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Net-metering and Net-billing, Part 2: Solar PV Policy: Net-billing

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Webinar Presenter

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Toby Couture Good day, everyone. Welcome to the International Solar Alliance Expert Training Course. This is session six, focusing specifically on net metering policies. This is a two-part session, providing an in-depth look at both net metering and net billing. So, net metering is part one and net billing is part two. Both net metering and net billing have become more widespread.

In recent years, we've seen a growing number of jurisdictions around the world outside of the U.S. and Europe developing net metering policies and net billing policies. A number of island states around the world are starting to experiment or have been experimenting with different variations on these policies. You'll see that there's a wide range of different terms that are used and that the terminology itself sometimes gets confusing. Sometimes jurisdictions don't use the terms in the same way as another jurisdiction does. So, sometimes when you hear net metering, it's actually a net fit or if you hear a net metering policy, they're actually referring to what analysts would call a net billing policy. So, there's some degree of – still of confusion and terminologically mix-up in this space.

So, I encourage you to when you see a policy - you know, if a country like Pakistan or Nepal or South Africa adopts or is said to adopt a net metering policy, take a minute. Have a look at the design. Look at what it actually does and how the policy works to be able to put it into context, because the different terms and different policies actually mean different things. We're going to try to clarify that through the course of this presentation, but I wanted to preface this with a quick discussion of that.

So, let's dive in. This training series is supported by the International Solar Alliance, which is a recently launched initiative to connect solar resource-rich countries around the world and scale up the growth of solar power. This training is also launched in partnership with the Clean Energy Solutions Center which is one of the leading technical assistance and capacity-building institutions on clean energy and clean energy policy around the word. This training, as I mentioned, is focused—it's specifically on net metering and it's found within module one out of this expert training course. You can see the different topics and the different subjects included here.

As I mentioned at the outset, this is part one, which focuses specifically on net metering. In a separate session, you'll see—you'll be able to look at and follow the training on net billing. I've also made a few references throughout these presentations to net fits, which are another policy hybrid that's emerging in this space.

So, a quick overview of the presentation. First, we'll look at the learning objective, some of the key highlights, a brief discussion of the historical context between net metering and rooftop solar policy. We'll cover the main body of the presentation. Then there will be a brief conclusion. At the end, there is a quick knowledge check with a series of questions based on the presentation.

So, first, the learning objectives. Obviously, to understand the rise of net metering, how net metering works and why, and also to get a sense of how net metering policies themselves have evolved over time and understand some of the drivers behind that evolution. We'll look at how net metering has been adapted in different jurisdictions around the world and we'll understand how the rise of these so-called prosumers are electricity consumers who also produce their own power, or a portion of their own power is starting to change the electricity sector.

So, with that brief introduction, let's take a quick look at the history behind net metering policies. In most parts of the world until the 1970s, utilities effectively had a monopoly on power generation. In many countries in the world, that monopoly remains effectively in place. But in jurisdictions across the U.S. as well as in Europe and Canada and the U.K., a number of jurisdictions started to loosen up that monopoly. Historically, there were also exceptions made for large industrial customers. So, large industrial customers like steel plants or auto manufacturing plants, pulp and paper mills were given the right within an existing utility grid to generate their own electricity. But that was kind of an exception and it was a long—these were case by case self-consumption permissions.

So, they were allowed to generate power. In some cases, even sell their excess power to the incumbent utility. But this was by and large not possible for, say, average household customers or small businesses primarily because of economies of scale. What made it possible for large industrial customers is that they had large on-site loads. They also had higher need for reliable power supply. So, there was an incentive for them to set up their own facilities either for primary power supply or for backup power supply. They were also able—

they were large enough that they could make use of conventional generation technologies. So, you could have a small onsite coal plant or natural gas plant supplying the needs of that large industrial customer.

In some cases, large customers also used hydro dams. So, a number of mining operations, a number of pulp and paper mills use a nearby hydro dam to supply their own power needs. This is also—if you go back in the beginning of the electricity industry, this was also _____ [someone clears throat] small onsite production would supply directly the local loads. But it became much less common throughout the 19—essentially from the 1940s to the 1970s. It's only after the 1970s that we really started to see this open up again. It's been driven by a number of different factors, as we'll see. But one of the most critical ones and what we're going to focus on mostly today is on the impact of solar, and in particular, low-cost solar and how that's really transformed this equation.

