. So, we can look at the results and it's more or less channeling the same message.

As you can see, we did some case studies in Rwanda and Kenya and Nigeria at that time and we tried to model the proper cost for end of life management of off grid solar products looking at off grid solar portable lighting, so called

PC1 up to solar home systems so called PC4. And as you can see the metrics it's mainly containing red numbers meaning we have cost. Under some scenarios I can tell you for solar home systems so PC4 we might have some black popping in meaning that the value of the copper cables and eventually the value of the lead acid batteries can eventually compensate some of the disposal of other fractions.

But still access to waste collection, transportation is always a cost. So, depending on where we are in Africa, depending on local markets, the impacts in terms of proper recycling it's around let's say 0.5 euro per product up to 1 euro per product. And as you can see this is translated into 0.5, 1, 2 per cent of the market price. And this table is of course excluding the potential cost of the first collection meaning the potential cost that one person maybe is the bearing when traveling from a very rural area the first point where we can drop off a product that might be \$1.00 - \$2.00 per product. But if it's a solar portable lighting so a product of 200 grams, 300 grams the impact in euro per ton of that first _____ collection is massive.

So, this is why I think we really need to develop a common and smart solution. We propose already in the first report some action items developing tool kits for end of life management of solar products, carry out some pilot projects. I have to say since I joined let me say this community or I started working with companies in the off grid solar sector, I'm really happy because I've seen a lot of good ideas, a lot of proactiveness so I'm really looking forward to seeing much more solutions implemented on the ground. And I'm sure that Athina after me can really bring some more positive message into the arena.

Stephanie Hernandez Wonderful.

Federico Magalini So I hope I met in the time so hand over to the next speaker.

Stephanie Hernandez Wonderful. Thank you so much, Federico. We would now like to welcome Athina to the webinar. Athina, are you there? We are not getting any sound. Athina can you try again? We're not able to hear you.

Athina Is this working at all? Hi.

Stephanie Hernandez Oh yes, yes. Maybe if you're on a headset move the mic closer to your mouth.

Athina How does that sound?

Stephanie Hernandez Oh beautiful, wonderful. Thank you so much. Welcome to the webinar.

Athina Thank you and thank you everyone for coming to today's webinar. Thank you to Federico, Declan and the rest of the presenters and organizers for organizing this. It's a really important topic. I'd like now to present a more practical perspective. As Phenix Recycling is an e-waste recycling company in Tanzania and east Africa. And I want to share with you some of the

challenges of implementing all of the great theory that we've just discussed. So, in Tanzania we have about 26,000 tons of e-waste produced per year estimated. To give you a little bit of perspective on what that means, that's the equivalent of the weight of all of the elephants in the Serengeti.

As Federico mentioned, about three per cent of this, three to four per cent is from off grid solar. So that's approximately 1,000 tons of direct solar systems plus all the indirect appliances, TVs, radios, fridges, etcetera. So, it's not a significant portion of the e-waste problem but it is a significant problem. E-waste in general is very difficult to deal with for a variety of reasons. First of all, specific e-waste regulation doesn't exist in east Africa. It does—there are draft e-waste regulations in Kenya and Rwanda but they're still being discussed. Tanzania and Uganda are in the process of creating drafts. So, it's unclear for companies exactly what the obligations are.

And it's unclear for regulators how to enforce responsible waste management with regards to e-waste. There's obviously environmental issues with e-waste both dumping as well as informal recycling. The finances around e-waste without clear regulation are very cloudy. Some people feel they should sell their e-waste. Other e-waste recyclers as Federico mentioned. We would like to be paid to recycle it. So that is a contentious issue. There's also lack of expertise. A lot of people don't understand or don't have the knowledge to properly manage e-waste.

And finally, one of the biggest problems is logistics. There just isn't the capacity here or e-waste recycling. It's estimated that the amount of e-waste in the region and globally grows 33 per cent every year. This might grow even faster because east Africa is a developing region. So Phenix Recycling is here to provide businesses and organizations with easy and responsible recycling solutions to help solve this crisis and to deal with the challenges that were discussed earlier in this webinar.

