CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

Tariff-setting Approaches for Rural Electrification

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Webinar Presenter

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Katie Hello, everyone. I'm Katie Contos, and welcome to today's webinar, which is hosted by the Clean Energy Solutions Center in partnership with African Association for Rural Electrification. Today's webinar is focused on tariff setting approached for rural electrification. Before we begin, I'll quickly go over some of the webinar features. For audio, if you have two—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. Doing so will eliminate the possibility of feedback and echo. If you choose to dial in by phone, please select the "telephone" option and a box on the right side will display the telephone number and audio PIN you should use to dial in. If anyone's having any technical difficulties with the webinar, you may contact the GoToWebinar's helpdesk at 888-259-3826 for assistance.

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Today's webinar agenda is centered around the presentations from our guest panelists, Emily Chessin and Ryan Cook, who have joined us to discuss tariff setting strategies and considerations for isolated mini grids in rural

electrification context. Before we jump into the presentations, I'll provide a quick overview of the Clean Energy Solutions Center. Then, following the panelists' presentation we'll have a question and answer session where the panelists will address questions submitted by the audience. At the end of he 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, 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 and the European Commission are members contributing 90 per cent of the clean energy investment, and responsible for 75 per cent of global greenhouse gas emissions. This webinar is provided by the Clean Energy Solutions Center, which focuses on helping government policymakers design and adopt policies and programs to support the deployment of clean energy technologies. This is accomplished through the support in crafting and implementing policies related to energy access, no-cost expert policy assistance, and peer-to-peer learning and training tools, such as this webinar.

The Clean Energy Solutions Center is co-sponsored by the governments of Australia, Sweden, 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 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; and an online library containing over 5500 clean energy policy related publications, tools, and videos; and other resources. Our primary audience is made up of clean energy policymakers and analysts from governments and technical organizations in all countries, but we also strive to engage with private sectors, NGOs, and civil society.

The Solutions Center is an international initiative that works with more than 35 international partners across a suite of different programs. Several of the partners are listed above—include research organizations like IRENA, IEA, and programs like SE for ALL, and regional focused entities such as ECOWAS Center for Renewable Energy and Energy Efficiency. A _____ key feature the Solutions Center provides is a no-cost expert policy assistance known as "Ask an Expert." The Ask and Expert service matches policymakers with more than 60 global experts selected as authoritative leaders on specific clean energy finance and policy topics. For example, in the area of rural electrification, we are very pleased to have Ibrahim Rehman, Director of Social Transformation Division, the Energy and Resource Institute serving as one of our experts.

If you have a need for policy assistance in rural electrification or any other clean energy sectors, 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 form at cleanenergysolutions.org/expert. We also invite you to spread the word about the service to those in your networks and organizations. Now, I'd like to provide a brief introduction for today's panelists.

First up is Emily Chessin, who is a senior associate at Meister Consultants Group. She specializes in renewable energy policy and regulation, strategy development and multi-stakeholder facilitation. And our final speaker today is Ryan Cook, who is a senior associate at Meister Consultants Group where he provides technical assistance and expert consulting services in areas of renewable energy program and development and implementation. And with those brief introductions, I'd like to welcome Emily to the webinar.

Emily

Good morning. Thank you very much for having us today. I'm just going to go ahead and share our screen. So, you all should be able to see that now. Great. Well, thank you for joining us today for this webinar on tariff setting approaches for rural electrification. As Katie mentioned, my colleague, Ryan Cook, and I are going to be providing this webinar to you all. To just provide a little bit more background about our organization, Meister Consultants Group, a Cadmus company. We're an international sustainable energy consultancy based in the U.S. with our headquarters in Boston.

We frequently collaborate with international institutions, multilateral development banks, and national governments to support them in renewable energy policy planning and regulation for both on-grid and off-grid renewable energy development. In 2017, we were acquired by Cadmus. Cadmus is an international technical and strategic consultancy with offices in the U.S. and Germany, and they have more than 600 experts in energy, transportation, environment, water, and other topics. So, today we're going to be speaking to you specifically about setting mini grid tariffs. Much of this webinar is going to draw on a resource that Ryan and I coauthored in collaboration with the National Association of Regulatory Utility Commissioners and USAID called the *Practical Guide to Mini Grid Regulation*. In the guide, we provide detailed guidance on developing a regulatory approach for mini grids in various rural electrification context.

And, in the guide, we include options for 20 key regulatory design decisions that go through a few different areas including policy and planning, retail tariffs, and also technical standards. So, if you want to learn more about the guide, you can find it on NARUC's website. And throughout the presentation, we'll also be pulling from resources from other institutions such as the World Bank and other resources USAID has developed, along with NREL in providing information on mini grid tariff setting.

So, in today's webinar, we're going to cover a few different topics. The first will be talking about the differences between mini grids and national grid tariff setting. Then, we'll talk about approaches to setting and determining optimal tariff levels. We'll talk about approaches for setting different tariff structures. Then, we'll discuss social tariff implementation and considerations

for cross-subsidies. And, finally, end with some illustrative examples for how different countries have gone about their mini grid tariff settings.

