

Efficiency for Cooling: Technology and Market Trends

—Transcript of a webinar offered by the Clean Energy Solutions Center on 21 May 2019—
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Webinar Panelists

Philip Voris
Charles Miller
Fadzai Chitiyo
Nyamolo Abagi
Jeremy Tait

This Transcript

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Philip

Today's webinar is focused on the efficiency for cooling technology and market trends. 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 your telephone. If you choose to listen through your computer, please select the mic and speakers option in the audio pane. If you want to dial in by phone, please select the telephone option, and a box on the right side will display the telephone number and audio pane you should use to dial in.

If you would like to ask a question, we ask that you use the questions pane, where you may type in your question. The audio recording 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 YouTube channel](#), where you will find other informative webinars, as well as video interviews with thought leaders on clean energy policy topics. Finally, one important _____ 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 research library, as one of many best practice resources reviews and selected by technical experts. Today's webinar is centered around the presentations from our guest panelists, who have joined us to explore emerging market intelligence on efficient off-grid appropriate cooling technologies such as fans, refrigerators, cool chain technologies, and icemakers. This webinar is part of the Efficiency for Access Coalition's Efficiency for Cooling

Communications Campaign, which shines a light on a range of topics, such as social impact of cooling, the latest off-grid technology in market trends, and how appliances fit within the broader cooling agenda, contributing to both increased energy access and greenhouse gas emission reduction.

Before we jump into the presentations, I will provide a quick overview of the Clean Energy Solutions Center. Today's presentations will be moderated by Charlie Miller, who is a senior policy expert at Energy Savings Trust. Then, following the panelist presentations, we will have a question-and-answer session, where the panelists will address questions submitted by the audience. At the end of the webinar, you will 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 Commission are members, contributing 90 percent of clean energy investment, and responsible for 75 percent of global greenhouse gas emissions.

This webinar is provided by the Clean Energy Solutions Center, which is an initiative of the Clean Energy Ministerial. The Solutions Center focuses on health and government policymakers to sign and adopt policies and programs that support the deployment of clean energy technologies. This is accomplished through support in crafting and implementing policies related to clean 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.

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 governments and government-supported institutions, no-cost virtual webinar trainings on a variety of clean energy topics, partnership-building with development agencies, and regional and global organizations to deliver support, an online library containing over 2,500 clean energy policy-related publications, tools, videos, and other resources. Our primary audience is made up of energy policymakers and analysts from governments and technical organizations in all 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 its suite of different programs. Several of the partners are listed above, and include research organizations like IRENA and the IEA, programs like SEforALL, and regionally-focused entities like the ECOWAS Center for Renewable Energy and Energy Efficiency.

A marquee feature that the Solutions Center provides is the no-cost expert policy assistance known as "Ask an Expert." The Ask an Expert service matches policymakers with one of the more than 60 global experts selected as authoritative leaders on specific clean energy finance and policy topics. For example, in the area of appliances, labels, and standards, we are very pleased to have Eric Gibbs, senior director of country and regional practices at CLASP, serving as one of our experts. If you have a need for policy assistance in appliances label and standards, or any other clean energy sector, we encourage you to use this valuable service. Again, the assistance is provided free of charge. If you have a question for our experts, please submit it through our simple online forum at cleanenergysolutions.org/expert. We also invite you to spread the word about this service, to those in your networks and organizations. Now, I would like to hand it over to Charles Miller.

Charles

Thanks very much. Only my mum calls me Charles but thank you. [laughs]

My name is Charlie Miller, and as Phillip mentioned, I'm a senior policy expert at the Energy Saving Trust, Energy Saving Trust, jointly with CLASP Access, the secretariat for the Efficiency for Access Coalition.

Next slide, please?

In our webinar today on cooling—sorry, let me talk a little bit more about the Efficiency for Access Coalition, first. Just to introduce the coalition, the coalition is a global effort to promote energy efficiency as a potent catalyst in clean energy access, and sustainable development more broadly. It was founded in 2015, and in that time has gone from being a yearlong call to action and collaborative effort under Global LEAP and Sustainable Energy for All, to a coalition of 13 aid agency [audio cuts out] together to promote high-efficiency, high-quality, and low-cost appliances. The aim of the coalition's programs is to accelerate technology innovation, to reduce the prices of these new technologies that they're enabling, and through those two mechanisms, to accelerate the scale-up of markets for off-grid and weak-grid appropriate products. The coalition also has a role in sharing information amongst its members, improving sector-wide coordination, and [audio cuts out] gaps and opportunities to do more to bring forth the day where everybody has access to efficient appliances. The Efficiency for Access Coalition has programs and initiatives across 3 continents, 44 countries, and 19 technologies, so, a pretty impressive breadth of activity.

And next slide, please.

We are currently running a cooling communications campaign. This is building on our previous agricultural technology campaign, which some of you may have seen. The aim of the campaign is very simple: it aims to shine a light on the efficient cooling sector. Which is not a particularly big or well-known sector, but one that I would say is attracting more and more interest from players within the sector, both on the government and the private sector side. So, with this cooling campaign, we aim to showcase the latest trends in technologies, in products, in business models.

But also, to begin to articulate what the key market barriers are at this relatively early stage in the emergence of these new technologies, and what the potential solutions for those market barriers might be. The scope of the campaign covers efficient fans, which can be anything from small-scale fans in east Africa intended to improve household quality of life. Through to much larger fans, for example, in Pakistan where access to cooling technology is actually a health issue because of very high temperatures. Also looking at refrigerators, everything from basic household refrigerators through to much larger refrigerators for business and industrial use, as well as walk-in chillers and other agricultural cold chain technologies. The campaign has three phases, building from a more general phase the outset to more technical content towards the end.

And we would invite any participant online that has some insight or information to share about their work in cooling, that they would like to promote it as part of the campaign, to get in touch with us. And we'll see what we can do to pull content from the experts, many of whom I'm sure are on this call, and to share that widely across the sector.

Next slide, please.

And this slide is just to quickly make you aware of some of the resources and publications that have been produced under the EforA Coalition, and we have a number of available reports. Perhaps the flagship is the off-grid appliance market surveys; they have been conducted every two years, and one is in draft at the moment, so watch this space for the next one of that. And a number of other publications, there, that you can go online and find on our website, as well as a handful of up-and-coming reports, some of which will be showcased today. The idea with our webinar, here, is to really provide a kind of a teaser of forthcoming publications where we've pulled the data together, we've done some analysis, we haven't written it all up yet, we haven't published it, but we just wanted to give stakeholders a sneak preview of some of the findings. Because we feel that there's a real appetite for the kind of information that our panelists have to share today and are keen not to keep people waiting until the finished product is out.

So watch this space; more launch and dissemination activities will be taking place when these publications are released. But in the meantime, this is just a teaser to whet your appetite and give you an early opportunity to ask some of the people involved in developing these publications and doing this research some questions live.

And with that, I will hand over to our first presenter, Fadzai. Fadzai is a strategic consultant at Dalberg Global Energy Advisors. She's got a background in inclusive business, renewable energy, financial inclusion, as well as a number of other areas. And previous to Dalberg, she was also working with the Bill and Melinda Gates Foundation, and has also done work with the GSMA and on financial inclusion, as well. So, a real range of experience from Fadzai.

And after Fadzai, we will hear from Nya, who is a manager within CLASP's East Africa office. Nya has a lot of experience working on off-grid experience in general, I would say, as well as a background in social enterprise in the nonprofit sector.

And then, finally, Jeremy Tait from the Refrigeration Technical Working Group, at Efficiency for Access. A highly-experienced consultant working on standards and labeling for ethical appliances, and the policies and regulations that have enabled those appliances to become more efficient and more sustainable. He's got experience working across refrigeration, heating, ventilation, and air-conditioning, and he's been leading our refrigeration technical working group over the last few years, and he'll be sharing some insights from the process of putting together a refrigeration roadmap.

So, with that brief introduction to our speakers, I'll hand over to Fadzai to go first. And thank you all for joining us today.

Fadzai

Brilliant. Thank you very much to Charlie. So, I think maybe before we drive straight in, I would like to provide a little bit of context around Dalberg, just in case some of you have not come across us before.

Dalberg is a group of business; we have 18 offices globally. And we typically partner with governments, private sector players, research organizations, a whole host of individuals within the development space, to provide an innovative mix of advisory, investment, research, and design services. We have previously supported CLAP and EFA, in 2015, to conduct the previous data for off-grid appliance market report, which assessed the state of technology for off-grid televisions, off-grid fans, and refrigerators. As well as, of course, projecting the state of the market from 2015 to 2019. This year, we've been involved, again, in doing a second edition of this report, which reassessed the market and is projecting, for the same type of appliances, what the market would look like between 2019 to 2030.

But we've gone a step further than that and have also started to look at effective business models that could potentially drive supply, as well as enabling factors to drive deeper penetration off appliances, and in particular, refrigerators in Asia and Africa. So, it's from this that we would like to share some of our insights for the refrigerator market. We'll focus a lot on the relevance of cooling technologies for households, so, what is the real impact. The state of the market, as well, today. And what are some of the barriers that we're seeing to growth. A little bit of insight around some of the key industry players that are driving product innovation, and how supply chains are also adapting to be able to cater _____ for these larger appliances.

And then, we'll finish off with our future projections, which I think everyone is excited about because the industry does take a lot of queues around, you know, where do we think market potential will be for these appliances. And just, I'd like to touch on areas where we think there should definitely be more focus to enable the environment going forward.

So, what is the impact for cooling appliances today? So, we've looked at this in-line with the sustainable development goals, one of which is obviously around no poverty. And we definitely see affordable access to new technology being an important part of this first sustainable development goal. So, being able to show ensure that we [glitch interferes with audio] cooling technologies really is a critical component of that. In addition to that, around zero-hunger, we've seen that access to refrigerators actually allows a lot of families to store food safely and for longer periods of time. There's quite a lot of research—not a lot—there's still new research that's being done around that, but we know that some of the stakeholders we've spoken to have said that customers have mentioned, you know, areas such as the ease of fewer trips to the market, and being able to bulk and save produce because you can actually buy in bulk, and also cooking less often, which can translate into some savings on charcoal, as well, being some of the benefits that households see around being able to store food appropriately, and safe food for longer periods of time.

There's also great applications for refrigerators when it comes to reducing risks of food-related infectious disease. We've also seen that beyond that, in the healthcare space, there's definitely strong value propositions that are starting to come into play for how to get last mile healthcare services out using refrigerators, and, you know, different types of cooling technologies, there. Finally, from a gender perspective, there's definitely an interest in role that refrigerators play in time poverty for women. There's definitely, you know, a lot more research that needs to be done into this area. There's conflicting [audio cuts out] some cases around whether it really does lead to, you know, tangible impact for women.

But we definitely see this as an opportunity, as women could spend less time on domestic tasks. So, knowing that there is relevance for this type of market, the next thing we wanted to pay attention to is what is important—what is the impact, at this stage, of cooling technologies on sale.

So, the current state of the market. To do this, we looked at some data that was provided by GOGLA. They have been engaged in trying to understand, you know, what is the state of sales across sub-Saharan Africa and Asia. And interestingly enough, 70 percent of the suppliers who have reported their data to GOGLA actually found that most of these sales for refrigerators were in sub-Saharan Africa. Seventy percent does sound high, but putting it in nominal terms, the market is still quite small. In 2018, we see that only 5,900 off-grid refrigerators were actually reported as sold, 4,000 of which were in sub-Saharan Africa. And so, there are still several barriers that are impacting, you know, penetration of this particular product across emerging markets.

The first one is really around the price point; it's definitely no mystery that this is still a challenge. We tend to find that, on average, televisions will typically cost about 200—they would need to go down to \$200.00, before they are considered affordable for a rural off-grid customer. At the moment, we're finding that with current retail prices, for a 50-liter off-grid refrigerator, that would range anywhere between \$270.00 to \$500.00. And that's quite a

conservative estimate, but that's the range that we—from different stakeholders. That would mean that current prices would have to go down by a minimum of at least 30 percent, for this product to start to make sense _____ the type of market that we'd like to address.

Another challenge is, you know, sort of changing the demand for households when it comes to refrigerators. So, we find that a lot of customers have adapted their lives to not necessarily require refrigerators, and so, there are significant challenges for individuals who are driving these products, and how do they create the right type of marketing and sales proposition for a potential customer. In addition to, of course, the high price point that they would be dealing with. The last area is around high energy consumption of current refrigerators, so, beyond price, daily consumption is still too high. And we're seeing that for refrigerators to be ideal for the current sorts of solar power and other renewable energy power sources that are available, refrigerators would need to consume around .2 to .3 kilowatt hours per day.

The current average is substantially higher; it's somewhere between .5 to .7 kilowatt hours per day. And so, as the market is still quite nascent, there's definitely ongoing development that's required to improve energy efficiency, and also create more affordable technology going forward.

So, based on what we know around the barriers at this stage, we've also done a little bit of research to understand how has efficiency or performance evolved over time. We definitely find that a lot of products are still, you know, not as efficient as we would ideally want. You know, sort of under optimal conditions, most products would actually require a solar panel and system that would be able to produce more than 200 watts overall. So we're finding that there's definitely still a huge disconnect between what we see as energy-efficient and how we anticipate, you know, sort of the prices changing. And obviously the level of R&D required to do that, as well, is still quite high, so there's still a lot to focus on in terms of creating the right type of product innovations.

There are three primary products that we definitely think are starting to head in the right direction and are driving the market when it comes to thinking about these challenges. The one is SunDanzer, which some of you might know actually won the Global LEAP Award for the best 50-liter fridge. They've managed to get their energy efficiency to almost .2, directly at .118 kilowatt hours per day, and that's significantly much better than most of the other products that we're seeing in the market. Fosera has also recently been developing their own 54-liter refrigerator. I think they mentioned that that's meant to be released in May or June this year, and that aims to consume round about .2 kilowatt hours per day, as well.

It's also one of the first models to be designed specifically for the off-grid appliance market. So, really exciting areas that we're seeing a lot of product innovation, there. The last one, which, quite interesting, is Embraco. You know, traditionally, obviously, more focused on _____, but they actually have further customized to bring up a fridge with Youmma. That is not only able to improve their energy efficiency and actually their ability to measure that, but

they've also sort of developed some of the first smart software integration system that allows companies to electronically adjust the refrigerator performance according to the external conditions and the battery load that they see when they actually setup their product onsite.

In addition to that, I think what's quite interesting about this product is, the manufacturer can obtain day-to-day analytics on the performance of the product. That has been used to actually inform, or, will be used to inform future product design. And I think it also starts to create an interesting case for the potential for _____ to become an interesting, you know, to have the ability to have the ability to actually switch on and off a refrigerator. If that comes into play, that will definitely affect some of the affordability barriers that we see, as well.

Another area we've focused on, beyond just, you know, understanding the technology and understanding the affordability barriers, was what is the current state play of different actors across the value chain that would actually be providing these appliances. And so, what we came up with was essentially ten different types of stakeholders that operate across the value chain to provide off-grid products. We've typically found that when it comes to refrigerators, the majority of players that are starting to bring these products into the market would be your traditional vertically-integrated manufacturers. By that, we mean stakeholders who perhaps were actually, you know, traditionally solar home system providers, the likes of M-KOPA, BBOXX, and have actually realized that, to continue to drive demand for their products, they actually need to start coupling that with appliances, as well. We've also seen that, in leading markets—so, what we are terming as a leading market is, typically, the likes of India where there is high access to finance, so some of the affordability barriers are taken away.

There's also, you know, sort of high evolution of these different types of actors across that market, so, lots of different players are in that value chain. In those types of markets, we've also seen a wider range of product models entering into the market, mostly driven by local distributors and retailers, in partnership with a vertically-integrated business or manufacturer. And what's interesting about that is, as we see these types of local retailers coming into the market, there's definitely opportunity for them to specialize more and be able to actually handle some of the distribution challenges that come with larger appliances that also require setup at point of sale. So, we have definitely seen that, in markets that are more developed, that's happening. There are cases, in nascent markets, where this chain is not well developed.

So, to give you an example of a market like Ethiopia, for example, you might not even have, you know, any branded manufacturers that have strong capabilities and presence within the market themselves. They'll typically have a representative, who would work together with one or two new local distributors or wholesalers, to distribute products. So, in areas like that, there's definitely much more need for emphasis and focus around sales and distribution, and aftersales support when it comes to larger appliances such as refrigerators. Another interesting area that we started to explore, and you

might notice is not shown on this particular slide, is who are some of the ecosystem actors that can also drive demand.

Here, we're definitely starting to think about mini-grids and mini-grid players being a key driver of demand. I think, you know, in general, we all know that refrigerators can be an important driver for household consumption of energy overall. So, this is definitely an interesting area, too, to start looking at how best do we get mini-grids into this ecosystem, so that they can create the right type of demand for those products. That said, we're not yet aware of any significant initiatives which have targeted fridge sales at sort of mini-grid sites, but we think it's a matter of time. It's definitely an area that will probably become more interesting for them. The one challenge will definitely be around the power source.

Mini-grids, at least in Africa, are often AC power, whereas, most off-grid appliances tend to be DC. So, _____ need to think about, you know, an inverter would be required in that particular case, and that would obviously carry an extra cost, as well, which goes back to some of our price and affordability challenges there.

So, based on all of this, we went ahead and decided to get a sense of what we think the potential serviceable market or off-grid refrigerators would be. I'd like to continue to profess that this is specifically for the household market. We have done some additional research to understand cases for _____ space, for example, where we definitely think there's a stronger productive new case, there, for this particular appliance. But for now, we just wanted to a quick sense of what is the potential at the household level. Typically, what we found is—so far, what we've found is that [audio cuts out] anticipate the largest growth will be driven by Asia, and specifically India in that market.

This is largely due to our assumptions around decreasing prices over time, which would typically bump up the number of households that would actually be able to afford an entry-level refrigerator. There's also a lot of uptake, already, of some of the more entry-level off-grid appliances in a market like India. So, we've already seen the boom of fans, in that particular market. We've also seen off-grid televisions starting to come into play and really growing, as well. And so, we're seeing that it's more likely that that type of customer will be able to actually transition and look for other types of larger appliances.

Another factor here with India, as well, will definitely be the ability to stack energy. So, we're seeing a lot of households in India that would switch between solar power, in rural areas, and some of the access to the grid or mini-grid power, as well. And so, we definitely see that particular country driving a lot of the growth for refrigerators. Our estimates for sub-Saharan Africa are a little bit more conservative; countries such as Sierra Leone, Uganda, you know, they're still unable to absorb this type of product at this stage. There's definitely a lot of interest from a lot of the ecosystem suppliers and players in this space, but we definitely think that the market still requires a little bit more focus on areas such as access to consumer finance, establishing the right types of distribution channels that go beyond your

traditional sole home system players. And with that, over time, we will definitely see that uptake, but it will be a little bit more conservative than what we're seeing in Asia.

So, based on all of this, what, then, needs to happen to accelerate growth in sales and uptake of off-grid refrigerators? From our perspective, definitely, there needs to be continued investment in R&D, particularly to improve energy efficiency, as well as the performance, just generally, of cooling technologies. I think there's a lot that could be done in terms of, also, incentivizing the entrance of global-wide grid players into the off-grid cooling market, that would definitely also accelerate the technology developments in this space. At the moment, we haven't seen a lot of [audio cuts out] but we definitely think that's an area that's really important. From a customer perspective, I think there's the need to have greater insights into household demand, and stronger productive use cases, particularly for SMMEs, as we've mentioned before.

We did some interesting research in Kenya, around that, where we tried to assess what the potential scale of that market could be. But also, these insights will really help to assist a lot of the businesses to effectively market these products, and really understand where the needs are for the different types of segments that they need to address and tap into. Financing, across the board, continues to come up. Of course, consumer financing will definitely be critical for this type of product, but beyond that, we're actually seeing that there also needs to be dedicated financing for some of the off-grid appliance players. An interesting example of this was, in Ethiopia, where we spoke to one of the industry associations and they mentioned that they were partnering with the World Bank and the local development bank in Ethiopia, to subgrant working capital loans for importers and wholesalers.

And just being able to unlock that type of barrier really creates the right type of environment to expand the market and to deepen their capabilities to bring in products. We've seen a lot of applications, as well, of results-based finance, particularly more for TVs and lighting products, but we definitely think there's an opportunity to use that type of mechanism to drive innovative distribution to the last mile. So how do you make sure that you actually incentivize some of those local distributors we're seeing come into the market, so that they would be willing to go into communities that are a little bit more challenging to invest in and distribute products. Finally, policy continues to be a hot topic. We've seen mixed responses from different governments across sub-Saharan Africa, some who have, you know, really taken to task removing tax exemptions, creating the right types of incentives for solar products to come into the market.

Others which have seen and perceived these products as luxury goods, and so, are not really seeing the link between driving these products and increasing energy demand in their respective countries. So there's definitely a lot of need to focus in those areas, as well, and we definitely go a lot deeper on that in the report. And then, of course, quality assurance becomes really important, as we start to see more products in the market. There's a strong need to really

make sure that we are ensuring the right standards, and we don't, you know, end up with market spoilage. And so, these are some of the areas that we definitely think need to be paid attention to going forward.

I'm going to hand over to Nya, who will be the next presenter.

Charlie

Actually, we're going to go to Jeremy, for now, a little bit out of order, but—Jeremy?

Jeremy

Hi, yes, Jeremy speaking—hopefully you can hear me okay?

Charlie

You sound fine, Jeremy, thank you.

Jeremy

Right, and I think my transfer to my screen has hopefully also worked, so you should see my first slide. Yeah, so, my name's Jeremy Tait. I've been very pleased to be the facilitator of the technology working group working for CLASP and the Efficiency for Access Coalition. And the task given to myself and the technology working group of stakeholders was to develop a technology roadmap for off-grid and weak-grid cooling appliances. And that's basically what we've done, over the past year, and I'm going to present to you the findings, the main findings, that we came up with. And the complete roadmap document will be published during next month, and at the end of the presentation, I'll give you the details of how you can sign up to make sure that you do get a copy of that, if you're interested.

So, I should probably start by saying what a roadmap is, or at least what—the roadmap as we have done it, to explain what we were trying to do with this. So, basically, the roadmap is a tool to identify and coordinate the initiatives and the investments that are needed to develop a particular market. In this case, clearly, off-grid and weak-grid cooling appliances. The roadmap process is very much consensus-based process; we engaged as many stakeholders as we could, to try and get a good amount of feedback and steer and a lot of input from those stakeholders, to make sure we reflected the consensus of those that we're talking with. So we started looking at the needs, we looked at the products that will be needed to develop that market, and then the technologies, and finally the R&D needed to enable those technologies.

So, that process has gone on for the past year, and—here we go. Right, so, what I'll talk about, in this session, are, firstly, just to clarify the scope, we've heard about a lot of different types of cooling equipment in the past half-hour, so I'll just clarify exactly what we had under the roadmap. I'll just talk to you, very briefly, about the way the stakeholders were engaged in that process, then, really, looking at the results. A few words about the status of the market as we understand it now, so, this is based on the stakeholder feedback we had. It's not so analytical as what you've heard from Fadzai just now, it's more anecdotal, but I think some valuable insights, nonetheless.

And in that section, we'll also look at the challenges and the needs we've identified, and many do chime exactly with what you've just heard, so I won't dwell on those. And then, we'll move on to talk about the priorities to develop this market in future, and this is mainly the technologies, that's really what

we're aiming at. But along the way, the stakeholders did identify quite a lot of other supporting initiatives that are going to be necessary to help this market develop. And I do want to talk briefly about some of those, because they are, I think, almost as important as some of these technologies, if we're actually going to see this market develop in a way that is economically sustainable as well as environmentally sustainable. So, yeah, we'll mention some of those, and I'll finish with just a brief idea of the next steps that are happening in this particular project area.

So, the appliances that we talk about for this roadmap, we focused in on the household and small commercial-type applications, and we looked at storage of food stuff and generation of ice. And we particularly were looking at the types of product, the types of technology that are going to benefit those in the rural and peri-urban environments around the cities, not in the cities. It's the sort of lower-income low-resources environments; we're aiming at appliances that can really help build access to the services and benefits to those who are just not finding that accessible, so far. So, we are very much trying to build on those sustainable development goals, through this particular development work. So, we're focusing on those types of appliances in the size range sort of 50 to 80 liters at the small end for the very small units used in households or—and then up to about 180 liters internal volume, or so, for the small commercial-type appliances.

And as we've looked a little bit at sort of the small agricultural-type markets, yeah, we might see appliances equipment going up to a cubic meter, maybe, that sort of size. But in this particular roadmap, we deliberately did not try and address the technologies associated with walk-in coolers, or with bulk milk chillers, or the sort of semi-industrial-type cooling equipment. We acknowledge that there's some good synergies with some of that, indeed, particularly on developing the industries and the supply chains, but this roadmap was focused on the smaller end. And also, we quite deliberately satisfied the technologies involved in the vaccine refrigerators. We did look at that for technology transfer, but, yeah, we weren't trying to look at the development of the vaccine fridge market.

During the process of the roadmap, we did actually realize that we had to also look at transport refrigeration, so, chilling of small volumes of produce from small farms, small holdings, et cetera. And we did also add that to the scope as we went along, and I'll mention a bit about that, later.

So, the process of the roadmap, basically, we started, back in May, with a workshop in Amsterdam. We had 45 or so stakeholders there, and out of that workshop, we grew a technology working group, invited a wide arrange of stakeholders. We eventually got around 60—60 to 70 stakeholders, varied backgrounds, these were components and appliance manufacturers, test houses, developers, experts, researchers, NGOs, associations, and other types. We were very pleased to get a wide range and lots of very positive input from the group. And over a process of just under a year, we had three separate large conference calls with a cross-section of those stakeholders.

But we also had four breakout groups looking at particular topics along the way, and an awful lot of bilateral and desk research done, through to the point where we developed a draft roadmap in December. But coming out of that process, we actually also produced a paper about the categorization of appliances. So, this was looking at the characteristics that define these products, their performance characteristics, and, really, all the building blocks of a very detailed technical specification for these appliances. So that document is available and will actually be annexed to the roadmap document itself, so you'll be able to see that. And we also did a paper on future test methods, and we'll return to that a bit later.

So, we had a lot of very good input; the draft and the final draft will be completed during June and published. That'll become available to you—I'll show you how to find out about that, at the end of the presentation. So, it was a great process, lots of engagement, and we did get some pretty good consensus.