What Phenix Recycling provides is a variety of services and benefits to help address all of the challenges with dealing with e-waste. So, we provide simple doorstep collection. We come to your hub, to your offices to collect whatever waste you have. We ensure that you're meeting all the environmental health and safety standards according to international best practice. We obtain all the permits and provide advice on the regulatory requirements for your business as well as giving an insight into the discussions around draft regulation and what's coming down the line so companies are not taken by surprise. We also deal with a variety of different waste streams, so you don't have to worry about sorting it. And then we provide a simple per kilo price structure.

So, we analyze the waste a business has, and we provide them a flat fee. This can be per kilo or per system to help them be able to translate those disposal costs back into their business modeling, budgeting and projections. We work with a variety of partners both locally and across the region including off grid solar companies like Mobisol and Phenix International. Our business model is quite simple.

What we do is we collect solar components from the businesses themselves. We bring it to our dismantling center where we do manual or mechanical dismantling and processing of the components. Essentially, we take it apart with a screwdriver and then we sell the various components both internationally and locally. As Federico mentioned, downstream off takers and recyclers don't exist for some of the fractions like lithium batteries and PWB. So that's the in theory it's a very high-level overview of what Phenix Recycling does and provides to businesses in the off grid solar sector.

But I'd like to share with you some of the challenges involved with growing this industry for both the off-grid sector companies as well as Phenix Recycling. The first is that one solar home system does not mean one solar home system. So, for instance, Mobisol just celebrated their half millionth sale of a solar home system. That does not mean that there's going to be half a million solar home systems that are going to need recycling because over the lifetime of these products, that one system that is sold comprises various replacement components as Declan mentioned. A lot of cables are replaced. Lights are often replaced. Sometimes batteries are swapped. TVs might break, and even solar panels might be replaced depending if they break or crack.

There's a huge discrepancy between the technical and commercial life span of these products. So technically in a lab a solar panel should last 25 years. LEDs might last three to five years. Charging cables should last even up to one to three years. However, in the field and in the rough conditions that these products are being put out into there's often an early rate of disposal. And a lot of this also happens for operational reasons. So, if a company who sells a solar lantern discontinues a certain line of product, then that entire line of product will need to be disposed of because they can't push that product into the market anymore. They can't reuse it and they can't use it as spares. So, it's not just how long should a solar home system or lantern technically last.

Operationally is another question. I wanted to touch base on what Federico also discussed is the cost of recycling. So, a lot of the questions we hear from businesses is how much will you buy my waste for. There is a perception that e-waste is valuable and should therefore be bought but I'd like to look at the case, an example case of a solar home system which consists of a plastic casing, a lithium battery, a circuit board and dismantling time. Now these are of course—this is just a gross simplification, but it gives us an idea here that if we look at the average value per kilo plus the weight of that product, we get a negative value for the entire system.

And this although the circuit boards and the plastic casings may bring in some revenue and even the aluminum frames for the panels, the cost of disposing for lithium battery, the dismantling time, transportation costs, getting the difficult components to green recyclers internationally. All of this means that ultimately the solar home system companies need to pay for the disposal of their product. In the region in east Africa right now I mentioned that there are not a lot of e-waste recyclers.

There are five at the moment including Phenix Recycling. There's one per each east African region. Phenix operates across the region. So rather than being a geographical e-waste recycler we go where the businesses require us. Some of these e-waste recyclers have high health and safety standards. Other ones do not. The customer service of some of the players has also been questionable and even if you take all five of them together, their capacity is not enough to deal with the e-waste problem in east Africa. All five companies are going to need to grow significantly and we might see more players on the market in order to handle all of the e-waste in the region.

So why does this affect you, my listeners? It's very important to ask the question where does my waste go. It is not only an environmental problem. The environmental and safety impacts of all waste including off grid solar waste is incredibly important. As Federico mentioned, we are looking at a crisis particularly with lead acid batteries. Regulatory requirements will come into place and as a business and as an industry sector, we need to be prepared for it because otherwise it can cripple us. There is a cost to the responsible management of waste and that's something that needs to be incorporated into budgeting and financial projections but most important for me is the brand risk exposure.