So, first, before we get into tariff setting, I think it's important to start off with some background of why are we even talking about mini grids toady on this webinar. So, as many of you know, worldwide, there's still 1.2 billion people that lack access to modern electricity services. And according to the International Energy Agency, more than half of these people could be served efficiently and effectively by remote, isolated, mini grids. Mini grids are also an attractive option for providing electricity services, because they allow for different types of business models including ownership, tariff design, technology that can accommodate different countries contexts and needs. So, given this, there has been significant interest from national governments, international donors, and also private firms in mini grids.

But, to scale up mini grids, it's going to require significant investment, particularly coming from the private sector. And in order to attract that private sector investment, mini grids have to be commercially viable. To be commercially viable requires mini grids to be able to cover their costs and also earn a reasonable rate of return through tariff collection and/or subsidies. So, before we start talking about tariffs to mini grids, it's also important to understand the cost and revenues of a typical mini grid, because, ideally, their tariffs are going to be covering their overall cost and allowing them to earn a reasonable rate of return.

So, their costs are broken up into three main categories—project development and investment costs; generation and distribution equipment costs; and then operations, maintenance and management costs. And then their main revenue streams that they have access to are the fees that they charge to customers for wiring and connecting them to the mini grid, the tariffs that they're charging for the electricity consumed by the different customers, and then any grants or subsidies that they are receiving from national governments or other types of institutions. So, those revenue streams though are going to be dependent on a few different factors. One of the main factors is going to be demand for electricity. So, obviously, if there is low demand then they will have less revenues. If there is high demand, they're selling more kilowatt hours, we're going to be bringing in more revenues.

And then, also, that demand is going to also be a factor of affordability of both the connection fees and the tariffs. If the connection fees and/or the tariffs are unaffordable for the customers, they will not have a customer-base. They therefore will not be bringing in revenues. So, as a mini grid developer thinks about their revenue streams, they also need to factor in the current and future demand for electricity and also the affordability of their connection fees and tariffs.

It's also important to recognize the difference between the national grid and mini grids when talking about mini grid tariffs. So, mini grids in general tend to require higher per kilowatt hour revenues than national grid utilities. And this is due to several factors. National grid utilities have the ability to have economies of scale. So, they can take their costs and apply them across their

wide customer-base to charge a lower tariff or even the same tariff, often called a uniform tariff, across their customer base. They can also cross-subsidize across customers.

And they also often have access to government subsidies to help further reduce the customer's electricity cost. So, national utilities' rates may not necessarily then reflect their overall cost of what it actually takes to provide electricity to service their utility customers. And, as a result, that can lead to some interesting dynamics with current customers or potential customers where customers don't necessarily understand the full cost to providing electricity services to them. This process of reducing electricity costs of the national grid customers can also result in customers kind of having unrealistic views of electricity costs and expecting low electricity costs no matter where the electricity is coming from—whether it's from the national gird versus the mini grid.

Mini grids do not have these economies of scale. They're going to be serving rural, remote areas and there may only be one mini grid serving a very narrow customer-base. So, they don't have this large customer-base to spread costs across, and they also have less flexibility in terms of cross-subsidizing across customers. And, frequently, they'll also have less access to subsidies to cover any revenue gaps. So, as a result of the decreased economies of scale and the remote nature of the areas that mini grids serve, their costs tend to be higher and therefore they have higher revenue requirements than minigrids.

And so, just to demonstrate what we mean when we say that mini grids tend to have a higher revenue requirement per kilowatt hour than national grid utilities, I'm showing you right now some data that came from a recent case study offered by the World Bank looking at Nigeria's mini grid sector. And what this data is showing is it's showing an average main grid tariff of USD $0.08 per kilowatt hour. And then they were able to collect data from a particular mini grid developer in Nigeria which showed that their average mini grid tariff was around USD $0.36 per kilowatt hour. So, you can see there's a big difference between the main grid tariff and the mini grid tariff—about a $0.28 difference.

And so, while these costs are going to be higher for the mini grid developer and for the mini grid customers, it is also important to note though that in many of these rural areas, customers are having—potential customers do already receive some sort of energy sources from non-grid energy resources. And so, this might be kerosene or candles for lighting. They might be paying mobile phone charging stations to charge their phones. And when you actually add up the costs often of these various non-grid energy sources, you find that the cost that customers are paying is actually potentially even higher than what the mini grid tariff might require. So, while they might still be higher than the national grid tariff, they often will still be providing a savings to rural customers and providing value to those customers.

So, it's also important to be aware of the different stakeholders that are going to be involved in the mini grid development planning process and then also specifically within the tariff setting process, and what their different

perspectives are. So, you have the mini grid developer. And their main objectives are going to be that they want to make sure they're recovering their capital and operational costs, that they're getting return on their investment so that they can also meet their investors' needs, and that there's going to be long-term predictability and certainly associated with their investment. And they also want to make sure that their tariff and the services that they're offering are affordable to their customers. Investors' interests are going to be pretty similar to the mini grid developer, but they're going to be very much concerned with ensuring that they are receiving a return on their investment and therefore that there is long-term predictability and certainty around that investment.

