CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

Distributed PV Compensation Mechanisms

—Transcript of a webinar offered by the Clean Energy Solutions Center on 13 September 2019—
For more information, see the clean energy policy trainings offered by the Solutions Center.

Webinar Presenter

Toby Couture E3 Analytics

This Transcript

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

Toby Couture

Welcome to the International Solar Alliance Expert Training Course. This is session three, focusing on Distributed PV Compensation Mechanisms. We have a big program today, lots of material to get through and lots of material, in particular, at the cutting edge of this critical area in distributed solar, looking at how projects are compensated under different policies like net metering, net billing, that we've looked at so far in the training series. I'm Toby Couture and I'll be leading this training.

This training is brought to you by the International Solar Alliance, in combination with the Clean Energy Solutions Center. This training is part of module one and focuses on providing an overview of distributed generation compensation mechanisms. We'll take a deeper dive looking at some of the specific issues that are impacting, again, the attractiveness of investing in solar PV, fundamentally the economics of distributed solar.

A quick overview of the presentation, as we dive in. As I mentioned, we have a lot of material to get through. I'm going to do my best to keep this within one hour, but I'm going to warn you, in advance, it's possible we trickle a little bit beyond the one-hour mark in getting through this. We'll start with a bit of historical context, understanding the mechanisms and what we mean by compensation mechanisms, and then we'll dive into the main body of the presentation following the seven following topics; excess generation, rollover, the settlement period, the impact of electricity tariff structure, the impact of demand charges, the use of mechanisms like ring fencing to protect certain parts of the electricity bill from being erased through self-consumption, and time of use tariffs. Then, at the end, we'll have a few concluding remarks, a bit of further reading, as well as a knowledge check with some multiple-choice questions.

So, the aim is to understand distributed PV compensation mechanisms, understand the aspects that influence the economics of solar projects, we'll look at the role of fixed demand charges, different fees, rising retail prices, and a host of other factors on the economics of solar. We'll try to understand a little bit more how and why these kinds of measures are being introduced in different utilities, in different contexts around the world and, essentially, to understand where utilities are coming from and where regulators are coming from when they try to alter the compensation mechanisms.

So, net metering policies, as you may recall from the training session on net metering, first emerged in the U.S. in the 1980s. Since then, net metering has evolved into a wide range of different forms, some of which are even difficult to categorize under the standard categories; net billing, NET-FITS. We've seen buy-all, sell-all type policies and a range of others. So, the policy evolution in this space is rapid. I'm going to attempt in this presentation to synthesize a lot of that material by looking, specifically, again, at the payment mechanisms.

Onsite power generation is becoming increasingly attractive for a growing number of customers around the world as solar power costs continue to come down. As a result, more and more customers are starting to invest in solar. In certain markets, there's very significant shares of households and businesses with solar—in particular, Australia, but also in places like Hawaii and in South Africa. So, very significant shares of prosumers and solar customers lead to more significant impacts on utilities. When solar customers are only, say, zero-point-two per cent of the total rate payer class, the impacts are fairly marginal. But what we're seeing in certain cases, in jurisdictions like Australia, for example, there are certain post codes in Australia where 75 per cent of single-family houses have solar on the roof. So, almost all households. In those cases, the impacts are becoming much more significant. Utilities are trying to find ever more clever ways to better balance the costs and benefits of solar for all customers while trying to keep rates as low as possible.

As the number has grown of prosumers, so, too, has the importance of compensation mechanisms. We've seen much more focused regulatory debate, much more focused regulatory hearings specifically on the issue of compensation mechanisms. We've seen very high uptake in some of these markets and that's, again, what's driving some of this change. Now, what happens in markets like Australia and certain markets in the U.S. potentially has very significant implications for what happens in other jurisdictions around the world whether it's in India, in Brazil, in South Africa, or in the Philippines because the policies that are being developed, the kinds of regulatory solutions that are being developed have a way of diffusing throughout the world and being picked up in other jurisdictions. We're starting to see some of that already happening.

So, traditional net metering, as a bit of a recap here, allows individuals and businesses with customer-sited generation to connect to the grid and be credited for the excess power they feed into the system. In other words, they get a bill credit that can be carried over into future months. The meter, under traditional net metering, rolls backwards. So, essentially, it's rolling forward when you're consuming and it rolls backwards when you're injecting into the grid. Whatever the net amount at the end of the month is what you pay.

Bill credits, under net metering, are typically granted in kilowatt hours. Customers can "bank", so to speak, their excess kilowatt hours and use them to offset their future consumption. So, if you are on vacation for the month of July and your solar system is producing fully, for instance, during that month, you will have significant net excess generation. You can use that net excess generation, in most cases, and carry it over to offset future consumption in future months. But essentially, by banking your net excess generation in kilowatt-hour terms.

Under net metering, as a result, the compensation mechanism is essentially the retail rate. So, if you pay $0.12 for your kilowatt hour, you get $0.12 in kilowatt-hour value back and you can carry that over in time, into the future. A key point here, which we'll come back to over the course of the presentation is that traditional net metering does not result in a cash payment. It simply credits customer-sited generation at a rate that is equivalent to the retail rate. So, in other words, you will get a bill of credit, but the utility will never send you a check. That's classic net metering.

This depiction gives you—enables you to see a little bit how this works in practice. You see a monthly load curve for a household fluctuating over time, with a dip around April/May, rising up again in the summer because of air conditioning load, and then back down again. You can see here the solar production coinciding, in fact, with the trough. So, during the months of March through July, the customer has significant net excess generation.

In jurisdictions that have feed-in tariffs, this wasn't really an issue because customers were not self-consuming. Under feed-in tariffs, customer exported 100 per cent of their output to the grid and they received a fixed, long-term price for that supply. This meant that customers continued to buy 100 per cent of their electricity from their utility. So, under feed-in tariffs as, for example, in Germany and other places, customers became mini IPPs or mini independent power producers, not true prosumers because they were not consuming their own onsite generation. They were selling 100 per cent and buying 100 per cent from the utility. This is what is sometimes called a buy-all/sell-all arrangement.

In jurisdictions, however, like the U.S. and Australia, most customers of solar PV develop their projects under net metering or what are sometimes called NET-FITs. Australia just calls them feed-in tariffs, but because it involves some component of consumption, of self-consumption, they're more accurately described as NET-FITs because you're only receiving a feed-in tariff for the net excess generation.

Under net metering and NET-FITs, the self-consumed solar generation is consumed, itself, and they only export the surplus. This has important implications. If, under FITs, for example, the customer continues to buy 100 per cent of their supply from the utility, the utility's cost base is not significantly impacted because they're not losing demand from self-consumption. The customer still buys 100 per cent of their power from the utility. The utility may then have to pay for that feed-in tariff generation to the customer, but under virtually all feed-in tariffs, they're also given the right to pass those costs on, or those costs are covered by government revenue, by essentially government subsidies. So, under feed-in tariffs, it was more revenue neutral for the utility. Under net metering, however, utilities experienced revenue loss because customers were self-consuming. They're self-consuming power with their own onsite generation, which registers for the utility as a reduction in consumption and translates directly into lost revenue.

Now, again, in small amounts, that doesn't really matter a whole lot. But when you start getting thousands, if not tens of thousands, if not in the low millions of customers with roof-top solar, it starts to have a very big impact. Utilities are increasingly concerned about this. As these concerns have grown, utilities have started to tighten the screws on compensation mechanisms and, in particular, have started moving away from classic net metering that compensates customers at the full retail rate. We've seen utilities introduce fixed charges and demand charges and various other approaches that have direct impact on the economics of solar.

So, let's try to unpack this a little bit further before we dive into the various instruments. As I point out, compensation mechanisms have a key distinction at their core between bill credits, on the one hand, and cash payments on the other. Bill credits is under net metering. A cash payment is under a NET-FIT-type arrangement. Whether you receive a cash payment matters. In some cases, utilities will specifically even say that there are no negative bills.

In other words, that they will not pay if you have more net production than consumption. They will just—essentially, you will forfeit your extra power, your extra generation, and the utility will take it for free. In fact, most net metering policies around the world are still designed in this way that, after a certain period of time, the net excess generation is forfeited. As we'll see, there are reasons for that. One of the main being to encourage customers to dimension their systems roughly to match their household or business demand, electricity demand.

So, by keeping that principle in mind, utilities have tried to enforce that by essentially not paying cash payments for net excess generation because utilities, by and large, do not want to encourage customers to invest in distributed generation. That's starting to change with shifts in utility business models, but it remains broadly the case that utilities are not supporting customer-sited generation and, in particular, customer-sited self-consumption.

As we just pointed out, the difference between a cash payment and a bill credit is fundamental. When you just get a bill credit, net metering is much less investable and, therefore, much less bankable than under, say, a feed-in tariff or under a NET-FIT because the bank will look at it and say, "Well, essentially, you're just getting a compensation that you carry over to your future bills, but it doesn't translate into a cash payment." In other words, it's not a revenue stream. Because the bank can't consider it as a revenue stream, they can't, in many cases, issue a loan against it. Fundamentally, the customer's credit worthiness is what determines whether they can get a loan for a roof-top solar project or not. Not the intrinsic bankability of the investment.

Under feed-in tariffs, that's different. Most feed-in tariffs are financed based on a project finance basis. The bank looks at the revenue streams, looks at the payment level and determines whether it's enough to cover the loan payments. If it is, the customer gets the loan. So, net metering is less bankable. That's a really critical point, particularly in jurisdictions where the banking market and the investment landscape is more challenging and it's harder to get loans.

Lenders, like banks, are often reluctant to issue loans because the value stream is less bankable, as we just discussed. This means that most net metering-based solar projects are developed by customers that have financial resources like larger commercial customers or by residential customers who can self-finance them, essentially finance them with cash. However, this has a consequence that fewer customers can participate and it reinforces the perception that solar is only for the wealthy. By and large, if you look across the U.S. and, indeed, in many parts of Australia, the perception remains that solar is for the wealthy, partly because it's mostly wealthy customers who have an interest, as we'll see in a moment. There are some additional reasons why it's particularly attractive for wealthy customers. But also, because they have the disposable income to self-finance the systems without a bank loan.

So, the value of a distributed solar project can be characterized simplistically as follows. The value of your self-consumed electricity, plus the value of any net excess generation, minus any fixed charges, fees, or taxes that apply. So, if your self-consumed electricity is worth a lot because you pay high retail prices, that's a major plus. It's more attractive. If you get a decent price or a decent compensation for your injected generation, that's also a positive. But if you are facing significant charges like fixed charges, demand charges, special standby charges, then it can be less attractive.

So, looking at this graphically, you can see here that it's possible to distinguish between residential and commercial customers and to look at how that impacts the overall compensation story. Most residential customers have the lower self-consumption ratio. In other words, they can't self-consume as much of their power because most people aren't home during the day. They're at work which means more power is injected to the grid. That means residential customers are more vulnerable to whatever price they can get for that or whatever compensation mechanism they can get for that net excess generation than commercial prosumers.

For commercial prosumers, the self-consumption ratio tends to be much higher. That means that they're less reliant on the grid injection price. Now it's important to distinguish that each of these different things can be compensated at a different rate. Now the grid injection can be compensated at the full retail rate, as under net metering, or it can be compensated at some separate rate, like net billing rate or some other variation of what it costs, for instance.

For the self-consumer power, it can be offset at the full retail rate or, in some cases, there's even attempts to make the self-consumed electricity get offset at a separate rate. That's typically done by using kind of buy-all/sell-all arrangements. So, the customer still has to buy 100 per cent of their supply from the utility, and they sell it. The utility, rather than buying it at a cash payment, they will actually use those kilowatt hours and offset on a per kilowatt basis the customer's bill. So, essentially using the customer's own self-consumed or their own customer-sited supply to offset their bill rather than the bill being able to self-consume. This is the case in some Caribbean islands, for example.

Now, the important consideration here for many customers who are investing in solar is electricity prices are rising. If electricity prices are rising and are expected to continue to rise, an investment in solar can be quite attractive. That is a major catalyst for certain solar adopters. A prominent example is in South Africa, which has seen an increase of over 350 per cent in electricity rates in the last 10 years. You can see here a chart of just how staggering the price increases in South Africa have been since the early 2000s. Very dramatic. That has catalyzed a lot of interest and a lot of buzz around investing in solar because it's increasingly economic to do so.

This means, in short, that the value of self-consumption rises progressively over time as retail prices rise. You can see this depicted as a sketch here. But it's important to underscore that it's not just about the compensation rate and whether you're getting a cash payment or just a bill credit and how much is credited. Other aspects of the design, the structure, the metering arrangements, and the taxation of self-consumption have a significant impact on the overall attractiveness of investing in solar.

So, let's try to unpack that a little bit more by looking at some of these variations. We'll start with a deeper dive into dealing with net excess generation and then we'll look at rollover, the settlement period, tariff structure, demand charges, ring-fencing, and time-of-use tariffs, with the hope that, by the end of this presentation, you'll understand what every one of these is and be in a better position to really wrap your mind around just how fascinating and complex the world of distributed solar actually has become.

So, let's look at excess generation. As you can see here, this is a standard profile for a residential household that shows the PV output over the course of a day assuming a very sunny week. You can see here the supply injecting into the grid on a fairly steady, predictable basis with the only day of the week having significant net injection being Sunday, the last day here on the curve. But having excess generation during a few hours of the week or month is not enough to translate into a bill credit under most net metering policies.

The customer would only have a bill credit that carries over into subsequent billing cycles if they produced more than they consumed, in total, over the month. In other words, there would have to be a net positive injection—they would have to have a net positive injection into the grid over several days of the month in order to generate a positive bill credit at the end of that month. Small differences would be netted out automatically by one's own consumption within that same billing cycle. So, for most small fluctuations, it cancels out within the same billing cycle.

The case of the July household that goes on holiday is opposite here because the household that's away on vacation will have, for that whole month, significant net excess generation that they will then need to carry over into the subsequent billing cycle. That's where net metering really become valuable and it enables the customer to have self-produced, essentially, for the equivalent of the retail rate. So, if the customer's paying $0.15 per kilowatt hour for the retail rate, they would be self-supplying at that rate, effectively unable to be compensated at that rate.

Now, in some cases, dealing with the net excess generation that we just saw, on the Sunday, is dealt with differently. Under some net billing policies, all instantaneous net excess generation is automatically credited at some specified rate. In other words, the moment you inject, it gets accepted by the grid. The grid meters that and says, "We will pay you for every net inject power kilowatt hour $0.10. That $0.10 credit just accumulates on your bill. So, it is effectively a cash payment, but it's still structured within the bill. You don't get a cash—you don't get a check in the mail. It's still kind of credited and balanced out or settled within your bill.

That's a big different than net metering where the crediting is settled in kilowatt-hour terms. So, again, there's an important distinction there between a kilowatt-hour settlement and a dollar amount or a monetary settlement. By doing this, it removes the risk of a customer being compensated at a higher future retail rate. For example, you could develop a large solar system on your roof, save up an ever-increasing bank of saved credits over multiple years and then use them in the future when electricity prices are much higher. So, you could essentially game the utility and save up and offset your future more expensive kilowatt hours with today's generation. So, kind of squirreling away savings with cheaper kilowatt hours today so that you can payoff more expensive kilowatt hours in the future. But most utilities remove that risk by forcing the settlement after one year. So, this is what's called the settlement period. We'll get to that in a moment.

This net excess generation that you carry over can be settled in a range of different ways. It can be settled at the wholesale market rate. We're seeing some jurisdictions in the U.S., in particular, starting to do this. The time of use rate. The avoided cost rate. In some cases, like in Austin, Texas at the value of solar rate. Or at some other rate set by the regulator, including zero. So, in some cases, they will take the excess power and essentially confiscate it or it will be compensated at a rate of zero. All of these possibilities are out there.

How this excess generation is actually compensated has important impacts on the attractiveness of investing in solar PV. Whether you are getting a bill credit or a cash payment matters, and whether you can bank that. Over how long matter.

A couple questions to help kind of expand a little bit on this. Again, we don't have time to get into all of the nuances but I want to put a few thoughts on your radar before we move on to the next topic. If the compensation rate is set at the retail rate, as under net metering, a number of questions arise. Why do some customers receive a higher compensation rate than others? For example, residential versus commercial versus industrial customers. If your meter is rolling backwards and you're getting the rate you pay, why should that be the case? Why would a commercial customer get more than a residential customer if the PV is—the solar PV is coming into the grid around the same area and is basically from, say, the same feeder and from the same size of solar system? That's an important question as another driver for some of the changes of what we're seeing here.

What about taxes? Commercial customers can often claim things against their taxes. That impacts the attractiveness, again, of the compensation formula. What is retail prices continue increasing in the years ahead? What is retail prices are already quite high, such as on the islands? There it can be very attractive already to self-consume. So, how utilities deal with the net excess generation becomes one of the only sort of screws they have, one of the only mechanisms they have to try to throttle or control the market. What about the possible of overcompensation that's driven a lot of the debates and a lot of the legal wrangling, in particular, in the U.S., that customers may be benefitting at the expense of other customers, what we call cross-subsidization between different customers, customer with solar and customers without solar. So, again, a host of issues arise here to which there are no simple and easy answers, but to which some of these tools provide partial answers, as we'll see.

If prosumers are provided with a payment that is below the retail rate, for example like a net billing rate, as we saw with the cash settlement example where they're settling at, say, $0.10 per kilowatt hour, is that rate fixed or does it them change over time? Does it track inflation, for example? How is this net billing rate determined for determining the value of that supply or that electricity to the system? Is that rate itself differentiated by customer class or is it the same for residential customers as well as for commercial and industrial customers? Furthermore, what about the consumption level? As we will see in the section on electricity tariff structures, many jurisdictions have higher tariffs for households and businesses that consume more power. So, how do you solve that in the rate formula? We'll look at that a little bit more in detail in the slides to come.

More questions for you before we move on. Does the net excess generation generate bill credits in real time, as is the case in certain policies, or only if the total meter reading for the month is negative? Can these bill credits be carried over or are they cancelled out at the end of the month? Is there an annual settling of net excess credits or monthly? Finally, can the customer ever, under any circumstances, receive a cash payment from the utility?

Which is sort of the Holy Grail for many utility—there are many suffering rate payers around the world who complain about their utility bills. The idea of getting a check in the mail from your utility has a particular appeal to it. That can be a major driver for some households to go solar. Is that possible under the rules and regulations and how that's drafted? So, these are all important background questions, background considerations to keep in mind as we move through some of this material.

Now, let's look more closely at the second topic, roll-over provisions. The roll-over period refers to the duration over which the cumulative net excess generation is banked and calculated. Typically, over one billing cycle. The roll-over period represents the point at which one month's excess generation—for example, if it's a monthly billing cycle—is calculated and then carried over into the next billing cycle. Most net metering policies will enable you to roll-over month after month until you get to a 12-month period or one calendar year, at which point then you settle the net excess. That's the settlement period, which we'll get to in a moment.

But the roll-over can vary. In some cases, the roll-over is even hourly. In Denmark, for example, any net excess generation at the end of the hour that you haven't self-consumed, again, gets cancelled. So, essentially, a huge incentive to optimize your self-consumption with your production so that there are never significant excesses of generation. That's fundamentally the logic here is trying to encourage customers to ensure that their supply of solar coincides perfectly with their electricity demand and that there's no significant net excess generation. Most utilities are more flexible. They enable you to go monthly, in some cases, even up to yearly and carry over your credits month to month until the whole thing is settled.

As you can imagine, a very short roll-over period does not allow the customer as much time to use up their net excess generation. So, if you're producing a lot on Monday and Tuesday because it was beautiful and sunny, and then it's cloudy on Thursday and Friday of the week, you ideally want at least that week so that you can consume that power, that excess power that you have used. That's particularly the case if the compensation rate is below the retail rate. Because then you have an incentive to want to ensure that the value of your generation is as high as possible. In other words, that you receive the full retail rate for the value of your solar generation before it is settled by the utility.

In some cases, the roll-over period if the settlement period. In other words, at the end of the month, you roll over your credits. They'll say, "You have, say, 50 net excess kilowatt hours. We will settle those at the following rate. Either we'll pay you nothing or we'll pay you some other rate." That then settles that generation for that month, enables the utility to clear it from its books, and you move on into the next month. But in other jurisdictions, particularly in the U.S., the roll-over period is monthly. You carry over. Then the settlement period is at the end of the year.

After 12 months, for example, under this third example of the settlement period, the excess credits are then finally settled. That means they're removed from the utility's books. This is often necessary for accounting purposes. So, if you think of our previous case where the customer—in some jurisdictions, net metering policies were designed to allow indefinite carryover. That meant you could continually oversupply, have net excess generation every month, month over month, infinitely into the future and generate a very large bank of saved up kilowatt hours. But that creates accounting problems because the utility then has a liability on its hands that it needs to then clear. So, for accounting reasons, they often like to get that off the books and settle it, whatever the costs may be and try to find a formula that allows that to be fairly settled. That's what the settlement period is for.

The main options are the following. It can be forfeited as under many net metering policies. It can be credited at some rate like the wholesale rate or the avoided cost rate. Or it can be remunerated at some rate. That means cash payment for the net excess. In some cases, the cash payment will, for example, be at the avoided cost rate or at the wholesale market rate. So, we've seen some policies in the U.S. where they'll say, "We'll let you get a cash payment. The utility has to buy it from you at the average wholesale market rate over the last month or over the last year." Then they'll pay you that. It may be \$0.05 or \$0.06 a kilowatt hour. But basically, you get that rate and the utility pays it out as a cash payment.

Different settlement periods have an impact on the attractiveness in investing in a distributed generation project like solar. The primary goals of most of these mechanisms is to try to encourage right-sizing. In other words, encouraging PV systems that are designed that roughly match the demand of the household or business. Because if you threaten, for example, to settle the generation—let's say your retail rate is \$0.15 but your actual cash payment is only \$0.05, even that may be enough to create an incentive for someone for a household or a business to say, "Listen; we're just going to try to maximize our self-consumption, not have too much net excess generation. Because if we have too much net excess, they're only going to buy it from us at \$0.05." Or, even worse, if the generation is forfeited, then you really have an incentive to not have significant positions of net excess generation. That's critical. So, the incentive for the utility is to try to encourage right-sizing so that you're not in a position of significant net excess. That's done, again, by offering zero for the net excess.

Now, let's look at the electricity tariff structure and the impacts that that has. In many jurisdictions, utilities apply what are called inclining block rates. Wealthier households pay more if they consume beyond certain bands of power. So, you see here, an illustration. Beyond 600 kilowatt hours, the rate goes up for the red customer, and for the first block customer, it goes up at 350.

That basically means if you are a larger consuming household, it's more attractive to self-consume because the kilowatt hours you're going to be wiping out help reduce your total monthly consumption and, therefore, reduce or offset those costlier kilowatt hours first. That means your solar system will pay off more quickly. So, that means your solar system will pay off more quickly. So, inclining block rates are solar's friend. They are a major—they can significantly improve the financial attractiveness of investing in solar.

That's not always intentional. The utility has inclining block rates for other reasons. The rise of solar has led to this dynamic and has generated a whole set of other problems. For example, in the Philippines, there were a few cases in 2016 and '17 where wealthier households were able to self-consume so much that they dropped below the, I believe, 50-kilowatt hours a month threshold and were essentially paying the subsidized electricity tariff rate that was reserved for very low-income households, for very poor households. It was like the subsidy category that was not even cost-covering for the utility. That means wealthy households were able to self-consume their way down into a subsidized tariff category.

Newspapers picked up on this and realized, "Whoa, wait a minute." Even if it's only a few households, which it was, it generated a lot of public attention because, again, wealthy households with large solar arrays were able to tap into subsidized tariff categories. Philippines have worked to introduce a measure to adjust that essentially by changing the rate category so that customers could not drop—customers with solar are no longer able to drop into the subsidized rate category.

This means, essentially, as you can see, the inclining block rate structure matters. Because the higher blocks are erased first, they make PV more attractive. They, therefore, inherently and arguably inadvertently—in other words, unintentionally—make solar PV more attractive for households who consume more electricity. But again, most of these rate structures were designed before customer-sited solar was a big market or was even a thing. So, they didn't have solar in mind. But now that we have rate structures that have inclining blocks in many jurisdictions around the world, if not most, this becomes a really important factor in solar PV compensation structures because, again, you're offsetting those costlier blocks of power first.

Now, let's look at demand charges. The same applies to demand charges. Demand charges are effectively imposed on the peak capacity that a customer reaches during that month or during that billing cycle. So, it usually refers to the highest 15-minute peak of an electricity demand within each billing cycle. Then you pay a certain fixed amount for that, usually dollars per kilowatt of capacity of KVA for that for reaching that demand peak. So, your demand charge rate will fluctuate independently of your kilowatt-hour price. Typically, demand charges are only applied to commercial and industrial customers, but some utilities are proposing them and some utilities are even applying them for residential customers.

Now, utilities argue that customers are using the existing grid as a storage system and are not paying their fair share. They argue that customers should pay more to support overall costs of maintaining the grid infrastructure and, therefore, they introduce demand charges. So, that it's not—so that the entire cost of the system are not recovered purely through volume metric rates. In other words, dollar per kilowatt-hour amounts, but that there's a dollar per kilowatt fixed component that you have to pay based on the total peak demand that you've reached in that month.

However, as with all policy, there are unintended consequences. Demand charges create powerful incentives to invest in onsite storage which is not usually what utilities are keen to encourage particularly not on the customer end. The commercial battery storage market in the U.S. is heavily driven by demand charge avoidance because, by staying below certain demand thresholds, you can significantly reduce your bill at the end of the month. Because of that, the storage economics of some battery storage systems in the U.S. can be two years or less. The payback time can be two years or less which is very rapid, again, because you are avoiding such sizable demand charges. So, you can configure battery systems to keep you below certain thresholds. So, as soon as your peak demand is going to go up above a certain amount, the battery kicks in to gear and prevents it from doing so. So, again, the market is adapting to these kinds of rate structures.

Ring-fencing, what does this mean? A key issue is whether a customer who has solar on their roof can offset all components of their bill or only certain components. In other words, whether you can use your self-consumed solar to erase all components of the bill like fees, including taxes, with your net excess generation. In jurisdictions that have fully volume metric tariffs—in other words, you're paying dollar per kilowatt hour for everything bundled into one dollar per kilowatt hour amount—offsetting the full rate is often possible. There's no restrictions.

But in jurisdictions where taxes and fees are accounted for separately in the bill, it's often not. You can only erase, for example, the energy-related components of the bill. Because the utility says, "We have to continue to maintain the network. We have to continue to maintain all these other components of the bill. That may be subsidy categories like low income, energy efficiency programs surcharges, renewable energy program surcharges and other things." The utility will argue, "We still have to pay those things. Therefore, you cannot erase them with your self-consumption." Those are fixed parts of the bill.

Now, sometimes, in most cases, in fact, those subsidy categories are still linked to the kilowatt-hour consumption. So, if you're self-consuming, you're still getting out of some of those components. That's why we're seeing more utilities pushing for different metering arrangements so that the metering of how much you consume yourself, how much you are generating with your solar array and, plus, how much you're injecting into the network so that all of those things can be metered separately and tabulated separately so that the household's actual consumption, including self-consumption, can be used as a basis for the calculation of taxation and fees.

Now, again, there's a host of legal issues and there's a lot more here to unpack then I have time to in this presentation but you can see that if you have—if you're starting to get behind the metering that way and get into people—and into the household to try to meter everything independently, you can ring-fence certain components and protect them by being erased by self-consumption. Some utilities are also changing their rate structure to make that possible.

For example, instead of making the payments for subsidy categories like low-income charges or renewable energy surcharges, kilowatt-hour based—in other words, volume metric—some utilities are moving towards minimum bills and are saying every customer has to pay a minimum bill of $20.00 a month. That $20.00 a month will be used to cover these various categories. That $20.00 is non-negotiable. It's non-erasable. It's what's called non-bypassable. Those charges are baked into the bill by dent of the fact that you are a utility customer. By being a utility customer, you have to pay that amount. That essentially ring-fences it in the bill structure. So, minimum bills are essentially a form of ring-fencing.

Now, for reasons that will be immediately obvious, ring-fencing has very significant or can have very significant impacts on self-consumption and the attractiveness of rooftop solar. In most household residential bills, fixed charges are quite small, somewhere around ten per cent of residential bills. Volume metric charges make up most of the bill. Now, that's certainly the case in places—in certain parts of the world. But in others, the rate structure is very different. The fixed charges will be half of the bill or over 40 per cent of the bill and on the other half, is volume metric. So, again, how the bill is structured matters. In other words, the starting conditions matter in the market for the attractiveness of residential or commercial solar PV.

As I pointed out a few moments ago, a key question is, "Who has to pay for the support costs for renewable energy or for energy efficiency programs and things like that?" That's another area that utilities commonly try to ring-fence so that they cannot be erased via self-consumption.

I've inserted an example here that shows a sample case. I'll leave this here for a moment just so you can sort of work through it. The household's 700 kilowatt-hours a month consumption, how much they inject, how much they produce. Then the impacts on the bill here below. You can see here different charges; the distribution charge, the transmission system charge, customer service charge, subsidy charges for, say, low-income customers, and then other charges. Plus, a subtotal, followed by the VAT with taxation, and then the total. You can see here that the household that just pays for that kilowatt hour at the posted rate of $0.10 a kilowatt hour will pay a utility bill for that month of $114.00 for that consumption.

Under classic net metering, the customer would have lower charges across the board because everything is recovered volume metrically from their remaining bill, the remaining consumption. You can see here this works out to a bill of only $45.00 a month. So, significantly lower. Net metering, if accompanied with ring-fencing, on the far right, you can see here where all of the fixed charges are ring-fenced. So, the distribution charge, transmission charge, all of those things are protected and baked into the bill as a minimum bill. That would be a very high minimum bill.

We'd be looking here at a $50.00 a month minimum bill, which is higher than virtually all minimum bill proposals out there. But it gives you an idea. You would then have a $20.00 bill on top, $70.00 total with taxes, just under $80.00 if the fees are ring-fenced. That means between the classic net metering case and the ring-fencing case, it's a difference of over $400.00 a year just because of the ring-fencing. Now that's $410.00 that the utility is not using to self-consumption just by tweaking its rate structure.

So, these are just simplified cases. It's an over-simplification, I stress. But it gives you an idea of why these kinds of compensation mechanisms discussions really matter. Now we can tweak this further and look at what happens if the compensation rate isn't the full net metering rate of $0.10 a kilowatt hour but rather some other rate like a net billing rate, let's say $0.06 a kilowatt hour. Then model that and model the impacts on the financial attractiveness. You can see here why this is becoming critical for utilities and why this is really a major—increasingly a major issue.

Finally, time of use rates. We'll look briefly at this before wrapping up. In some jurisdictions, customers with solar are being given the option or are being required to have their compensation linked to time of use rates. So, if you're a solar customer, you are forced into the time of use rate category. In some cases, it's optional. You can opt in or opt out. In others, it's being forced. This is an example of an early evening peak jurisdiction where the peak is between 4:00 and 9:00 PM. This would be the case across much of the developing world where the power peak tends to be between those hours of 4:00 and 9:00 PM as people come home.

But in other jurisdictions, the peak is a bit more during the day. This shows a midday peak which is a bit—or traditionally has been more common in the southern parts of the U.S. and in California where this would still be quite attractive to switch into a time of use compensation category because then you're being compensated at the peak rate, which is during those daytime hours, in this case between 11:00 and 5:00. So, that would be perfect for a solar customer. Now the risk, of course, is that as more solar customers start to do this, the peak demand effectively starts to shift because more and more solar is being injected into the system and hollowing out that daytime demand. So, if you want more information on this, I encourage you to look at the duck curve training session on strategies to deal with that. That's a separate training unit that touches on this in greater detail.

So, this kind of a time of use structure would be positive for solar PV investment. By contrast, some jurisdictions are doing their daytime rates like this. This is an example in Hawaii where you see the midday power consumption cost very low. This is, again, because of solar power surging in Hawaii because of high retail prices, and then a very high evening rate. Now that means that for solar customers in Hawaii, for example, it would be very attractive to invest in potentially battery storage to increase their ability to reduce their consumption during those evening hours. That's one.

Another thing that may start to get attractive is to install the solar panels facing westward so that the production profile of the PV system shifts later to the day so that they're producing more power between, say, 5:00 PM and 7:00 or 8:00 PM, therefore, able to tap into that compensation—that higher time of use-based compensation. So, all of these issues are connected and they impact the fundamental economics of investment solar. Different time of use structures matter and have direct impact. So, it's not enough to say, "Oh, time of use rates are great for distributed solar projects." That's not necessarily the case. It really depends on the context. For that, customers really need to look more carefully at what the time of use rate structure is and whether it's optional or mandatory.

Critically, for many of these innovations and many of these approaches, we need advanced metering infrastructure. So, it's necessary to monitor grid injection and grid consumption and real-time self-consumption even using smart meters so that this can be better regulated.

Now, a few concluding remarks. I think we're just about within the hour mark. So, I'll warp this up here. We've covered a lot of material and a lot more could be said about many of these. But hopefully, this gives you a good, solid overview of some of the key issues at stake. We're seeing a distinction emerging between the self-consumption rate and the export rate. That's a key sort of background trend that's emerging here. We're seeing a trend towards utilities compensating distributed solar projects at a rate that's set below the retail rate. In other words, in most cases, solar is beyond grid parity. It can be produced for less than the retail rate and utilities are starting to recognize that and reflect that in the compensation formula. They pay less than the retail rate or compensate less than the retail rate for solar. Otherwise, they argue it's over compensation.

We're seeing a movement, patchy but happening towards offering cash settlement for net access generation instead of just bill credits. We're seeing ring-fencing becoming more common. Certain components of the bill are being locked in, non-bypassable to protect against utility revenue erosion. That includes the introduction of things like minimum bills, which we touched on. We're also seeing time-based rates or time-of-use rates starting to emerge more commonly and being discussed. But again, the devil is in the details.

Because solar is now below the retail price the customers pay in a wide and growing number of markets, the landscape has definitively shifted. Some would argue, as I have in the past, that the genie is now out of the bottle. That means that governing the growth of distributed solar is poised to become one of the main challenges for electricity systems and, indeed, for utilities in the years ahead. So, expect more rate and regulatory battles and debates to unfold around these different issues and these different ways of changing the compensation formula and expect a lot more discussion, fundamentally, around these different things.

The key for customers is to understand what is happening and not simply to be on the receiving end of utility-driven changes. Now, often customer advocates or consumer advocates will argue in favor of consumers' interests to try to make sure that utilities aren't unfairly compensating distributed solar projects or doing things that are completely counter to the public interest, but that's only in jurisdictions where you have a robust regulator and you have the consumer protection advocate that can make this case in front of the regulator. In cases where that's not the case or in jurisdictions where that's not the case, it's really important to look at and to push for fair compensation, fundamentally, for distributed solar. Because, again, distributed solar is now cheaper in many jurisdictions than the grid price and can produce cost savings even for utilities and for customers. So, it would seem counterproductive to try to unduly constrain that. So, customers should get clever, should get smart, and better understand these different compensation mechanisms, these different approaches and therefore be in a better position to adapt and to argue for different provisions.

I hope this has provided a good summary and synthesis of some of the key issues. Again, there's, no doubt, more to be said. I've provided here a couple of references, a couple of reports that are helpful in fleshing this out further and encourage you to have a deeper look at what your utility and what your regulator is publishing about the conditions in your local market as well as some of the consulting firms and others that are putting out material on this. Again, the first and most important step is to get educated. Hopefully, this has made a small contribution in that direction.

I'd like to thank the International Solar Alliance for their support in this training series as well as the Clean Energy Solutions Center that have helped make some of this information, again, more widely available to drive that education and that awareness. I'm Toby Couture from E3 Analytics. I'd like to thank you very much for your time and for your attention. I invite you now to stick around for a few quick multiple-choice questions. Have a great day.