If the off grid solar sector doesn't responsibly choose its waste management partners, it's risking breaking trust with its customers. If a customer goes and buys a solar lantern from a third party that was sourced from an improper e-waste recycler, he or she will not differentiate that from buying it directly from the company itself. And often if these products which were meant for recycling get resold, they're not to the quality standards that are being marketed.

And this leads to a loss of trust with customers which can quickly spread to genuine customers. So, it's not only an environmental problem. It's not only a regulatory problem. It's also a business issue in terms of choosing your responsible waste management partner. So, thank you all for listening. You can find out more at our website and our Instagram or get in touch directly. I'll just—

Stephanie Hernandez Wonderful. Thank you so much Athina. Now we would like to go to Prajna. Wonderful. We can see your screen. Wonderful. I believe you're still on mute. If you could unmute.

Prjana Khanna Yes. Clearly had been on mute for a while. Very interesting to once again listen to some of our colleagues and peers here, Federico and Declan and Athina. Great setting the scene. So, from Philips Lighting Foundation perspective I just wanted to give a bit of a macro picture from our side on because from our perspective we are—our vision and mission is on enabling access to light. Sorry. Is there a way of making this—bear with me. It's not moving to the next slide. Is there anything that I need to do? Yeah. It's there. Super. We—our vision and mission is to enable access to light and which by default also means access to energy.

And again, by default we're working in specific geographies that you're looking at the sub-Saharan Africa and southeast Asia, primarily a lot of emphasis also on India. For this what we—for this what we've done is really mapped out the value chain, not the reverse logistics but the first even just getting into the last mile distribution and last mile penetration off of solar lighting products which in itself as you can, anybody, all my peers in the call here will understand it's a big challenge and there are many barriers already to getting the products out there. So clearly, there would be larger barriers also to getting the products back in.

The approach that we take as a foundation is to try and take the pressure off, the financial pressure off and the piloting pressure off our various companies that are out there bringing the product into the last mile for them to take the responsibility at this stage already when they are trying to survive in very meager circumstances for their, in trying to get a commercial value proposition already existing, right pricing structures, ensuring their financial viability in this state.

So, we as a foundation are focusing a lot on piloting, enabling local technical development of various actors, their training capacity for processing of recycling, of solar e-waste management but also a transfer of knowledge from what Athina was also touching upon before on where you're shipping a lot of your recycled elements to international whether international standard recognized recycling agencies which increased the cost of the recycling in total. So, our approach primarily has been to try and break from the silos across the sector. We're trying to bring together, map all of the various initiatives and pilots because there's very little and far between that is happening.

You saw the last slide of Athina. But there is a lot of learning we can have together to enable the volumes to—to enable Athina's business to be a commercial success you need to be able to service many. And where does the pricing for example need to be built in? Is it the product that the producer and the manufacturer is bringing in as the distributor shares some of the burden? Do we also bring in the burden onto the customer? So, all that thinking specifically has been so strongly affiliated to Philips Lighting which has its own, manages its own solar product portfolio.

And there are many—there are various many different models that we can possibly experiment or see exactly how we can take that burden _____ create. Already the pricing structure where the _____ of that recycling or responsible end of life management disposal is built into the cost of the product. So, we, our approach is to learn to deep dive, see what is happening. Some pilots are happening in India. There are some pilots happening in Africa because being just done workshops in Rwanda, in Kenya and then to strategize trying, bring together the various enablers, the actors in this end of life value chain and to try and bring multipurpose financing together towards bringing pilots into this space that you can test and model across the various geographies, bringing best practice from one geography to another geography.

Once there are some pilots that actually are proven as successful that we can again lead an influence and buy in enable the rest of regulatory frameworks where it's sharing best practice, enabling industry standards in this very nascent industry electronically. And then of course the pioneer the pilots and try and scale and understand what are the resources that are required to, that will enable us to overcome the barriers to scale as well. And it's a circle that we have to keep going around.

This is a small snapshot of what would be in any electronic e-waste management or the various opportunities to be able to have responsible end of life and how the product would possibly flow into various secondary markets. And this is how—this just demonstrates all the various pilots that can be and what various solutions can be applicable across different geographies and context. In a country like Tanzania which is a part of less densely populated, bringing back reverse logistics is far more complicated than a country like Bangladesh which is extremely densely populated, and it makes—it takes away some of the other pain points that you would experience in Tanzania for example and there are different, there are already different levels of maturity in e-waste management across these geographies as well.

For example, in India there's already a more—it's more advanced. There is a lot of regulatory pressure. So, for lead bulb recycling for example it's mandatory for all producers to be taking back their lead bulb recycling. Can we already leverage those existing collection points for the same purpose of bringing back solar lighting? So, there's a lot of various opportunities out there as well. While there are challenges, there are opportunities there as well. The I think the biggest differentiator in the approach in the vision that we take from the Philips Lighting Foundation is to enable local to local servicing.

The idea of actually shipping products and elements are way back into Belgium or to other parts of the world for processing is just purely adding to the cost and it's absolutely unnecessary. So, starting actually from even process the product in the local market to actually making sure the disposal is also done according to the international standards, this can be enabled. It just needs to have the transfer of technology, transfer of knowledge. All these various barriers can also be individually addressed. If you have a large problem and if you're confronting the e-waste problem of solar industry it becomes big. But if you break it down into specific smaller problems and set into place there are enablers and actors who can take on the chunks. You have all the advocacy agencies that can take on some of the sensitization that needs to be done.

Can we also leverage on the logistics existing in this space to take on the task of bringing on a risk logistics proposition and across the various geographies doing various pilots and keeping the momentum going with the aim of enabling a locally, a completely locally driven solution for this problem. And one of the key things that we're looking at doing in the future is also working with the research teams both in house with infinite lighting because we have the opportunity to [Break in Audio] is repair, recycling, is there anything in between?

We are looking at also doing is it possible—one of our research as we're talking about not waiting for the products to be 100 per cent dead but to try and intervene and at 70 per cent before it's fully end of life to try and convert that into a secondary product. So, there are projects that they are building into there. Can we create as Athina is also doing bringing the solution, the recycling solution to where the business is, and we create mobile recycling and processing plants that can go from city to city to service various distributions? Piloting all of these in the coming months and years together with the experience of our peers on this call. Thank you.

Stephanie Hernandez Wonderful. Thank you so much. And thank you to all the panelists for the outstanding presentations. As we switch to the discussion I would just like to remind our attendees to please submit questions using the question pane at any time. And now I'd like to turn it back over to Luc to have a discussion.

Luc Severi Wonderful. Thanks everyone for great presentations for really showing what's already happening but definitely also highlighting some of the challenges that currently exist in trying to find or trying to work towards solutions. So, I guess my first question for you is, and this is for all four of you. What do you see as the single most critical barrier holding back further action or action at a wider scale. Let's just answer this in the order that you presented. So maybe Declan can you just give a quick sense like what do you see as the single most critical barrier holding back these solutions?

Declan Murray Thanks Luc. Great question. I think it's from my perspective and experiences it's actually acknowledging it and I think we're well on the way to doing that just in the kind of three-year journey that I've been researching and thinking about these kind of questions. More and more people have been thinking about it, getting involved and starting to investigate it. So, then I guess the follow on to that is how do we get more people to acknowledge it. And I think Federico in his presentation gave us a great discussion of it and Athina mentioned it as well which is the problem is that next to regulate e-waste this might be a very small percentage.

And the other challenge being that it's very dispersed. So, it's actually quite hidden. If we look to how action was or is being taken towards regular or mainstream e-waste products it was—part of it was to do with some of these exposes from CNN or Green Peace where we found huge sites of unhealthy informal recycling of products. And that's not going to happen with these off grid solar products when they're actually dotted around in people's drawers and houses around the place.

So, I think, yeah, the barrier for me is acknowledging that it's an issue that we need to be taking action. And then of course how do we get everyone to acknowledge it when it's actually still quite a small fraction but it's the main thing that makes it unique and kind of intractable challenge is the fact that it's very dispersed. It's not centralized in these urban dumps that we, that come to mind when we think of e-waste normally.

Luc Severi Thanks Declan. Federico, what do you—what's your view on this?

Federico Magalini Three main standing blocks or elements. The first one is that in majority of countries we do not have a legal framework for e-waste management including the final _____ which is the basically element that can eventually help or support the investment by interpreters in development of the missing technical infrastructure which is as Athina said which is also then my second point. So, in many cases, we need a little bit of development of local infrastructure meaning recycling plant but also options for downstream fractions to ensure we can close as much as possible material loops locally which is in principle let's say the aim of _____.

And a third element it's awareness of the people. People should be aware how to properly dispose those products and then to again lean to what Athina said getting the mindset that not necessarily you need to get paid when you get rid of your products, of your waste. If it's a source of spare parts for to repair maybe that's something we can discuss. But when we are disposing something for the purpose of recycling material recovery you should not pretend economic compensation in the majority of cases. So, these three elements, policy, recycling infrastructure and awareness from consumers.

Luc Severi Athina from your point of view of being on the ground and seeing the fractions coming in, seeing the products coming in what do you see? What's been your biggest problem and maybe even in starting up your organization and maybe even convincing organizations and distributors to buy in to this philosophy?

Athina I can't disagree with anything Declan or Federico said but what I would say is the number one challenge is the off grid solar is a business. It's a fast-moving retail good and has slim profit margins and incredibly complex logistics. The issue of recycling those components sadly was not taken into account in the scale of those business models. It is being discussed by these companies but incorporating it into what they're doing while reaching the rapid growth rate is an incredibly challenging issue.

You have two particular challenges for these businesses to get on board with responsible recycling. And the first is the cost. With the e-waste they have paying for that disposal is a bit of a pain for them because they haven't budgeted that cost. They haven't planned for it. It hasn't been in their investment plans. So, putting that in is something they're working on, but it takes time. The second problem is as Declan said, all of the solar products they've sold that are in the market, retreating those.

Customers especially with lead acid based systems are not going to take a 40-pound battery and carry it all the way back to a shop for the pure reason of disposing it without some incentive. So how do these companies then convince their customers to bring back those components? So, I think those are going to be the two biggest challenges which translate to challenges for us is collection and getting access to the waste.

Luc Severi And Prajna from your point of view I'd be curious to learn. What do you see as the critical barrier?

Prjana Khanna

I think this is very, very well laid out before we already by Declan, Federico and Athina. However, I'd urge us to think about this that we're working in extremely—the very fact that this is solar e-waste. It is not solar e-waste that is coming out of Berlin or in Germany. We're talking about this last-mile context where getting the product in is already the challenge. And so, bringing it back out and then all the, also the related pricing structures and everything that goes around it, it's a challenge. However, it needs to be broken down into parts. Any big problem if it's seen as a big problem it's unsurmountable.

However, if you break it down, you reach out and enable a person who can bring solutions to each and specific one by one by one the specific parts of the problem. But a customer incentivization. Can we make—can we show that the customers are given financial incentives to bring the product back? Or is there a way of if there are trucks going out to bring fertilizers to a certain end context can we bring back those 40-pound batteries and is there some logistical solution that can be built in context by context. So, it's about breaking these, each of these specific challenges down by one by one and enabling the actors to do their work there to enable a robust solution. And it's not insurmountable then.

Luc Severi

Exactly. No, thank you so much all of you for highlighting. There are many challenges but it's nice to see that this is evolving and we're seeing pockets of solutions. I think one of the—another potential issue is the fact that we have, we don't have much regulation. There's not a strong regulatory framework in multiple countries especially in sub-Saharan Africa. And the regulation that exists could potentially even harm business opportunities to come up. I'm thinking in particular of the Basel convention which makes it harder to transfer waste from one African country to another.

So maybe for Athina because in the slide that you showed showed that you're working in east Africa. How are you approaching a more regional approach which will be absolutely necessary for multiple fractions given the low volumes but also given the fact we have smaller countries in the region such as Rwanda and Burundi and Uganda, landlocked smaller countries that will have to rely on the more regional approach. So how are you approaching this and how are you experiencing the trends? Are there positives? Is it something that you see involving in the way that you want it to?

Athina

I would say that we're approaching it very carefully. As mentioned by Federico we have international conventions like the Basel convention and it was also a topic addressed at the UN environment assembly last week. We need to balance the need to stop hazardous waste and e-waste dumping which is what convention like the Basel convention are there to do. And they're very necessary. But at the same time ease movement of waste that is going to responsible recyclers. And that is not an easy task. So, I can't say that I've seen a trend so far. I think it's too early but it's being discussed. And trans boundary movement of waste, as you said Luc, it's necessary with small volumes is a huge challenge as well.

Luc Severi

Yeah. And linked to that Federico given that you did research over so many countries and highlighted a couple in depth in the research that you also presented are there any outliers or any pioneers, any champions that you've come across either on the private sector approach in terms of the actors that are working on it or on the more public approach in terms of regulatory framework and say extended producer responsibility schemes. Anything that stands out right now that you think could be a model for other countries?

Federico Magalini

Well, at the moment I'm really, really looking forward to see how the east African communities so these five countries will implement the e-waste strategy they define and agree on last July. And you might have seen recently Rwanda opened a brand-new facility that was set up by the government. Now the government handed over to a private operator to run the facility, improve the facility. And I think it's quite interesting development to see how this can move on. And I think if it creates some good cases in Africa I think could be really, really interesting.

And I mean I met a few weeks ago Athina. I was really also impressed by their plans, what they are doing. I think it's really—I think we have few good cases. I would say a few blossoms of what could be good solution, good champion in the area. Of course, we all know that one or two recyclers in a country is not enough. But if we have one or two to showcase it would be the best proof to go local government that entrepreneurs can work and create jobs locally and find local solutions for waste management problems. So, I'm really curious to see developments at east Africa at the moment.

Luc Severi

Yeah. Great. We're all looking at what's happening with a lot of hope as well. Thanks for that Federico. Question for Declan and Prajna. It's a topic that I think we could organize an entire webinar on which is how do you actually—how can we approach this issue before it becomes one? And I'm looking more at design. I'm looking more at repair. I'm looking at reduce before we talk about recycling. So, Declan, you mentioned the story about repair, repair clinics, about replacement parts.

In your experience in Kenya in particular how do you see this currently happening? Is this something that's being lead more through actual distributors and the manufacturers actively taking a design approach to ensure that products can be repaired quickly, that spare parts are available such as for example in the mobile phone sector we have the Fair phone which is actively trying to take that approach. Or is it really more in an informal way where it's just trying to extend the lifetime of a product?

Declan Murray

Thanks. Yeah. Another great question. I think there's room for both. I guess what you've kind of touched on there is perhaps one earlier with product design and you mentioned the example of fair phone. One kind of side project that I've been involved with through my research is a website called the off grid solar score card. And it's theoffgridsolarscorecard.com and that website is basically just trying to push that conversation to talk about how we might better design products. So, if you go to the website you can take apart, disassemble a solar product, answer a series of questions about how repairable or replaceable or recyclable various components of it are and then you get—

each product gets a ranking from A to E. So that's one way I think that we could push product design improvements.

And then perhaps in the markets where we're talking again if you look to mobile phones and the shop where Martin went to buy that cable across the road also sells all manner of phone keyboards, phone batteries. And then you've got other shops where you're selling mobile phone smaller components like microphones and speakers. And I think a lot of that hasn't come from your phone manufacturers but has come from the market where you've had a demand especially in countries in the global south where perhaps there is more of a kind of repair economy, repair culture happening.

And I was last in Kenya in September and was really excited. It's not one of our certified kind of light and global brands but some of you might have come across a company called GD Lite, Lite spelled L-I-T-E. And I found their batteries for sale. So, they sell various kind of solar home systems and for the first time I saw in _____ where a lot of my research has been done in Kenya I could buy a single battery. So, I'm wondering if that might even develop kind of a bit more organically the way that it has done as more and more customers like Martin maybe are demanding look, I want to replace the battery.