You then have the regulator who could be involved in different aspects of mini grid regulation, policy, and planning; and could also be responsible for helping to regulate the tariffs of mini grids. And if this is one of their roles, they're going to want to make sure that the tariffs are fair and reasonable for the customers. They're also going to want to make sure that the mini grids are recovering their costs and earning a reasonable rate of return, and that these tariffs are affordable to customers, and that customers are also protected from the mini grid operators.

And then, finally, you have the policymakers. And these are often going to be government officials. And they're going to want to be able to show to their constituents that they're helping the country meet the rural electrification goals. Assuming that mini grids are part of this, they're going to want to be able to say that the mini grid sector is growing and be able to point to mini grids that are now serving rural populations. However, they're also going to want to make sure that the tariffs that are being charged to customers are affordable.

And policymakers might have a different interpretation of what affordability means and might feel pressured to push for lower or uniform tariffs for mini grids even if these aren't economically realistic. So, it's important to keep all of these different stakeholders' perspectives in mind as you're thinking about mini grid tariff setting, and broader mini grid development issues.

So, now that we've kind of laid that context: What is an optimal tariff for a mini grid? So, as we said before, ideally, the tariff is ensuring that mini grids are able to earn a reasonable rate of return and recover costs, that the customer's rates are affordable, and politically feasible. So, some of the most common tariff levels we see. The first one is uniform national tariffs. And we'll often see that governments feel the need and the desire to want to offer the same tariff to all customers across different categories. So, residential, commercial, and industrial would pay the same retail tariff no matter where they live or how they receive their electricity. So, whether you're receiving it—you're an urban customer receiving your electricity from the national grid or a rural customer receiving your electricity from a mini grid, you're all going to be paying the same tariff.

The second type of tariff that we frequently see are called avoided-cost tariffs. So, as I was showing before on the example of Nigeria, often customers are

transitioning from other energy sources to the mini grid. And so, they've been paying for those electricity sources and, frequently, those costs are higher than the mini grid tariff might be. So, the avoided-cost tariff ensures that the mini gird tariff is going to be equal to or below what that customer would've been paying for past energy purchases such as kerosene for lighting.

And then, finally, the cost-reflective tariff. So, this is a tariff that's going to allow mini grid operators to recover their full capital and operating costs and receive a defined and reasonable return. And this is often considered best practice in many different circles. So, to talk a little bit about some of the benefits and drawbacks of these different tariff options. So, for uniform tariffs some of the benefits is that it's often a politically preferable approach. It ensures that rural customers will not pay more for electricity than urban customers. And it's generally viewed as a fair and equitable approach, and easy to communicate and justify to customers and political constituencies.

Some of the drawbacks though is that it's often an insufficient tariff for mini grid developers to recover their costs. As we showed before in the example of Nigeria, you saw that there was that $0.28 difference between the national grid and the mini grid tariff. So, for that mini grid to be financially viable, it's going to need some sort of cost recovery mechanism, whether it's subsidies or grants, to make up that difference between revenues and costs. And that difference is often termed the viability gap. So, without a supplemental revenue stream to close the viability gap, mini grid investments may be very challenging. It could eventually even discourage mini grid investments.

With avoided-cost tariffs, these are going to ensure that the customer is either going to save money, because they'll be paying less than they were paying before for their energy services, or that they'll at least receive better services for same or less level of expenditure. Some of the challenge with the avoided-cost tariff is that in order to understand what cost the customers were paying beforehand there's a lot of different resources that customers could've been using to meet their energy needs. And so, coming up with this cost can be a bit challenging. And so, you could run the risk of setting a rate that is either too low for the developers to fully recover their costs, or you could end up setting a rate that ends up being actually too high for customers, that they can't afford. The other thing will often happen with avoided-cost tariffs is that many of your customers will end up likely paying a higher tariff that's going to be different than the national grid customers.

So, the last type of tariff option that we see frequently is cost-reflective tariffs. And this is, as I said before, kind of considered best practice. It's the most effective option for incentivizing private sector investments in mini grids. This is a priority for a country's rural electrification. And it also maximizes developer's ability to recover cost and earn a return on their investment. Some of the drawbacks, which we've mentioned, have been that it could be politically—it may not be politically preferable to have cost-reflective tariffs.

Mini grid customers are also likely to pay more for their electricity than urban national grid customers. Again, it might not be politically preferable to have

that. And you're likely also going to see different rates for customers with different electricity providers. Not all mini grids are the same. They're going to have different cost structures and therefore will likely have different revenues and will need to think about how they want to structure their tariff and what level tariff that will need to be. And the last thing is with the cost-reflective tariffs you need to ensure affordability, which can sometimes be a challenge.

So, in thinking about these different types of tariffs that we see, we wanted to talk a little bit about: How do you then go about setting cost-reflective tariffs? And so, I want to go over one of the most common ways. Many of you might be familiar with cost of service or cost-plus regulation. This is the most common approach for determining the allowable tariff for a utility, and it can also be used for establishing the tariffs for a mini grid.

So, in a cost of service regulation what the regulator is basically trying to determine is the utility's revenue requirement. So, in doing do, the regulator, they're trying to determine the cost of the utility to provide electricity services to all their customers plus an agreed upon rate of return. Once the costs are determined, the regulator then can establish the utility's revenue requirements. And then, from there, the utility's tariff can be designed so that the utility covers its costs and earns an agreed upon return.

So, the same approach can be used to determine mini grid tariffs for the specific mini grid project or projects, if the mini grid developer is involved in a series of projects. They would determine their costs plus a reasonable rate of return. The rate of return can be determined by the developer or it could be determined by the regulator. So, once those costs are determined, they can establish their revenue requirements. And then, from there, they can determine the tariff so that they can cover their costs and earn that agreed upon rate of return.

So, while this might be best practice and one of the more fairer ways to design a tariff, it can be quite resource intensive, both for the mini grid developer and also for the regulator, if the regulator is going to be involved with tariff approval. Particularly, if a country's looking to really scale up the amount of mini grids, you have to design and approve a tariff for every single mini grid. That could become quite resource intensive. So, some countries have started thinking about ways to reduce some of the resource burden of those seeded with cost-reflective tariffs. So, for example, Senegal has developed tariff caps for different classes of projects based on the technology of the project and the subsidy level that the project is receiving.

And so, basically, if the project falls within the technology and subsidy level class, it then receives a specific tariff. And the tariff cannot be above a certain level which the tariff is capped at. And then, also, in Nigeria recently the regulator developed a cost-plus software tool for mini grid developers to calculate their tariffs for the individual projects. So, there is one methodology that both the developers and the regulators are using, and then it allows it to be an easier review for the regulators.

So, once the tariff itself is decided upon, the level that that tariff needs to be, there's then a few different ways that mini grid developers can go about structuring their tariff. And so, I'm going to talk about some of the common rate structures that we see. So, the first is energy-based payments. So, this is going to be based on the amount of energy consumed, measured in kilowatt hours. So, for the total amount of electricity the customer consumes, there's a dollar per kilowatt hour cost. And the customer then is charged based on total kilowatt hours consumed.

The second option that we've seen frequently, and this can also be combined with energy-based payments in one tariff, is demand-based payments. And these are going to be based on the peak power consumer in a given payment period, measured in kilowatts. And these are frequently applied to larger users like a commercial-type customer. And then, also flat payments is another option. And, again, we have—you can see tariff structures that combine energy-based payment, demand-based payments, and flat payments into one tariff structure. The flat payments are often a fixed payment per month or over a specific payment period, and they're going to be regardless of consumption level. It's just going to be a flat payment for that fixed period of time.

And another way we've seen tariffs structured is in terms of pay-as-you-go payments. So, basically the customer would pre-purchase the amount of kilowatt hours that they're going to be consuming for a period of time, often termed energy credits that they'll be purchasing. And they'll consume these credits. When they've consumed all of them, they then have the option to go ahead and pay for more, But, once they're consumed, they don't have access to that electricity service until they basically top their account back up.

So, there's lots of other tariff structures that mini grid developers are using as well, but these are some of the kind of main ones that are seen. And so, some of the other types of tariff structures are energy as a service, or a per-device tariff. So, the tariff is structured—say, if you have one lightbulb or a cellphone charging, your tariff is going to be X. Add in a refrigerator and your tariff is going to be a little bit higher. Seasonal tariffs, this is specifically for—often seen for hydropower projects where there's going to be a dry season or a rainy season. Lifeline or inverted block tariffs, and then also time of use tariffs.

So, with that, I'd like to turn it over to my Colleague, Ryan, to talk a little bit about tariff design options and close out the presentation.

Ryan

Great. Thanks, Emily. So, I'm going to talk a bit about some of the different fundamental decisions that regulators and policymakers have in determining how to design and structure a tariff. One of the first questions that of course would need to be asked is: Who will design the tariff? And there's a few different options here. Either the developer can design a tariff, a regulator can design the tariff, or it can be done as a collaboration from the two.

So, looking at the first of these options where the tariff is designed by the developer. This would actually mean that that tariff is unregulated. So, the

developer would design the tariff level that would work for them and that would obviously recover their costs, and then they would solicit agreements to this tariff from the community that they plan to serve. Now, of course, it's in the developer's interest to ensure that customers are willing and able to pay the tariff that they wish to charge. So, there is a cap on the amount that that developer could charge. You'd, of course, need to be an attractive offer to the community and presumably would have to be a more affordable source of energy or greater value than the non-electricity energy sources currently available to that community.

However, even with acknowledging that, customers may still be at a disadvantage in negotiating a tariff compared to the mini grid developer. So, for this reason, sometimes regulators prefer to intervene in the tariff setting process. Option two would be where the tariff is set directly by the regulator itself. Here, using whatever method that regulator deems to be most appropriate, they would determine the tariff and tariff structure for a particular mini grid project or set of projects. And they would maintain complete control over the tariff setting process.

While this does ensure that there's adequate consumer protections in place, and that the community served by the mini grid will be given a fair rate, it does have a potential to be overly rigid and limit flexibility. There could, for example, be a particular project that has higher than usual costs or whatever other reason would need to have a specific tariff structure. And without the input of the mini grid developer in the tariff setting process, those could be ignored and those projects could be unviable. The third option would be a collaboration between the developer and the regulator in agreeing to and setting a tariff. In the most common way that this would work is the developer would propose a tariff level to the regulator, which would then be reviewed by the regulator and the regulator could either approve it, amend it, or reject the tariff.