The fact that solar can be produced at a competitive price directly on someone's rooftop is a game-changer. It essentially undermines the traditional justification that utilities had for their monopoly status. One of the justifications underpinning a utility's monopoly has always been that they could produce power cheaper than everybody else and more reliably than everybody else. But the fact that solar is now starting to become more cost effective and, in many cases, even cheaper than the utility provided electricity supply and, in many cases, can even be more reliable than the utility power supply, we see the market changing. Net metering policies are one part of that change or essentially a signal of that shift. They're one of the enabling policies that enable customers to more effectively develop onsite sources of power generation.

It's important to keep in mind in this debate that there are different benchmarks against which renewable energy technologies like solar, for example, are competing. This often gets mixed up in the whole debate around grid parity. So, here, in this graph, we tried to show, essentially, the different benchmarks that renewable technologies bump up against as they get cheaper and cheaper. So, you see here, the different lines refer to the levelized cost of energy of different technologies.

You have these bands which are just approximations or ranges for the retail price on the first-hand, the LCOE of conventional technologies, and, finally, the wholesale price range for wholesale or bulk power on the system. You can see that as renewables have gotten cheaper, they've bumped, they're crashed through the retail price range in a growing number of jurisdictions and they're increasingly now cheaper than even the LCOE of new conventional generation technologies. Even more recently, we're seeing that renewable energy like solar is becoming even cheaper, in some cases, than the wholesale market price. That's really a game-changer in its own right.

So, it's important to keep this in mind to understand the fundamental concept of cost competitiveness and how this plays out and why this matters. So, in order for net metering to function or to be attractive, solar or the distributed generation technology has to at least be in this first range of the retail price.

So, as long as you're within the range of the retail price, there can typically be a business case for rooftop solar. That business case gets better and better the more economic—the cheaper solar becomes and the more retail electricity prices increase.

So, if you look at jurisdictions around the world, there are some where electricity prices from the utility are actually going up quite rapidly. If you look at Australia, South Africa, a number of jurisdictions through Latin America, many parts in Africa and Asia, power rates are going up quite quickly. That is a further driver that makes solar power even more attractive, even more economically competitive, and is really driving the adoption of distributed solar. As the economics get better, we can expect that trend to continue.

As I pointed out, net metering for small customers didn't really make economic sense, in most cases, in the 1980s and '90s, partly because retail prices were lower, but also, critically, because renewable energy technologies were more expensive. The first policy that was introduced, the first net metering policy worldwide was established in Minnesota in 1983 and it experienced comparatively little uptake. It was essentially a very modest—a modest degree or renewable energy development occurred. This started to change, however, as solar and other renewable energy costs have declined. That's partly why we've seen a growing amount of interest in net metering and other policies to govern distributed generation around the world.

So, now let's take a closer look at the policy itself. How does net metering work and what are the key design elements that make up a net metering policy? Net metering effectively allows individuals or businesses with customer-sided generation to connect with the grid and be credited for the excess power they feed into the system. So, this is where the concept of the net metering comes in. The bill that you receive is actually based on the net electricity consumption from the utility. So, what you normally consume minus what you injected into the grid. Whatever is left is your net electricity bill.

Most net metering policies operate on the basis of bill credits. So, in other words, every kilowatt hour you inject into the grid is counted and is banked as a kilowatt hour. Then you can carry that extra kilowatt hour that you may have produced on Tuesday of a given week and use it to offset a kilowatt hour of consumption in the following days. So, you can essentially bank that consumption and use it later.

The basic formula behind net metering is very simple. The compensation rate is equal to the retail rate. So, if you are paying $0.15 per kilowatt hour, then effectively you're getting a kilowatt hour of value for what you inject into the grid. That means the value of that kilowatt hour is based on the retail rate you pay. That's classic or traditional net metering. It's important to underscore that net metering does not involve a cash payment. It simple credits customer-sided generation at a rate that is equal to the retail rate.

So, there's no cash transfer. It's, in that sense, purely an accounting mechanism that allows customers to use the grid to inject their supply, their extra supply to the grid and offset consumption during other future times. So, the core incentive is fundamentally savings on your power bill. It's not to generate directly financial returns or cashflows, so to speak. There is no transfer of money under net metering policies. It's effectively just a credit on your bill.