And this is a very simplified summary of the consensus of the current market, and as I said, this is very condensed. The full roadmap has a lot more of a nuanced explanation of these markets. Inevitably, there are going to be things here which people will say, "Hang on a minute, that's not true _____." But, yeah, I'm trying to give an overall impression, and, yeah, at the risk of not giving the sort of detail which people will want to see on this slide. But basically—and I should also point out that the stakeholders we talked to, the majority were based on African experience, which is an interesting contrast to the description that you just heard from Fadzai.

So, yeah, there may be some differences, here, in some of the data. But this feedback we got reflects what's out in the market now, and some of the things you've been hearing from Fadzai, like coming out of the global LEAP test program, clearly, that's the brand-new products that aren't yet in the market. So that's something else to bear in mind when you're comparing what you're hearing today. So, at the household level, I'm afraid it was quite a pessimistic picture, really. Consensus view was that we've got some very challenging economics to deal with, here, which has resulted in quite low penetration.

We have the fridge being a very disruptive influence on the solar home system in the off-grid situation. Certainly, it's, a fridge would tend to increase the power demand by probably a factor of three, from a typical household, solar household system, compared to the appliances that are typically used—the TV, the light, the fan, the phone charger. And probably looking at something like five times the total cost of the usual set of household appliances. So, yeah, and in a situation where the fridge is not going to be run for all of each 24-hour period, perhaps, either from not the power available _____ or the owner can't afford to supply that power for 24 hours a day, they're clearly getting a pretty—a reduced service from that fridge anyway. But it's much more positive outlook for mini-grid and weak-grid area for households, but still economically challenging.

And we do think that the absence of pay-as-you-go accessibility for these units, at the moment, is potentially a limitation on growth, there, particularly

in the African market. Although, there are other markets that could be exploited with that pay-as-you-go compatibility, perhaps. So, uneconomic on the majority of possible situations for households, but we found a much more promising outlook for small commercial cooling. So, this is kiosks, small shops, selling, or, looking to sell cool drinks, perhaps frozen drinks, some other food types. But beverages were a large part of the target market, there, and we're getting a lot of interest, a lot of demand. The economics make a lot more sense when you've got the productive use situation, you've got a revenue that you're building, and we're seeing some very good evidence of revenues being boosted by having a fridge in these small retail situations.

So, much more likely, there, and some good stuff coming up, I think, from Nya, in a minute, that'll put some more detail on that in terms of user perspectives. But in the market at the moment, what we're seeing is repurposed household appliances being used for these sorts of applications. We're not seeing actual commercial appliances that you typically see in the more advanced economies, they're not appearing very much, other than perhaps through some of the big beverage companies that are building their networks out. _____ the soft drink suppliers are providing some of the more commercial bottle Cola-type units, into off-grid and weak-grid areas. But other than that, it tends to be household appliances that are just simply being used for this other purpose.

The third market area that we looked at is the small icemaker, and we really looked at this because of the very high potential. This is offering the potential for a very flexible source of cooling for many different applications in agriculture and food supply chain, building access to markets to small suppliers, small producers. Allowing them to get their products to a broader market, to increase the value of those sales by delivering a product that's in a better state when it gets to market. If it's something like fish, which clearly goes off extremely quickly _____ dairy and vegetables and fruit, if they can be kept for more days, the farmer can earn a lot more money from that crop. And so, economically, it's a very attractive area, but very few people are doing it yet.

And although we have found some really great very inspiring demonstrations plants of icemakers that are making a big impact in these particular areas, so, we do think this is a big growth area for the future. But at the moment, very little going on, at the moment.

Just to illustrate how disruptive the fridge is, in this situation, this is looking at a household situation. This is a chart that was published by Dalberg, in their 2016 study. This is what watt hours used in a day, fridge on the righthand side there, very substantial power demand, and most home systems are not set up to provide that, simply are not able to deliver that power. But in the future, yeah, we will see systems with higher power outputs, and I think we'll probably see the power demand of the fridges going down a bit, but the supply possibilities will increase and we'll see much more compatibility in households.

So, the challenges, in summary, you've heard most of these before, I won't dwell, but, yes, we've got high power demand especially for icemaking. And it might be worth pointing out, but power demand goes up with ambient temperature. If we're going up from 30-32 degrees up to 43 or so, we could see a 50 percent rise in the power demands for the fridge giving the same service. It's just a matter of physics, I'm afraid. So, power demand is going to be—continue to be a challenge. Economics we talked about quite a bit; productive use is a lot more promising.

We don't have dedicated appliances for this market, yet. We've heard about some good examples coming through the line now; we want to see more of that in the future. Another problem, a challenge for those trying to get appliances, is they don't have transparency of performance, there are no test methods internationally agreed, data formats are all over the shop. If you're trying to work out what their plants can do, it's pretty hard, now. And harsh conditions give poor reliability. We hear a lot of complaints of failures in fridges in household—well, particularly commercial applications. They tend to be not repairable and there's no tech support, so, it's a challenging environment, generally, to set up the market.

So, what are we going to do about it? Well, the priority needs that we identified were storage, icemaking, and transportation—those are the ones that we focused on. These are the ones that are going to make the biggest difference to future growth, as far as we understand.

What does this translate to in terms of particular product needs? Well, when we drilled down into the detail, we split the market into the mini- and weak-grid, as contrasted with solar direct drive. When you get into the detail of specifications, the appliances are going to be significantly different in many cases. And so, it's necessary to understand which part of this market you're really going for, with any particular product specification. But the ones that are going to make the big difference are cabinets to small retail, your sort of bottled coolers or units used in markets, display cabinets, et cetera. Then we've got the containers for getting produce from the small supplier through to the market, to increase revenues, that's going to be an important market to develop.

We've got icemakers of different scales, depending on the power supply available. And the other one we've mentioned in this table, here, the flexible module chiller systems, this is really interesting potential market, we think, and I'll say a little bit more about that one now.

Shipping fridges to their market is challenging. They tend to be bulky; they tend to be a box of space, really, in many cases; and they get damaged on the way. If you can ship modular components, they are cheaper and easier to move around, they're more robust on the way. But in particular, if you can supply easy-to-assemble components or modular systems, they can be assembled by local skills, and you can build employment, you can build skills in the local economy, that can then access and design and build its cooling systems to meet that local demand. So _____ could be sort of modular systems could be adapted, and the University of Hohenheim has done some

great work, in the last couple of years, actually getting some of this type of equipment on the market and seeing it in use. And they are already seeing a lot of very high interest and capable local people able to assemble and put this stuff to use, adapted to the local demand.

So this is quite a high potential economically and to deliver cooling. So –

Charlie

Hi, Jeremy, this is your one-minute warning.

Jeremy

Okay, right.

I won't dwell on that.

The technologies that are needed to develop this, then, are compressors and controllers. At the moment, the market is being developed, is being run on a very narrow range of compressors, and if we're going to see these high-efficiency variable speed compressors exploited, we need to have good control systems for those. And modular designs we talked about—I've mentioned enough about that. But control systems will be key to exploiting the fridges as part of a mini-grid system, or even a community power system. Fridges can be disruptive, they're high power demand, but they're flexible loads.