So, option two, that could be—the second type of question that would need to be answered in the design of a tariff would be how you would want to approach the subsidies and social tariffs. In certain instances, it may be preferable to charge a lower tariff than the cost-reflective level to some or to all mini grid customers. However, it's important to note that in cases where you're charging at a level below what is needed to be cost reflective to all or to some customers, that would create a revenue shortfall for the developer called the viability gap. And this must be made up elsewhere for the project as a whole to be financially viable.

So, a few different ways that we've seen subsidies and social tariffs work in mini grid projects. The first would be to charge cost-reflective tariffs for energy purchases, but to subsidize connection costs. Because, this upfront capital cost is occasionally a barrier for new mini grid customers. So, in this case, there would be grants provided either through the government or from international donors to provide for the initial upfront connection of a project. But, then, from there on, customers would be expected to pay unsubsidized, cost-reflective tariff amounts.

Option two, if it were desirable to charge a lower tariff for energy purchases over the life of the project, such as saying that you would prefer to have a uniform national tariff applied to mini grid projects as well. One option would be to subsidize the energy price of the mini grid customers through a small surcharge on the energy bills of national grid customers. This would allow all customers throughout the country, whether they received power from a mini grid or from the national grid, to be charged a same rate of energy. Now, of course, this means that the developer would presumably, assuming that their costs are greater than the costs of the national grid utility, would not collect enough revenue from their customers to meet their cost requirements. And this means that that revenue shortfall would need to be filled by additional contributions. And one way we've seen this work elsewhere is the surcharge that's added to the bills of main national grid customers is collected and provided to mini grid developers to fill in that gap.

And a third way to—or a second way of thinking about cross-subsidization would be by cross-subsidizing different classes of customers within the mini grid customer base itself. So, this would be limited to cases where, say, a mini grid project is going to serve a commercial center as well as a series of residential customers. And the willingness and ability to pay of certain classes of customers, such as the commercial business, would be greater than residential customers. It may be feasible in some cases to charge a higher rate of energy to those commercial classes of customers and a lower rate to residential classes of customers, and thereby use one group to cross-subsidize the other and still maintain profitability for the mini grid project developer.

So, now we want to talk through a few different case studies and examples of how we've seen some of these concepts in practice. So, first, we'll start with Tanzania. And, here, Tanzania permits cost-reflective tariffs, but there is a tiered process that they've put in place to conserve their costs of staff and regulation. For projects that are smaller than a hundred kilowatts, then no regulatory approval of a tariff is needed. In other words, it's up to the developer to set their own tariff levels. If more than 15 per cent of customers of a particular mini grid developer file complaint to the regulatory commission however, the regulator will intervene and may adjust a tariff if they determine it to be necessary.

For larger projects, ones that are larger than a hundred kilowatts, the developer will propose a cost-reflective tariff to the regulator and then the regulator will either approve, amend, or reject it. So, this would be that third collaborative option that we discussed previously. So, with this dual approach, this allows Tanzania's regulator to conserve their resources by focusing them on larger projects. So, they're not forced to review each small mini grid project as it comes through but are only devoting resources to those that are either larger or those that have been flagged as issues for concern by the community.

This approach has revealed a tendency by mini grid developers to size projects below a hundred kilowatts, at a level that wouldn't trigger that regulatory oversight. So, that's an important consideration to keep in mind

to 7ensure that for smaller projects there's still some sort of a safeguard to be put in place. And, in this case, the safeguard that Tanzania put into place is to have the appeals process based on customer complaints.

A similar process is in place in Nigeria, which also has two different options. These are both options for projects that are under a hundred kilowatts. In the first option—and as Emily mentioned before, Nigeria has developed a cost-reflective tariff calculator, which a developer could use to calculate their own cost-reflective tariff, which would be used in their new service territory. Alternately, the developer has the option of negotiating terms directly with the community. And if at least 60 per cent of the mini grid's new customers agree to a particular tariff level, then the developer is able to bypass the regulated financial model calculation and set the tariff directly with customers.

As of 2017, all mini grid operators in Nigeria had chosen the latter option, presumably due to the lower regulatory hurdle. But, in either case, either the developer of the community could request a review of these tariffs from the regulator. So, similar to Tanzania, Nigeria has put in place a process that first allowed developers to directly negotiate with the community, but where that does not turn out to be successful, it does have a regulatory fallback option.

So, we also have a few different case studies about cross-subsidization. First, we have an example from Peru. And so, Peru has adopted a policy where they really want to maximize participation in mini grid developments. And as a decision on how to do this, they have determined that mini grid rates should be equal to the country's national grid tariff. So, throughout the country of Peru, all customers pay the same amount for electricity regardless of whether they're mini grid customers or national grid customers.

Now, of course, this creates a revenue shortfall for mini grid developers. So, to account for that, the country has put in place two primary types of subsidies. The first is a direct subsidy that's paid to developers to bring down some of the capital and operational costs of the developer that's paid by the country's—primarily through the country's rural electrification fund. But, the second, and I think more interesting subsidy put in place is a cross-subsidy between national grid customers and mini grid customers, which we discussed previously. So, customers to the national utility have a three per cent surcharge on their electricity bills. And this is collected and redistributed to mini grid developers to compensate for the reduced revenues that they face because they're only collecting at the national tariff level. And through this approach, Peru has had pretty good success in increasing their rural electrification rate, which has gone up from 30 per cent in 2007 to 55 per cent in 2010.