This diagram published in a recent report by NREL from some colleagues provides a snapshot of net energy metering. You can see here a quick diagram outlining the basic mechanics. So, there's solar production through the wires. A bidirectional meter, typically. In the beginning, there were also dual meters, where you needed two different meters. Now, most metering is done by a bidirectional meter. Then you have the netting between consumption and production. At the end of the month or at the end of the billing cycle, the bill takes that into account. So, it will tabulate your consumption. It will subtract your net grid injection and you will be paying the remainder.

Now an interesting feature of net metering and one of the main drivers in the growing number of jurisdictions for developing a customer-sided solar system is actually that retail rates are going up over time. So, as you can see here, as retail rates go up—in this case, this illustration at 2.5 per cent per year—the actual value of that solar goes up over time as well because your future kilowatt hours are going to be worth even more than the current ones. That means every kilowatt hour you're consuming yourself in future years is actually worth more and more as retail rates go up.

Over 60 countries around the world have adopted some form of net metering. We've seen quite dramatic shifts in the market driven by policies like net metering among others, in combination with feed in tariffs and net billing and, in Australia earlier, net fits. In some regions, residential solar currently surpasses 200 per cent of maximum daytime load on certain feeders. We see this in jurisdictions like Hawaii and even in certain feeders across Germany where high shares of solar during the daytime actually are much greater than the residual load on those individual feeders.

Germany currently has an estimated 1.65 million individual solar systems, the vast majority of which are sited on households and small businesses. In Queensland, Australia, recent statistics show that over 30 per cent of households have a solar PV system. So, you can see a fundamental market transformation is underway and in jurisdictions where the right regulatory conditions are present and often where net metering or net metering-like policies are available, households are really starting to get in on the action. This is becoming increasingly economic [audio skips—inaudible] and the price of solar goes down, driven by competition among businesses and driven also by economies of scale in the solar sector as well as by rising retail prices. Such a large uptake of distributed generation arguably signals a very fundamental shift in the power industry. Many analysts think we are very much at the beginning of this transformation.

Net metering is most commonly used for rooftop solar PV projects. Not exclusively, but most commonly. So, typically, projects are under one megawatt in size. It is, however, a policy that can be used for larger scale projects, up to ten megawatts and in some cases even larger, and it's also not explicitly or not exclusively for solar power. So, most net metering policies in the United States, for example, allow multiple different technologies. So, they have a list of eligible technologies and you're allowed to use any of those eligible technologies to self-supply a portion of your own consumption.

Now, in most cases, solar is becoming the default choice of customers, partly because it's easier, partly because it's cheaper, but also because it's more modular. So, you can install 1.8 kilowatts if you want, or 7.2 kilowatts. The flexibility and modularity enables you to really adapt your total system size to your available roof space or available land space. That flexibility is a major asset. Net metering projects are typically connected at the distribution level, though there are cases where net metering is permitted at the transmission level or at higher voltage levels.

As we saw a few moments ago, net metering policies allow customers to bank their excess generation, so their net excess that they provide to the grid typically up to 12 months. This isn't universal. Some jurisdictions allow longer. Some shorter. But the—called the norm increasingly is 12 months. These excess credits in one month or billing cycle can be used to offset credits in future months up to that 12-month period. After 12 months, there's what's called the settlement period or sometimes called where the credits are trued up. Where those credits are settled, effectively the utility looks at the balance for the year and if you're in a net excess position, if you have too much injection, in most cases, as unfair as it sounds, most of those credits—in most cases, that extra solar power that you've provided to your neighborhood utility is effectively forfeited. You will not be compensated.

The reason why many utilities continue to justify this as a policy design option is that it encourages customers to design their systems at the right size. So, it's to encourage right-sizing. So, in other words, the utility doesn't want customers developing substantially over-dimensioned solar PV systems. They want you to roughly be able to offset your own onsite consumption but not more. So, this reflects the traditional—the logic that customer-sited generation should, from the utility's perspective, be purely treated as demand reduction.

That's another fundamental debate in the solar sector, of what is the future of customer-sited generation. