Virtual Net Metering and Wheeling

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Webinar Presenter

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Toby Couture Welcome to the International Solar Alliance Expert Training Course. This is Session 16, focusing specifically on Virtual Net Metering and Wheeling and how these different applications are being used to support the growth of solar PV in various jurisdictions around the world. I'm Toby Couture from E3 Analytics and I'll be delivering this training session.

So, the supporters of this training series are the International Solar Alliance and the Clean Energy Solutions Center.

This training is part of module three, which focuses specifically on the future of solar policy, looking at where the market is going, what are some of the trends we're seeing, and what are some of the innovations that could help reshape the solar market in the years ahead.

So, quick overview of the presentation. We'll look at learning objective. We'll dive into what net metering and wheeling in particular are. Then, we'll look at virtual net metering and virtual power plants. We'll examine some of the costs of these different applications, look at some of the challenges and some of the advantages, and then, we'll have a look around the world at where virtual net metering and wheeling are being allowed and how that's working in practice.

And then, we'll close with a few concluding remarks followed by a knowledge check at the end with a couple multiple choice questions.

So, the aim is to understand how virtual net metering works, how wheeling works in practice, understand how these different innovations are being used to support the growth of solar PV, and we'll look at some of the challenges and try to understand better what some of the issues are and why they matter.

And then, finally, we'll try to learn from case studies around the world of where these are being used.

So, let's dive in.

Net metering is a policy that allows customers to self-supply with their own solar generation and export their net excess generation to the grid. In other words, everything that they can't consume themselves or that a household or that a business can't consume themselves is exported to the grid and can then be used by other customers. Now, put yourself in the shoes of someone with solar on their roof or on their premises and you're injecting excess power into the grid on a, let's say, a sunny Sunday when your business is—electricity load is quite load or where your household electricity demand is quite low. All of that excess generation is being fed into the network on this beautiful sunny day, and you want to know, "Well, what am I going to paid for that net excess supply that I'm feeding into the network. I pay to take power from the utility; what are they giving me if I inject power back to them?"

And in the case of net metering—as we saw in the training session net metering—what we're talking about with net metering is not a cash payment. In other words, you will not get a check in the mail from your utility. What you will get is typically a bill credit. In other words, you'll get some compensation on your bill that can help kilowatt hour by kilowatt hour to erase—or at least reduce—your power bill from your utility. So, if you pay, on average, let's say, $50.00 a month for electricity and you inject a certain number of kilowatt hours into the network, typically, net metering enables you to erase your bill, essentially, kilowatt hour by kilowatt hour, at a certain rate.

Now, again, there's a lot of debate around what that rate is and whether it's just the full retail rate or some amount less than the retail rate, but the basic mechanics are the same. You can inject your net excess and use it, essentially to offset power consumption in other times of the day or of the month. Now, wheeling is slightly different. Wheeling allows you to produce power at one location, transmit it over the distribution grid, and use it to meet self-consumption elsewhere on the network. In other words, you could, if you were a business that was in an urban area but your roof space is quite limited or you didn't have a suitable roof for solar—because, for example, there's lots of shading, other buildings nearby block the sunlight during many hours of the day, or your roof orientation isn't right—you may not be able to really make full use of the solar—of the rooftop that you have for solar generation.

It may be smart—it may even be more economically attractive—to build that project—or build a solar project—elsewhere on the network at a different location and use that power to virtually, let's say, offset your consumption elsewhere on the network. And that's essentially the heart of the issues that we're going to look at in this session.

A number of jurisdictions around the world—including Brazil, Jamaica, Jordan in the Middle East, as well as Pakistan and many parts of the US—enable owners of embedded generation—or what's often called "distributed generation"—to wheel their power from one site to another. Typically, in order to do that, you have to pay grid access fees. So, the utility will charge you a certain amount and there's different ways of charging this for "using the grid" and distributing that power. So, if you're that business that has limited roof space and you had a solar project—let's say a 30 kilowatt project just outside of the city or elsewhere within the city—that power can be delivered to you virtually and can offset your bill in practical terms, but you will often be charged a small fee for the use of the distribution grid, and that, essentially, enables the utility to recover its costs for grid infrastructure and can still make sense for the business to do so. The ability to wheel power in this way—in other words, to produce power elsewhere on the network for consumption at another location—is critical to enabling community solar, in particular, which is where groups of customers get together.

It can even be not only residential customers; it can also be commercial customers. It can be institutions like universities and schools, and even churches can get together and invest in a community solar project located around in the neighborhood or elsewhere. And wheeling is necessary—or at least laws and regulations governing/enabling wheeling are necessary—to make that possible. So, you need to be able to be meter the output that gets injected into the grid from your solar system—what you produce—and then, each individual house is metered, and there needs to be a mechanism in place to allow that to be offset so that everybody can use wheeling to wield their power in combination with a net metering policy or, as we'll see with what's increasingly being called "virtual net metering", to offset your own consumption on site. So, why is it called "virtual net metering?"

Well, we saw that net metering is when you have supply on your roof that's offsetting your own household consumption directly. It's what we often call "behind the meter" generation, because it's behind the utility's electricity meter. So, essentially, it's on your side of the meter, along with your appliances and other things. The difference with virtual net metering is that the asset—in this case, the generation asset—is not behind the meter on your side; it's elsewhere on the network and is basically just a source of distributed generation and can feed power into the grid and can then be used virtually to offset your actual consumption in your household. So, again, there's a number of different drivers behind the emergence of net metering and virtual net metering that we'll get into over the course of the presentation.

Net metering effectively describes how much power is consumed and can be offset, in compensation terms, from solar power. So, how are you compensated for your net excess generation on your current power bill? So, as I said, if you have $50.00 a month, net metering is essentially the process that enables you to erase that—progressively erase that bill—through self-generation. And wheeling is the act of transferring power from one location on the grid to another—again, typically involving the payment of some kind of grid fee.

Wheeling is particularly important—and is being used, also, for technologies like wind and hydropower—but it's also increasingly critical for solar PV, especially in urban areas. There are lots of different markets looking at wheeling. There are lots of different customers and businesses in different parts of the world clamoring for some kind of virtual net metering provision so that they can self-supply by building a generation facility—a PV plant—elsewhere on the network because they either don't have suitable land near where the load is or they don't have enough land or, for various reasons, the roof or land they have is just not suitable for solar generation—typically because of shading, because of sometimes environmental constraints, sometimes just because of proximity to the other buildings or if it's in a construction area. There's always the risk that another building will create shade in the future, so, you may want to just get security, put that solar project elsewhere where you know that you will be able to be shade-free and can control the site without those risks. Another advantage, obviously, of siting your project elsewhere is that you have more land.

And when you have more land and more space, you can typically also get a lower installed cost. So, one of the main drivers behind community solar, in particular—which uses virtual net metering, in most cases, is that you can effectively build a larger system together. You get economies of sale by grouping together with many other households and businesses and institutions, and together, you can all get a lower cost of generation, which means it can be economically more attractive to band together than it is to just build an individual solar system on your individual rooftop. So, again, that's one of the main drivers. Until recently, it wasn't possible for households and businesses to do this—or at least not easy for them to do this.

Businesses have been able to do this for longer—since de-regulation—since liberalization of the electricity market opened up. It was also common in the beginnings of the electricity industry where facilities could produce, for example—could tap into a local river or a local stream, produce hydro generation, wheel it down the wires—which they typically owned—and use that generation for their own self-consumption at the industry before it even went into the broader distribution grid. And, in some cases—in the beginning—those generation assets were built specifically to feed one business and then, only later, when the power grid developed more fully, were there arrangements developed to allow those legacy industrial and commercial sites—hydro—run-off river hydro projects, for example—to connect to the grid and actually become a supplier, become a generator. So, all of this—you know, there is a deeper history. What we're seeing more recently is essentially trying to standardize and simplify—remove the red tape, make the process straightforward so that households and businesses can generate power somewhere different from their premises—from where the electricity demand is—and wheel that over the network to offset their bill. So, this is essentially the overview in a nutshell.

Now, as this chart shows—this table shows—there are various kinds of net metering. The one that's most commonly known and used is the single owner—where solar is on a single property like a household or a business. That's the most common. In other cases, we're starting to see meter aggregation, where solar can be on multiple different meters or there can be multiple different meters—like on a farm. You can aggregate all those meters and make that one solar project on the farm offset the consumption from all of those.

So, that's an increasingly—that's a growing market segment, if I can refer to it that way. There's also multi-site aggregation, where you have solar on multiple properties with multiple different meters that can all be fed and offset in a way through various kinds of net metering policies. This is often used, for example, by city-owned buildings. So, many cities across the US—and indeed, around the world in Australia, India, China—are developing solar themselves. This kind of multi-site aggregation enables users like that—with multiple different buildings—to generate efficiencies—essentially develop multiple sites at once or connect multiple sites together to offset power demand across the network of different sites and different loads.

This could also be of interest for shopping malls, for example, or hotels or other groups—grocery stores that have large roof spaces—and multiple facilities, multiple locations in a given city or a given area. So, again, there's potential for each of these to become a fairly significant market segment in its own right. A fourth option is multiple owners, where you essentially have one owner but, for example, many renters—like in a multi-unit residential building. You can aggregate the tenants together and install the solar project on the roof and the savings are then spread across the different owners in the building or the different renters or tenants. This, obviously, requires a lot of work to get everybody on board and make sure that everybody's—some utilities are starting to make this easier by developing special programs for multi-unit buildings.

In many cases, it's very difficult and it's only when you really have unanimity in a building and everybody's on board and you have a committed group of people who are prepared to invest in the time in negotiating with the utility that you can get these kinds of arrangements developed. But it's starting to happen and we're starting to see more developments being unlocked that use this kind of tenant aggregation. And then, the fifth and final one is virtual or community solar, where the solar project is located off site. As we've seen—multiple different properties, multiple different buildings. It could be households, companies, or institutions, and the savings are spread through the many different users.

Now, in most cases under community solar projects, your share is directly linked to your financial share in the project. So, if you build together a 50-kilowatt system and you invested, let's say, 2 percent of the total amount required to finance that 50-kilowatt system, you would then then get 1 kilowatt of generation—essentially, capacity—and it would be broken down pro rata or on a piecemeal basis. You would get the output—essentially, 1/50th—of the output of that plant if you invested 1/50th of the original investment. So, that's essentially the mechanics in a nutshell.

Now, let's look at this a little bit more closely.

Some communities, as we saw, live in multi-unit housing where the rooftop space is insufficient to host a system large enough. That's particularly the case in high-rise or condo style buildings. You just don't have the roof space. So, for cities that are increasingly dense and building densely—in Asia, in parts of Latin America, in many parts of North America and Europe—the attractiveness of being able to do solar on your own but elsewhere via virtual net metering is growing, because people are increasingly aware of energy issues. Climate change is rising on the agenda.

People want to make a difference, want to make a contribution. And although there are many things you can do to reduce your emissions that have nothing to do with solar, solar is one way in which people and individuals and businesses are demonstrating their commitment to trying to secure cleaner energy. And virtual net metering is emerging as one tool to help facilitate that, specifically for multi-unit residential buildings or for businesses—as we saw earlier—that don't have suitable space.

Now, in recent years, a number of cities and communities across the US have started using virtual net metering, and a number of countries around the world have started to pass laws and regulations to enable this. And you can see that community solar has been growing very rapidly. In the US, this remains an ongoing story and shows, essentially, the level of interest in this—partly because of economies of scale, as we saw; partly because of growing awareness; but also, fundamentally, because of bill savings. It can be cheaper—and it often is cheaper in a number of—in a growing number of states, in a growing number of regions around the world—to self-supply a portion, at least, of your electricity demand needs. And that's opening up a lot of innovation in the sector and driving a lot of change.

Which brings us to the topic of virtual power plants. If all of these different distributed generation assets—or even a grouping of them—can be networked together and operated as one functioning generation asset, you have, what we call, a virtual power plant. It can use software controls, algorithms, to optimize output, load profile, provide frequency and voltage regulation—a number of other ancillary services—to the network, therefore making these generation assets more useful—in other words, more valuable—to utilities, and it enables fundamentally better economics, because you can coordinate these systems in a smarter way. We're also starting to see virtual power plants using demand response aggregators—that means, connecting different loads as well as supply sources into a virtual network that, again, is intended to try to optimize, improve flexibility, and improve the overall operations of these different assets. So, in other words, these solar projects—small scale demand response loads—can act in concert with one another and can collectively be smarter than any of their individual parts.

So, you get, in a sense, of dynamic where the whole is fundamentally greater than the sum of its parts and can be, again, much more valuable, much more useful, to the utility and can start even supporting grid stability, reduce the risk of outages, reduce the risks of other frequency and voltage fluctuations on the network. So, this is a very exciting and promising area of investment and development in electricity markets, partially enabled by policies like virtual net metering. So, the business model consists, primarily, of pooling and marketing generation facilities and connecting them with flexible consumer loads—either residential or commercial and even storage systems—into more aggregated wholes. And those kinds of virtual power plants are a really—in many ways—a new frontier in the evolution of the electricity industry.

This gives you a visualization of some of—essentially, of how virtual power plants can be conceptualized. On the left-hand side, you have generation assets—either from biomass, biogas, solar, wind, et cetera—storage facilities. All of that can be connected to smarter loads on the demand side—whether consumer loads, industrial loads, et cetera—to better optimize output and better optimize the operation of the power system.

Now, we've seen some of what this means in practice—how net metering and virtual net metering work and why they matter. Now, let's look at some of the costs.

The owners of transmission and distribution infrastructure typically don't like letting others use their infrastructure for free because they paid for that infrastructure and, just like highways, for example, there is a usage cost and those usage costs can be recovered via tolls. So, just as on a highway you pay—in many countries, in many parts of the world you pay tolls to access the highway or at least the newer highways, then, your fee is helping contribute—helping finance, essentially—that investment. And the same logic applies here. The distribution grid is built or is being built—is being expanded, is being improved and modernized—requires constant investment, requires constant maintenance. And the usage of that network is increasingly being charged separately for distributed generation sources.

So, if you're using the network—particularly in a virtual net metering configuration where you're supplying power elsewhere and consuming it virtually on a site—the utility is adding wheeling charges to help offset that—in other words, to help recover some of those fixed infrastructure costs. Now, we are seeing different debates unfolding around the regulatory principles that should be used to determine what those rates should be and essentially, the underlying logic remains the same—as with many other power sector investments—that they should allow for cost recovery and ensure that the process is fundamentally non-discriminatory and transparent. In other words, you shouldn't have to call the utility 15 times and try to get a form—a customized form for your individual project and go through all the effort and the due diligence of getting that together. Processes should be standardized. Forms should be available online and everybody who's interested should be able to—and eligible, I should add—should be able to participate.

Now, utilities will often impose restrictions on who can participate in virtual net metering or even net metering policies. We'll see, sometimes, utilities imposing restrictions, for example, that customers need to be in good standing. In other words, they need to have paid all their bills and need to have a reliable record of bill payment to qualify for the program. They need to—there's a number of different hoops that need to be jumped through, often application fees and so on, but again, the idea is the process should, ideally, be non-discriminatory and transparent. And regulation is increasingly pushing utilities to do so—to move in this direction.

Now, determining the cost of different wheeling charges is, itself, a bit of a science, and a lot of economists get excited about this. There's a lot of modeling going on determining different ways, different cost approaches. We won't get into all of that. The most common approach remains the first—the Postage Stamp Mode. You can see here a few different ones with more sophisticated structures.

Nodal pricing is emerging as a very hot topic in a number of markets—including in Europe and North America, as well as New Zealand—to provide more direct locational price signals. Where we end up and where different jurisdictions go on this is really—only time will tell. There are different tradeoffs in doing so. The complexity, obviously, for small customers should be minimized, because households don't have, often, the time or the understanding of power market dynamics to comb through detailed regulatory proceedings and complex explanations. So, again, simplicity is, in itself, a valuable principle, and many of the examples that we see around the world—Jordan, Brazil, et cetera, which we'll look at more closely in a moment—tend towards the simpler approach.

Now, as markets get more sophisticated—and also, as generation units we're talking about get larger—then, more sophisticated approaches may become necessary. And that's where nodal pricing and more sophisticated mechanisms may start to become necessary. So, I could imagine differentiation between project sizes. Projects below, say, 50 kilowatts could still operate—or even 100 kilowatts—could operate on a simpler mechanism, a simpler pricing system, whereas more larger projects above 100 kilowatts would have to be exposed to more dynamic, real-time pricing like nodal pricing.

The Postage Stamp Model essentially allows the costs to be allocated between the users based on their share of the total peak load on the system. So, it's a calculation that results in a flat transmission charge per kilowatt hour that's equal to the total transmission cost divided by the systems peak load. Again, we don't need to get into all of this. This is just to give you a sense that, for the use of the grid infrastructure, if you're doing virtual net metering, utilities will charge. And the methodologies by which they do charge for that usage can matter quite a lot for project economics and are likely to become an increasingly contested area in a growing number of jurisdictions.

Now, let's look at some of the advantages and challenges.