A second example that we want to bring up on cross-subsidization is from the Philippines. So, here, the Philippines have long had a cross-subsidy between national grid to mini grid customers as well. And in these cases, it's actually even been lower. The mini grid customers, the tariff is capped at half of the national uniform tariff level. So, mini grid customers will pay less than national grid customers, despite the costs to mini grid developers being higher

than the costs to national grid customers. The Filipino government has attempted to reduce the subsidy amounts in recent years, but have countered some resistance, both from customers and from developers.

From customers, this is because they've become accustomed to lower costs of energy and are understandably reluctant to increase those to cost-reflective levels. And on the developer side, they've become dependent on subsidies, and the high level of the subsidy that's been provided to developers over the years has limited incentives to become more operationally efficient. And so, now that this strong subsidy program has been in place, the government is just having some difficulty weaning off of that subsidy program.

So, now we want to shift gears a little bit, because we've talked a lot about calculating cost-reflective tariffs and we want to give an example of how this would work in practice. So, there's a variety of different calculators that are out there that can be used to set and understand what a cost-reflective tariff would be. We're going to use one that's been developed by EEA PDF, which is part of the mini grid policy toolkit that the organization has developed, which is another excellent resource. The link to that toolkit is on the screen there. Unfortunately, I believe their website is down for maintenance this week, but if anyone's interested in this excellent tool, we'd be happy to circulate it.

So, I'm going to close out of the presentation real fast and go into this tool. And I'm quickly just going to give a quick demo of some of the key concepts. Regardless if this is the tool that you use—and the governments of Tanzania and Nigeria have similar cost-reflective tariff calculators in place—you're really fundamentally trying to understand: What are the costs of the mini grid project over time? What are the expected kilowatt hour sales? And, as a function of those: What is a cost-reflective price for kilowatt hour?

So, giving a quick demo of this. I'm going to try your attention primarily to the cells that I've highlighted, because, obviously, there's a good deal more detail in the model that I don't think we need to go through right now. So, the basic information that's required to calculate this tariff. First is understanding: What are your kilowatt hour sales per year? So, here, we have some different customer classes in this example project we're looking at, and a forecast of sales per year over the life of the project.

The second main factor is: What are the operating costs of the project? So, for this project we would have fuel costs, maintenance costs, costs that are recurring in each year of the project. And so, entering a forecast for those. Third would be the capital costs of the project, so the cost of constructing it. So, obviously, you would need to create a generator as well as a distribution network and a variety of other infrastructure assets. So, putting in a schedule for those. Obviously, these are primarily upfront costs. As well as understanding how long these assets are expected to stay—how long their useful life is expected to be.

And the final element that's really important to calculate a cost-reflective tariff is understanding the difference between debt and equity in the project.

So, it's important to know what percentage of the project is being financed through debt versus paid for directly by equity. As well as understanding how long the loan period would be, what the interest rates on any loans would be, what return on equity is expected from project investors. And, from that, you're able to calculate a weighted average cost of capital, which is used to calculate revenue requirements.

So, once this information is known, then you're able to calculate the cost of the project out year over year. And I won't get into the depreciation formulas that are going here, but I want to draw your attention to the bottom, which is after we've calculated out the cost of the project year over year. Then, as a function of that cost, we're able to calculate out what return on capital is needed to meet the project's investor requirements. This would be the plus part of the cost-plus calculation. So, once we know this, then we're able to calculate a tariff.

So, the costs of the project are fundamentally the sum of the operating costs—the costs that he developer pays year over year just to maintain and operate the project—the depreciation on their initial capital expenses, and the return on capital that's needed to meet the developer's investor requirements. So, given this total cost and given the expected kilowatt hour sales of a project in a particular year, then you're able to calculate: What is the dollar per kilowatt hour amount that must be charged to customers in a given year in order to both meet the project developer's cost requirements and also to meet their revenue requirements? And so, this would result in—in this particular example project would result in a tariff that would look like this over time—in nominal terms, then in real terms. And, of course, depending on the preferences of the regulator and the developer, you could smooth this out into a _____ rate over time.

So, with that quick example, I'm going to turn back to our PowerPoint and offer some concluding thoughts. So, one of the key takeaways that we want to emphasize is that it's really important to consider mini grid tariffs as distinct from national uniform tariffs, due primarily to the higher cost of service. A connected concept to that is that if you want to encourage private investment in mini grids then it's really important that mini grid developers have an adequate pathway to profitability and that there's means for them to recover their costs and earn a profit on their investments. This is the primary reason why simply using the national uniform tariff for mini grids as well in many cases is infeasible, because private developers wouldn't be able to collect enough revenue to recover their costs.

In cases where developers can't charge cost-reflective tariffs, that can still be financially viable if subsidies are provided. And while there's many options for designing a regulatory structure, there's not really a single best approach. It's really about finding the approach that works the best in a particular context. And as we saw from the approaches in Tanzania and Nigeria, regulators may find it helpful to conserve their efforts and their resources by focusing on larger projects and by focusing on projects that have been flagged for concern either by the developer or by the community.