And then of course we get into discussions about generic components and product designs. There might be some confrontations to be had there. And sorry, one last thing before I hand back to Luc would be—and Prajna mentioned doing things locally. I'm also interested to see what happens with companies like we have Forsera who are doing, they're assembling solar home systems in Kenya and in Ethiopia and I think if we can assemble products at the beginning of life, when we reach that end of life it might mean that the resources, facilities and skills that we need to get these products back to say to a company like Phenix are already there. So yeah. I think there's optimism. Yeah.

Luc Severi Great. Thanks, Declan. Prajna, maybe some thoughts about designing, designing for repair.

Prjana Khanna Absolutely.

Luc Severi Approaching it. Yeah.

Prjana Khanna Absolutely. And I'm really glad Declan you brought this in because I wouldn't want to steal Manev's thunder. Manev who is head of our solar portfolio is on the call as well and I know that he's just launched a new product bearing very much this in mind. So Manev are you still online? Can you share a little bit about the new design product that you brought in based on the feedback from the teams?

Manev Yeah. Thanks, thanks. So, I think I completely agree and I think the kind of point that Declan was speaking about is some of the insight that has gone into designing a product. So, while at one end we are extremely busy trying to build sustainable routes to these difficult to access markets. But I think on the

other side so while we clearly a space shared with _ where we're trying to make sure that there's a certain kind of understanding on where the Philips Lighting as a market is, as a company is going and building business for solar products.

But I think the point that we spoke about which was on design. So, what we have clearly understood that when you take away the product, clearly the battery is one component that has a very different I will say life cycle in terms of disposal vis a vis the other components. So, we've actually tried to create—we're actually looking at creating not only a product which has a small compartment where you can change the battery. Frankly, the products are normally good for 10 or 15 years of life, the LED, the box, the components, the circuit board. Nothing happens to it and of course it has a very different life cycle for recycling.

But from the battery perspective, we're actually looking at getting the consumers to understand that you can replace a battery but also trying to create a complete supply chain for batteries along with the product so that we can get access to these older batteries and then see how they go into the specific focused recycling channels. So, it's not only an innovation for the consumer which helps to drive the overall cost of ownership on the _____ change. We also probably have a model that will help us get to do more responsible business from a recycling perspective.

So, these are two objectives that we are looking at entering the market, Africa. East and central Africa is definitely one of the markets that you will be seeing these products very soon in. So that's fine too. It depends on how we're trying to do this.

Luc Severi

Thanks so much, Manev. Thanks for joining this call as well at the early time that it is for you right now in India. We're slowly running out of time. Also, just as a quick reminder for all the listeners. Feel free to submit your questions in the chat box. We'll have a bit of time to address some of them but those that we can't address today we'll address at a later stage. We'll make sure that all questions get emailed to all the panelists. So, feel free to engage either now or later with the panelists with your questions.

I want to ask one more question specifically for Athina but maybe Federico wants to join in as well. On the economics of it, on the cost of it, me, myself coming more from an ICT recycling point of view the story has always been a very positive one that's been sold. Same with cell phones that when you look at the product there's a value to the product which means the solution is private sector approach. It's a business approach. And while I don't disagree with it, I think there's a big caveat that we need to make here which is that while as a whole as Federico mentioned some solar whole systems may actually as a whole, as a complete unit may have some value, a positive value if you're able to get every single component.

And it's that if that I just want to highlight because solar home systems are—it's a system. It's a compilation of components which means those components are very easy to just replace one with the other. And there's no

guarantee that Athina is going to get an entire Mobisol unit. You may just get the battery which is the cost factor. Or you may just get the printed circuit board which is the valuable one. So maybe just a quick—I wanted to make sure that we discussed this as even if the economics as a whole give a certain picture, there's a reality that we need to take into consideration which is that the big word that we always talk about which is cherry picking.

And it's in this case in electronic waste it is quite easy to cherry pick. It is easy to extract those parts, those fractions, those components that have a value which significantly impact the bottom line of companies wanting to approach e-waste as a business. Athina, what's your experience with cherry picking with an informal sector where that often takes place and how that's impacting or how you're approaching organizations to make sure that that's avoided.