So, first, as we've seen, virtual net metering allows a wider share of participants to get engaged, including multi-unit residential buildings that have long been shut out of the solar market, businesses without sufficient roof space or with too much shading, et cetera. Virtual net metering can also help businesses and households reduce their power costs, which is important. It can allow better project siting to take advantage of better solar resource potential—so, in some cases, again, choosing a better site with better orientation, better angle, can reduce the cost of installation and actually improve the output, so, you get significantly more efficient systems, and maintenance can also be contracted centrally. So, if you have a larger system, every household doesn't have to clean its own individual solar panels. The maintenance of the system—cutting the grass, trimming the brush around the systems and removing dust—can be contracted centrally, thereby, providing again, economies of scale for the users.

And fundamentally, it also can have benefits for the utility in that distributed generation projects can be developed closer to the sub-station, which can reduce issues with the grid. So, a number of different upsides that are starting to change the market potential of non-co-sited solar PV.

Now, some of the challenges. It can be difficult, obviously, to determine the value of transmitted power. So, as we saw as the outset, if you are injecting power into the grid—you have excess solar electricity, you're feeding into the utility—the first question that will come to mind is, "What am I getting paid? What is the utility giving me for that electricity? Is the price static—in other words, fixed?

Or is it dynamic—in other words, changing in real time? Can I offset the fixed charge on my bill like network charges and other things or taxes? Or can I only offset the consumption charges—in other words, the actual per-kilowatt hour consumption charges on my bill?" All kinds of important questions around how virtual net metering—net metering more broadly—compensates users. Furthermore, such projects could reduce—or negatively impact—reliability if there are too many independent power producers—in other words, too many virtual power plants or virtual net metering projects—wheeling at the same time on the same feeders.

So, there is a question of—can a group affect—and whether—if there's too many aggregated in a particular area on a particular substation or near a particular substation—whether that, in itself, could generate issues and, furthermore, wheeling charges are often not dynamic enough to reflect real-time issues such as congestion. So, if there's congestion on a particular feeder under the Postage Stamp Model, that will typically not be reflected. In other words, the location specifics—specificities of the grid—will not be reflected in the price you're paid. And that's why some are arguing we need to move to more sophisticated approaches like nodal pricing that will allow more dynamic—more real time—pricing to emerge. The challenge is, obviously, if you own a solar system—let's say you've participated in a community solar project with a number of your neighbors and local businesses—and then, you're on a—you're exposed to dynamic pricing for the wheeling charges, your investment's already been made, so, you're essentially a price taker.

You have no influence over what that price is. And, if it's too dynamic, it could actually be negative for the project and the project owners/investors who are part of it. So, it's really important to look more carefully at how these charges are set and how dynamic they are, how they can—what are the ranges within which they can fluctuate, to also protect, fundamentally, project bankability. Because if banks don't know what the revenue impacts are going to be of changes in wheeling charges, it can be difficult to get the financing—particularly with complex structures, with multiple different owners, multiple different credit histories, different down payments. It opens up a whole set of issues.

So, trying to reduce risks in the regulatory landscape is key. This is another reason why we're seeing a move towards more virtual power plants and aggregators that are starting to pull together these different assets. Because then, you can reduce risk by better optimizing the operation of all of them collectively.

Now, a few case studies before we wrap up.

Jamaica has undertaken a detailed analysis to try to establish locational wheeling prices—looking at a load-flow approach. Pricing under this approach arguably provides a better reflection of each users' proportion of overall power system use, and you're starting to see where this is trending in Jamaica.

In Jordan, the regulations allow customers to produce power at one site and transmit that electricity to another site that is either owned—as long as it's owned or leased by the same consumer or legal entity. So, there's a requirement that it be the same legal entity in each case. In order to do so, the embedded generator simply has to pay a small fee and the power provided can be either in real time, or it can be net metered as part of the country's net metering policy. So, again, you have a fairly basic, simple, approach in Jordan.

In Brazil, the wheeling rules also allow a customer to sell their net excess generation to another customer on the network, but it does not have to supply the same legal entity as the case in Jordan saw. So, there's more flexibility around who's the ultimate off-taker. A so-called "user of system" charge—that's a wheeling charge—is applied as wheeling fee for each unit of electricity that's transported in this way.