And, finally, I want to emphasize that social tariffs are certainly possible for mini grid customers. A best practice that we suggest you consider in this case would be the case of Peru where a small surcharge on national tariffs is used to fill the gap between collected revenue and required revenue for developers while still allowing for different tariff levels to be charged. And so, with that, we'd like to thank you for your attention. We will answer your questions in a moment. Our contact information is on the screen here, if you have any questions for us.

And, again, we recommend that you give a look to the *Practical Guide to Mini Grid Regulation* that we authored along with USAID and NARUC, which is available at naruc.org/minigridguide. There's a wealth of other excellent resources on mini grids as well that we link to as part of the guide. So, thank you for your attention and we look forward to your questions.

Katie Great. Thank you, Emily and Ryan, for that outstanding presentation. I just want to remind our audience, as we shift to the question and answer session, to please submit your questions using the question pane at any time. We'll also keep up several links on the screen throughout for quick reference, to point to where you'll find information on upcoming webinars and previously held webinars, and how to take advantage of our Ask an Expert program. We've had some great questions from the audience today that we'll use the remaining time to answer and discuss.

Our first question for both Emily and Ryan is—this attendee said, "Most of the countries expect off-grid mini grid developers to charge the uniform tariff that apply on national grid however, these uniform tariffs are not financially viable. Are there examples of pricing models that have worked elsewhere and are still profitable?"

Ryan Yeah. That's a really good question. And I think that this one came somewhat early in the presentation, so hopefully has been answered by now. I think that we absolutely agree that financial viability is important and that simply adhering to the national uniform, tariff may not provide viability for project developers in some or most cases. In cases where it's still preferable to not charge cost-reflective tariff amounts, we would suggest something along the lines of what Peru has done with their cross-subsidization scheme, which has allowed a national tariff level to be charged to mini grid customers while still maintaining developer profitability by collecting and redistributing funds from a small surcharge on national tariffs.

Katie Great. Thank you so much. Our next question is, "During the presentation you said mini grids provide sustainable value to the customers. Could you be more specific about what you said during that?"

Emily Yeah. So, when it comes to mini grids versus national grid extension, often mini grids are the more cost-effective way to deliver kilowatt hours to rural populations compared to national grid extension. Though, in terms of providing value to customers, while the grid tariffs themselves might be more expensive than the national grid tariff, the actual cost of developing that off-grid infrastructure of the mini grid tends to be less expensive than doing full

grid extension. And as we also mentioned before that frequently that tariff that the national grid customers are paying is being subsidized in different ways by utility or the national government. So, it doesn't necessarily reflect the cost of actually providing the grid services that national utility customers are getting. So, I think when we say that customers can receive substantial value from the mini grid, it's one that is more cost-effective often to provide the electricity from a mini grid rather than from doing national grid extension.

There was also a question about: Would the return on investment be better for investors from the mini grid versus the national grid? I think that's probably like dependent on the situation of the particular mini grid and the returns that they're aiming to have versus the current financial situation of the national utility and what types of return they're able to provide to their investors. So, I don't think I have an answer that could meet all situations for that. I think it will be somewhat context specific.

Ryan Uh-huh. And one other thing that I would say on the value of mini grids to customers is, again, the comparison of the cost per kilowatt hour that a customer would pay through the development of a mini grid and comparing that to the costs of traditional forms of energy. When we think about kerosene lighting, when we think about mobile cellphone charging, we don't often think in terms of kilowatt hours always. But, if you were to put those on level bases, generally speaking the cost that a customer would pay through receiving mini grid electric service is lower than the costs that many of these customers are currently paying for traditional sources of energy. And, therefore, those customers would receive a good amount of value from mini grid development.

Katie Thank you both. Ryan, in the toolkit, what should be included in the staff costs inside the operational costs?

Ryan That's a good question. I think that—to speak more broadly about operational costs, there, you're looking really at any cost the developer would incur on an ongoing basis. So, some of these are going to be physical product charges of fuel—this is a type of mini grid that consumes fuel—any maintenance costs, and then the labor costs of any staff of the mini grid. That will, of course, be paid salaries over time. Which I believe what a staff cost question is referring to. But, really when you're—I guess the broader point that I'd draw is that when you're doing a cost-reflective tariff setting process, you want to make sure that you're taking a broad look at all of the types of costs that this project would incur over time and making sure those are reflected and accounted for.

Katie Thank you. Thank you for that. Our next question from the audience is, "Would you recommend a different type of tariff methodology depending on the generation technology?"

Ryan Yeah. I think that's a really good point. And, yes, I think that we would. Emily kind of brought up that seasonal tariffs may be more appropriate for hydropower projects, for example. There's a number of projects that are very small, solar mini grids, only a few kilowatts in size. And, here, the way the tariffs are structured is often more of hours per day of electricity or it's more

creative tariff setting approaches to account for the fact that there's lower reliability. So, I think that it's very common practice and will be recommended to tailor those tariff structures to the technology that's being used.