If they're controlled effectively, they can soak up excess power when it's available, to store ice, to chill products. When there's a peak demand on the power supply, fridges can be shut down, and they will sit there quite happily whilst power is diverted to other uses. And so, there's a lot of potential for load management, if the control systems are in place to do that. Software to specify and select appliances is also going to be difficult—is going to be complex, but essential, to get a system that's going to work. And software to help the _____ an expert system to make those specifications is crucial. And, yeah, there's a need for technologies to enable these systems to deliver cooling even in very high ambient temperatures, and that is all going to be necessary to facilitate the market. Yeah, repairability and reliability, crucial, as well. Circular economy—we need to work towards that in the medium-term, as well.

There's a lot that needs to be done to help to support these technologies, as well as just the R&D. We do need to have the test standards, we need to have financing, we need to have the skills to install and maintain. We're going to need to understand the affordability of the systems, to help steer in the right direction. And we need to think in advance on waste issues—fridges could be a challenge, in the future, to these markets, if they're not designed for easy dealing at the end of life.

And, so, we've identified a bunch of technologies which we think are going to be important. We've identified a range of supporting initiatives. Where do we go next? Well, there's at least £1 million of grants being allocated, at the moment, and this information will be informing the future grants that are going to be made available. There will be calls—a second call will be coming out, in the coming weeks and it will be steered by what we've found.

We need to look at partnerships with developers, and I think we need to look ahead at a quality assurance framework, perhaps in light of what we've seen with lighting equipment. Because it enables policy to support development of the market in the right direction.

Finally, I'll just say that this is where you can sign up to the newsletter, and that is where you will hear about the roadmap, when it's available.

And I will, with that, hand over to Nya, to continue with results of her field trials. Thank you.

Nya

Thank you, Jeremy. Hi, everyone, I hope you can hear me well and see my screen. Can I [audio cuts out] from you, Charlie, if everything is okay?

Charlie

Everything looks great, thank you.

Jeremy

Looks great.

Nya

Thank you.

So, I'm going to be briefly talking about the Global LEAP Awards that Fadzai and Jeremy have briefly mentioned in the presentations and telling you more about our learnings from _____ that we carried out for off-grid refrigerators.

So, just to give you a bit of background about the Global LEAP Program, as Fadzai and Jeremy identified in their presentations, the market for refrigerators is still very nascent, and there are several challenges to stealing this market. So, the Global LEAP Program tries to accelerate adoption of highly-efficient products, and we do this by using a competition-based approach, to drive innovation in early-stage technologies, while building valuable technical and commercial market infrastructure. So, each _____ competition round consists of research and planning phase before the launch, and this is then followed by rigorous product testing in accredited laboratories. And we're testing products for energy performance, quality, reliability, and then we put this in front of a panel of expert judges, and ultimately, a winner is announced. And we disseminate this product information, therefore, making it easier for distributors, who want to introduce these products into the product line, to be able to identify supplier of highly-efficient off-grid products.

So, we have run several Global LEAP competitions, in the past, for TVs, fans, refrigerators, and we are currently in the process of running another awards program for refrigerators, as well as solar water pumps. And then, one of the outcomes of the awards is we pair this with the results, this financing mechanism, to reduce the financial risk associated with large-scale appliance procurement. So we're incentivizing distributors to buy this product, these highly-efficient products, in bulk, than they would without the presence of this incentive. And therefore, trying to push the market forward in this way.

So, just to give a little bit of context before I dive into the details of the field testing. One of the things that we say a lot is that nobody buys electronics or

solar panels; people buy the services that these electrons and solar panels make possible. So, off-grid appliances, including large-scale equipment and productive use appliances like refrigerators are things that actually provide these energy services. So, by reducing the amount of electrons needed to provide a given energy service, super-efficient appliances allow customers to get more energy service but the same power size system and reduce the overall cost of the system required to provide those services. So, what this chart is showing us, these are the results of a 2017 analysis from researchers at Humboldt State University.

And what they found is that, the most energy-efficient versions of appliances need less PV and smaller batteries to deliver the same service as inefficient appliances. The chart shows that an appropriately designed DC solar fridge requires approximately a tenth of the energy delivery system of a conventional refrigerator.

And so, now, diving into the details of our field testing. Given that the market for off-grid refrigerators is quite nascent, the 2017 Global LEAP Awards included a unique feature, which was the introduction of three innovation prizes. These were prizes for energy efficiency and overall value, those based on the laboratory test results, and the _____ innovation prize was for appropriate design and use experience. This _____ portion of the innovation prize was going to be based on field testing, so what we actually wanted to find out is how do those products actually perform in the real-world when put in front of consumers. So what we did, at the end of laboratory testing, we shipped all products that pass the testing, from the laboratory in the Netherlands to Uganda.

And so, there was over 36 products in total, and these products were installed in preselected entrepreneur shops. So, market dynamics have indicated that small retail buyers are the most likely early adopters of refrigeration technology, given both the high cost of these products and the potential to generate new revenue sources from the use of the fridges. So, we installed remote monitoring systems to collect technical data from the fridges, so we were able to collect instantaneous power consumption, accumulated energy consumption, as well as the daily power available from the solar home system. And this quantitative data was supplemented by qualitative feedback, administered by a biweekly _____ service, and this service were collecting more nuanced user feedback about their perception of the technology, the ease of use, if there had been any changes in their business. And additionally, we also made some observations on the quality and durability of the product.

So, what are some of our findings? So, power consumption of a fridge is really dependent on the refrigerator settings, the amount of the refrigerant used, _____ regulations of the compressor, as well as the relative humidity and ambient temperature of the location. In the lab, we standardized these metrics, in order to be able to make a direct comparison of the refrigerator performance. But in the field, obviously, we could not control for these metrics, but we assume that there—we anticipate that there'll be a deviation in that energy consumption in the lab as well as in the field. But

what we found is that 88 percent of these tested fridges consumed more energy in the field than in the lab, and the _____ in the performance was as high as 124 percent, in some of them, which was quite shocking. And so, what this graph is showing us is that most of the products were consuming more energy, and one of the reasons for this could be that the refrigerators were primarily being used to cool beverages.

So, the entrepreneurs will try to maximize the utility of their fridges, by filling them to capacity with cold drinks, and then throughout the day, they will take out cold drinks and refill the fridge with much warmer drinks, to replace those that are being sold. So, this constant cycling of cold and hot drinks greatly affects power consumption. And so, while more field testing is really needed to understand some environmental end user patterns that could be affecting energy consumption, and how products can be better designed to address some of this user behavior.