The fee is applied, essentially, for each unit. You can see a brief diagram showing, essentially, how that's done on the far right. Electricity fed into the grid is registered as credits, and then, electricity from the grid is then essentially exposed to this wheeling charge per kilowatt hour. Two meters are used—one to meter the electricity output at the point of injection—or what's called the point of common coupling—and the other to meter the import of power consumption at the point of consumption in the household. And then, the difference is netted out.

In Pakistan, rules adopted in 2016 allow licensed generators to sell power to other bulk power consumers on the network. Bulk power generators are defined as those with a capacity greater than one megawatt—so, this is mostly targeting larger installations. The generator simply has to pay a wheeling charge for the use of the system and the shift in Pakistan is starting to contribute to opening up of the market. Pakistan's solar market has been growing quite rapidly in recent years, partly driven by increasing challenges in the electricity market, increasingly challenging water related constraints that are impacting power generation, and policies that increasingly enabling both solar and other renewable generation technologies to connect to the grid. So, this virtual net metering is emerging as an important part of Pakistan's overall policy and regulatory framework for renewables.

And finally, in the US, there were 16 states offering some form of virtual net metering—which are listed here—with different requirements, different rules, different eligible customers, and some of them applying only for solar while, in other states, they applied to a range of different technologies. You can see here, also, that in some cases, it's utility specific. So, in the case of Minnesota—Minnesota has multiple different utilities. Xcel Energy is only one of them and Xcel Energy is the only utility offering the program. So, different conditions on a state by state basis, but you can see that it's spreading.

This has grown, significantly, from just a couple states in early 2010s and now to, as we see here, 16 states offering some form of virtual net metering.

Now, a few concluding remarks.

Net metering combined with wheeling—namely virtual net metering—offers a new solution to the financial complexities of power generators selling to power consumers. It enables households and businesses to produce power elsewhere on the network more efficiently than they could on their own premises, and still participate—still consume virtually—a share of their own power generation and have that offset from their bill by their utility. So, we're seeing a lot of innovation to try to unlock this market potential, because, again, for many people in urban areas—for many businesses in urban areas—it's just not easy to go solar. So, the potential of virtual net metering is that it can help crack that open and make it possible for a much wider number of customers than was possible before. There's a number of benefits, as we saw, both for customers as well as for the utility of moving in this direction—can improve the business case, improve the operational sophistication; reduce maintenance related cost for users; can enable greater economies of scale; lower cost power; can produce bill savings for a wider number of customers; and can even be used—cost effectively by the utility if integrated smartly—as a virtual power plant—as part of a virtual power plant—to actually improve the integration of variable renewables by connecting it either with other generation assets or with different sources of demand.

So, you have a whole new—in a way, a whole new universe of possibilities opening up to enable a more interconnected, a more distributed, power system. Obviously, there are still challenges that remain, including on the technical front, and regulation still has to catch up. Policies are still fairly basic where they are adopted and there are, by far, more jurisdictions in the world that do not allow this than there are that do. So, there's a lot of discussion, a lot of emphasis—in various markets around the world—to try to get similar laws and similar rules passed. There are attempts, for example, in Durban, in South Africa—the utility of Ethekwini is looking more closely at virtual net metering as well as improving its small-scale generation program to allow exactly this, recognizing that this could unlock a number of additional investments and, fundamentally, it's being demanded by customers.

As with much else, in the utility market—in the utility business increasingly—customer choice, customer preferences are driving the utility agenda. And in markets with liberalized—with consumer choice where customers can actually select their supplier, that's even more the case, because customers are flocking to the utilities that are making it possible for them to be part of the action—to invest, to be part of the solution—in investing in renewable technologies and improving local energy security. So, there's a push from the consumer and that's helping to drive this, and we're seeing a number of utilities step up and start to make this possible. Despite the fact that, again, it remains the case that more parts of the world do not have this than those that do.

So, some further reading on these topics.

A few different overviews here for net metering and wheeling; a summary piece looking at the emergence of virtual net metering, as well as some of the advantages; a recent report here from NREL looking at distributed solar and the cost and benefits. So, with that, I'll wrap up. I think we've covered, essentially, all the basic information, provided links throughout to a number of different country case studies, and now, I'll stop there and let you shift onto the brief questions knowledge test.

Thank you very much. This has been Toby Couture with E3 Analytics. I'd like to thank the International Solar Alliance, as well as the Clean Energy Solutions Center, for making this training series possible and look forward to joining you on the next training session. Thank you very much and have a great day.