Emily Yeah. And I think, also, with mini grids in terms of technology selection, if it's a solar-based or wind-based mini grid, they're often using some sort of backup power to provide 24—if they're trying to provide 24/7 service. And so, if the backup is diesel, that might lend itself to a better type of tariff structure versus if it's a battery backup system. But, yeah, I think depending on—the technology can help dictate the type of tariff that the developer designs. And so, the traditional kilowatt hour tariff that we tend to see for national grid utilities might not always be the best fit for mini grids.

For example, I know of some very small mini grids that have been developed throughout India that use per-device tariffs, and they're small, solar-based mini grids. And they basically have designed their tariff based on the different types of devices that the customer might be using in their household or their business. And that's been a very successful way, and also easy way to communicate the costs of the mini grid to different customers.

Katie Great. Thank you both. You mentioned some of the case studies during your presentation. Can you share the Senegal and Nigeria tariff methodologies?

Emily We can share the—definitely Nigeria. That is available online, so we can provide the link. I would need to check if the Senegal is available online. If not, we could point in the direction of resources that talk a little bit in-depth about what they've been doing there. I can also just provide some links to some of the most current resources that document different countries' approaches to tariff setting.

Katie Wonderful. Thank you, Emily. Final couple of questions coming in. What is the best kind of tariff?

Ryan [Laughs]. Yeah, I think that's a really big question. I think that the short answer is that there is not a single best kind of tariff. I think instead it's smart to think about this in terms of general principles. So, one of the principles in tariff setting, of course, is that the rate should be fair to customers. And I think that in the case of a mini grid project there's responsibility for the regulator to ensure that the price is in line with what the market would bear and that it's also in line with what the expectations of the community would be. Another important principle is that in order for you—assuming that you would like to have a strong participation in the mini grid market, then the tariff needs to be set at a level that provides adequate profit incentive to developers to participate. and so, that's really why we recommend the cost-reflective tariff structure as a best practice, because it's the best way to ensure that developer is able to get the returns that they need to continue to invest in the market.

But, from there in terms of, you know, whether you want to offer cross-subsidies between mini grid and national grid customers or between different

classes of customer, whether you want to structure your tariff on a per kilowatt hour basis or a per-device basis, those are really decisions that would depend much more on the details; both of the community and the country that are being considered, as well as the technology that's being used by the developer.

Katie Thank you, Ryan. And I think we have just enough time to ask one more today. What sorts of things should governments be doing beyond tariffs to attract investment in mini grids?

Emily Great. That's a good question. We've been narrowly focused on tariffs, but there are a few other types of decisions that governments can consider when it comes to their mini grid planning, and particularly how they're going to regulate or if they will regulate mini grids. And so, I think one of the other decisions that is important to set upfront is—we've been talking about isolated mini grids. So, these are mini grids that are not connected to the national grid. But, what happens if the national grid was to arrive where the mini grid is currently located? What happens to that asset?

And is it able to maintain its generation and distribution, and interconnect to the national grid, or can it only maintain generation and sell directly to the national grid? So, thinking through kind of what are the different scenarios that could take place if the national grid was to arrive, and allowing the mini grid developer to have some understanding of what that will be, so they can plan for that. If that situation was to occur, what would happen with that investment, so they can continue to have some certainly around that investment? So, I'd say that's one thing to consider, is what happens when the national grid arrives—if the national grid and when it does arrive to where the mini grids are currently operating.

The second thing would be around licensing and permitting of mini grids. So, what is the process that a country is going to take to provide the kind of authority for the mini grid to operate in the area that it's trying to serve? Does it want to take a traditional licensing approach, or does it want to consider maybe tiered licensing or permitting depending on the size of the project, or the technology of the project, the impact of the project? As Ryan said before, the cost-reflective tariff setting can be quite an exercise for both the developer and the regulator. Going through a full licensing or permitting process can also be quite the exercise for a regulator and for a developer.

So, thinking about ways you can streamline and expedite processes for projects that maybe will have less impact or of less concern. And then another area to think about is in terms of the quality of service that he mini grid maybe has to provide to its customers. And this can also be in connection to whether the national arrives—when the national grid arrives. Are they going to be held to the same quality of service standards as the national grid, or can they basically work with their business model and work with the customers they're going to be serving to kind of come up with the quality of service that meets both needs? So, I would think those are some of the issues.

The last one would be: What approach is the government going to be taking to their mini grid sector? We've seen countries that take more of a top-down approach where they do—more centralized top-down approach where they do large rural electrification planning, decide which areas of their country mini grids are going to best serve, and then they might run a concession process to provide those service areas to one or two mini grid developers. Versus more of a bottom-up approach to the private sector to come in and decide where they think mini grids are going to be best. We've also seen countries take kind of a two-track approach where they're doing both. So, I think those are some of the decisions that governments can also be thinking about outside of tariff setting.

Katie

Great. Thank you, again. And on behalf of the Clean Energy Solutions Center, I'd like to extend a thank you to our expert panelists, Emily and Ryan, and to all our attendees for participating in today's webinar. We very much appreciate everyone's time and hope in return that you got 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 our Solutions Center resources and services including our 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 any of our previously held webinars.

Additionally, you'll find information on upcoming webinars and other training events. We're now posting the webinar recording to the Clean Energy Solutions Center YouTube channel. Please allow about a 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. And this concludes our webinar.