So, this inconsistent product performance really does compromise service delivery, and can have a negative effect in accelerating the market. So, from a qualitative data, we asked users how many hours are expected the fridge to be operating per day, and then in addition, what amount of downtime could they tolerate per week. So, what it started showing us is that 85 percent of the users expected the fridge to be operational for between 8 to 24 hours per day. And more than 50 percent of them could tolerate no more than 6 hours of downtime a week, so this translates to less than one hour a day. So, if you incorrectly size a refrigerator, so, if you size it based on the energy consumption in the lab, but it's actually using more energy in the field, then, the secondary implications of this could be that you don't have enough PV and enough battery to actually support this service requirement that the consumers are expecting. And in that sense, this could damage the reputation of the refrigerators as not being reliable or delivering the expected service.

And so, another thing that we noted there, so this was based on kind of like the process of installation and then use of the product, as well as serviceability. So, user characteristics, obviously, these customers are living in very remote areas where it's difficult to not only deliver the product but also to access service. A lot of them, unlike AC fridges that are, for the most part, kind of plug and play, off-grid refrigerators will still require some technical expertise to be able to connect the PV battery and the fridge together. And so, they are looking towards a technician, and technicians in remote areas, what we found is, a lot of these technicians were not certified technicians. In addition, these users have really low levels of comfort with appliance technologies, this fridge was the most expensive asset that they had, and they were all first-time users of refrigerators, and their English literacy levels were quite low.

So what this means, from a manufacturer's perspective, is that when you're thinking about your user manuals, you need to put in mind that maybe make use of more pictures than words. And then, make the products as plug-and-play as possible, to kind of remove the guesswork from it. And then, in addition, building in some appliance protected mechanisms, just because that

process of installing the PV, connecting the PV and battery, the whole energy system with the fridge, what we found is these technicians are kind of just using the experience from maybe repairing AC fridges, and trying to translate that into connecting a DC fridge.

So, what impact on the quality of life did these refrigerators have? And so, this was very exciting to find out, and we saw that, across the board, the revenues, for most of these entrepreneurs, their revenues increased, on average, from \$12.00 a day to \$29.00 a day. And so, this was just from the sale of cold drinks, and in addition, the total daily income increased from \$29.00 to \$70.00. Because oftentimes, when a customer came in to buy a cold drink, they would not only be buying a cold drink but they would be buying additional products that are being offered by the entrepreneur. In addition, 50 percent of the entrepreneurs in the study reported to the expanding into a new business line, mostly, selling fruit juice, adding fruit juice, or things like milk or some other products that needed cooling that they were not offering before.

And so, I want to finish with some quotes from our customers. This is one of the testers, Shabana in Mbale, where he says customers are coming in great numbers, he's making great sales, and the fridge has really brought change into his life.

And Proscovia, she says that this is a secondary benefit of the increased benefit from the fridge, "Getting this fridge has helped me, because if a child asks me to buy them a book, I can take money from what the fridge has earned us. The money is there, and I use it." So this is just to show, while the sample size was quite small, only 36 entrepreneurs, there still is an opportunity to do additional research and _____ more understanding, and this technology is very much needed and could have greater impact on rural communities. Affordability and energy consumption, as well as all of the other challenges identified by Fadzai and Jeremy, also require, have to be solved before the products are affordable and can be made available to these consumers.

And so, with that, that comes to the end of my presentation, and I'm going to pass it on to Philip, to tell us more. Yeah, thank you.

Philip

Thank you, each of our panelists, for those outstanding presentations. As we shift to the Q&A, I'd like to remind our attendees to please submit questions using the question pain, at any time. We'll also keep several links on the screen, throughout, for quick reference, that point to where you can find information on other upcoming and previously held webinars. And how to take advantage of the Ask an Expert program.

For now, I would like to pass the presentation back to Charlie, so he can proceed with the Q&A. Charlie?

Charlie

Thank you very much, Philip. I'd like to invite the participants to please submit questions in the questions box. I'm going to ask a couple of pre-prepared questions that we have, here, to our panelists, and then I'll take a few questions from the audience.

The first question is really for any of you who want to take it, but I would like to get your sense of how the different efficient cooling solutions that you presented today are going to be powered. Jeremy, you touched, for example, on the fact that, you know, in some cases, it may be possible to power these technologies with a solar home system. But in other cases, it may be more appropriate or more feasible to use a larger component-based solar system, or even possibly a mini-grid. So just any reflections that you may have on what kinds of technologies are likely to power refrigeration in particular, I'd be very interested in your reactions to [audio cuts out].

Jeremy

I could kick off observation from our experience—this is Jeremy. From what we've been hearing from stakeholders, the current solar home systems simply will not be able to provide the power for a fridge, in the majority of cases—they're just not built for it. So we are looking at some future power systems, so I think—which will have to have upgraded capacity to accommodate a fridge of any reasonable size. And not withstanding some of these very efficient units that seem to be coming through, but we need to look at the affordability of those very, very high efficiency units. I don't know if Nya perhaps could make any comment on that side of it, but, yeah, that was my perspective. I think, really, the mini-grid is where you're going to see better use of these technologies, particularly for a commercial application where you need that reliability of supply, as well.

Nya

Yeah, well, for the household applications, I think there's a lot of research now going on, and people are looking into direct drive fridges that don't need the PV systems, I mean, that don't need the battery system. And then, also, better use of phase change materials that will help with the cooling. So I think these—I think I—I'm going to disagree with you on that one, I think the [audio cuts out] are also working on bigger battery systems to accommodate larger appliances, as the demand begins to shift that way. And then, at the same time, manufacturers are being more innovative and trying to figure out how to have fridges that consume less energy. So, I think it will be both, I think, yeah, from a commercial perspective, there's definitely the opportunity for connecting microgrid companies, as you mentioned. And then, from a domestic level, I think there's a lot of interesting innovation going on from both the manufacturers and the distributors' side.

Charles

Thanks, Nya. So, many grids are largely component-based, so the systems are more likely to be able to power fridges today, based on current electricity requirements. But we're also seeing _____ solar home systems kind of getting larger and responding to the challenge of producing enough power. And so, you think that plug-and-play solutions, you know, will grow, frankly, in response to this market opportunity, in future. Thank you.

One of our questions from our audience is with regards to whether any of you are aware of refrigerator manufacturers partnering with any of the pay-as-you-go platforms, such as Angaza or Solaris. And I think that links into the related question of, where do you see the potential solutions to the consumer financing barrier, which I think everybody recognizes? And ultimately, do you see the end users being primarily households? Or do you see SMEs

being, you know, perhaps a major or even a more important than households themselves? So, I want to ask two [foreground noise interferes with audio] to the panel, there: one is around affordability and pay-go, and the other is around whether the ultimate end users are likely to be households or whether we're looking more at SMEs.