Athina

That's a really great question and a great point, Luc. Thank you. In general, we haven't come across a solar system in east Africa that does have a positive value. I will just put that out there because of the challenges with logistics, because of the lack of full downstream off takers particularly with circuit boards and batteries. Those have to be shipped outside of the continent. No solar home system has a positive value. The companies we work with and other companies we've approached are willing to pay for it and I think they've gone through the learning exercise of realizing that their systems don't have a value, that they do need to pay for that disposal.

Cherry picking is a huge problem and the informal sector is here. It's incredibly effective in terms of collecting valuable components. And it's not something we should look at negatively. But we need to find ways of using the informal sector to collect even the nonvaluable parts. That aspect of it using informal sector to collect nonvaluable fractions is not a business solution and it won't come naturally in the market. That's going to need a lot of external financial support whether that's governments, grants, foundations, regulation, etcetera. Phenix Recycling works directly with businesses, so we have the benefit that we can work with them to collect all of the components that they have.

And we ensure that none of that is disposed of improperly. So, we don't have to deal directly with cherry picking with our customers because we do collect all of the components. But cherry picking with the informal sector is an issue which I think Federico can also comment on.

Luc Severi

Federico any final thoughts on this issue?

Federico Magalini

No. No. I think it's absolutely right what you said Luc. I mean and in the first report we did for the FED there is already quite evidences on that and in the two new reports that will hopefully be released soon there is already more insights for Kenya and Rwanda. Off grid solar recycling even if we speak only of solar portable lighting and the solar home system without devices connected, it's a cost. And it's a very high cost in particular because of lithium phosphate batteries and other few elements.

So, it's the story of e-waste of a business and with these products it's not working. So, it's really what I said. We need to inject some money into the system and this is why we need to have a system built which is cost effective because we want always to keep this injection of external money as low as possible because it's societal goal. So, it's absolutely what you said. It's not like mobile phones. It's not like with desktop. I have to say there's very few e-waste products that are proving having to be a business case. For the majority of the e-waste products, we need financial support for sure.

Luc Severi

Great. Thank you and thanks to all of you. Thanks Declan, Federico, Athina, Prajna for these wonderful insights, for your presentations. I think this is a taster. I'm looking at the clock. It saddens me a bit that we need to wrap this up. But I'm sure this is not the end of the conversation. I look forward to a new year where we can hopefully make further in roads and making sure that is, this issue is acknowledge more, that there is more awareness that we're able to find more local solutions, options for downstream fractions and that we see progress on the policy side as well.

I think my final, my final thought, my final comment for all the listeners as well. If you weren't already convinced about why we need to worry about this issue, why we need to talk more about this issue, while we know that energy access is the sector is evolving in a positive way. We see every week now we see more investment heading into the sector, more products being deployed, governments taking the lead, private sectors taking the lead in terms of actually providing energy access even though today we still have about a billion people lacking energy access.

The reason why this issue in particular is actually really important is because we're not actually only talking about the waste that's generated through the solar energy products but by giving access to energy, giving access to electricity through households, we're actually unlocking further potential e-waste through appliances that all these households will start using. It's kind of—it is an amplifier, this, the energy access is amplifying e-waste both through the actual deployment of energy products but also through the appliances that are being used on these energy products.

So, that's just a quick take away for all of you about why this matters and why we need to square it. Whenever we say oh this matters, no, it matters twice because the problem is kind of being amplified. Let me end there. Katie, it's all yours.

Stephanie Hernandez

Wonderful. Thank you so much Luc and thank you again for the panelists for that informative discussion session. For any questions that we didn't have—we were able to answer a lot of the attendees' questions during that great discussion. For any that we weren't able to get to we will collect with those attendees offline after the webinar.

On behalf of the Clean Energy Solutions Center I'd like to extend a thank you to all of our expert panelists and our attendees for participating in today's webinar. We very much appreciate your time and hope in return that you had some valuable insights that you can take away for your ministries,

departments or organizations. We also invite you to inform your colleagues and your networks about the Solutions Center resources and services including no cost policy support through 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 also now posting webinar recordings to the [Clean Energy Solutions Center YouTube channel](#). Please allow about a week for the audio recording to be posted. And finally, I'd like to kindly ask you to take a moment to complete the 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 and this concludes our webinar.

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