Fadzai

Hi, this is Fadzai. So, I would like to respond to the question around the opportunities [glitch interferes with audio] particularly in this space. I think, you know, when you think of just the price point for this product—and this is my personal opinion based on the research that we've done—I definitely think that the SMME market [audio cuts out] to become the more appealing segment to look at. We've heard some of the comments from some of the players who were starting to bring in, you know, specifically off-grid appropriate appliances into the space. And we actually did some interesting research around that, where we just tried to look at Kenya as a potential example. Looking at the fact that, you know, if we look across the main sectors where we have small shops, restaurants, and bars that provide the right type of economic activity to actually own a refrigerator, there are about 570,000 SMMEs that already report, you know, electricity constraints.

And then, if we look at market penetration for solar refrigerators in Kenya, at the moment, it's currently close to zero, right? But as prices drop and awareness rises, those businesses are likely to be [audio cuts out] market to tap into. We actually anticipate that [audio cuts out] if we assume that only ten percent, so one in ten of [audio cuts out] need a refrigerator, we'd still represent a cumulative market of about \$20 million. So, that type of targeted product design that would cater was some of what Nya was mentioning when she talked about, you know, how long do these types of businesses need to have a refrigerator on for. Can we create a reliable product that's energy-efficient, that can run for longer lead times? That really opens up opportunities in sort of those kinds of markets.

Charles

Thank you. And we have another couple of questions, here, looking over at the policy side. I mean, I think it's very early-days for governments to be taking an interest in these nascent and emerging technologies and markets, but have you seen any recent or upcoming policy developments from governments seeking to create an enabling business environment for, for example, for cold chains or for refrigerators?

Nya

So, I know the Kenya government is currently looking at a minimum energy performance standard for refrigerators, but this is AC refrigerators. Or if it was a DC fridge that could also be powered via AC, then it would have to fall into the maps. But just DC-powered fridges, there is no policy, yet, and yet, to your point, I think the market is too nascent and too small for any policy work to be going on.

Jeremy

Yeah—Jeremy, here—I can—I'd like to, yeah, pick up one of those points that Nya made, that there is definitely policy emerging for the on-grid appliances for refrigerators. And, I mean, I know in recent years Ghana has been quite active on this, because they became very concerned about the dumping of old fridge products from developed markets going into Ghana,

as grid access was growing. People who wanted a fridge, they were getting secondhand appliances quite cheaply, which were creating a waste problem. And were very poor efficiency, they were taking a lot of power from the grid. And, yeah, I think we do have to be wary, as we're promoting the growth of the market for fridges and cold chain food, I think the policy framework's got to keep pace with this.

The governments in these countries that are trying to increase access, I think they need a robust framework to control this and avoid products which are rapidly being banned in a lot of the more economically advanced regions, now, through high efficiency requirements. We want to avoid those being dumped into the economies where people are—you know, there's a lot of demand for these appliances, but not the regulatory frameworks. So, yeah, I do think it's important for us to work with the policymakers, to make sure this keeps pace. And looking ahead to the waste implications, as well, there's some really great work going on in that field, in certainly a number of African countries, looking at setting up recycling facilities, looking at the needs for that. So, yeah, it's actually right to identify that as a need to focus on in the future.

Fadzai

And so, just to chime in a little bit on this beyond just policy, because I think we do tend to get stuck on do we have the right types of tax exemptions, is there, you know, remove duty, import duties, et cetera. But one of the really interesting insights we got from a lot of the industry associations, that either deal in the renewable or solar energy space, is that where some of those frameworks are available, there are challenges in actually implementing those exemptions, for example, at customs authorities. So, in addition to governments, you know, who are quite progressive actually taking onboard some of those exemptions or creating incentives, there's also a need to actually train the right type of officials to understand, "What is an off-grid product? How do I assess that this is different from a traditional appliance that would come into the market?" Right? And I think there's definitely some investment that needs to be made there, to upskill and train individuals around that.

Charles

Thank you, Fadzai, I think that's a really important point you've raised, there, about the importance of implementation beyond just policy.

I'd like to close with a question for Nya, if I may. Both Fadzai and Jeremy, I think, gave us a good overview of the market barriers that are being faced around consumer and distributor access to finance, around technology, around business models, around technical assistance needed, capacity building. But Nya, I feel like you're sort of closest to the companies, if you like, through your work providing results-based financing. And I would like to ask you, from the conversations that you've had with businesses receiving results-based financing, if you have a clear sense of what additional forms of support you feel they would most value. I mean, would they like supports around building out the evidence base for the impact of these appliances, so that they can do more informed sales and marketing? Is it more to do with capacity building?

If you could identify their top kind of nonfinancial need, what would you say that was?

Nya

Yeah, thanks for that question. I think the one that always stands out is kind of like market segmentation, so, understanding what type of product meets what kind of user and at what price point. And that's related to the expected service delivery, right? So, for example, as I mentioned in my presentation earlier, a lot of the entrepreneurs were using their fridges to sell beverages, and cycling through this constant opening and closing to access the beverages was causing increased power consumption. So, for example, if manufacturers just designed fridges with better compartments, that kind of like met this use case scenario for entrepreneurs. So you could have a compartment for, like, cold drinks, and another one for warm drinks, so that you're only opening one of those compartments at any one time, for example, right?

So, and then the second thing is, you know, just related to affordability, it's, okay, at what price point does it make sense to finance the product for a business? And how much revenue will they be able to generate? And how long will it take them to pay back the product? And then, even for, if it's for domestic use, if it's for a group like a savings group or a farmers group, what are their refrigeration needs? And how willing are they to pay for the product, and how are they able to pay for the product?

Yeah, so this boils down to market segmentation, that's always, that's, like, the number one need that they have. And then, from a manufacturer's perspective, it's just getting—understanding the users better.

Charles

Right, got it, so it's a lot to do with understanding what usage looks like in the field, and then the implications for that in design and for business models, as well.

Nya

Exactly.

Charles

Thank you very much.

Well, with that, we're at time, so I'd like to close the Q&A. Apologies to our participants who sent through questions that we've not been able to answer. I'll take a look at that list, and I'll farm out the questions that we haven't been able to respond to, to our participants, who will respond to them on e-mail. So you can expect a response to your questions, following this webinar.

With that, I'd like to just close with a big thank you to our panelists for excellent presentations and a great kind of summary discussion. I only wish we had a lot more time, as there's clearly a lot to discuss, here. But I think that only serves to remind us that we should watch this space for the forthcoming publications and the more detailed discussions that will take place around them, in due course, over the next few months.

And with that, I'll hand back to Philip to close the webinar.

Philip

Great, thank you, again. On behalf of the Clean Energy Solutions Center, I would 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 also invite you to inform your colleagues and those in your networks about 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 would like to view the slides and listen to a recording of today's presentation, as well as previously held webinars. Additionally, you will 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 for about one week for the audio recording to be posted.

Finally, I would 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. This concludes our webinar.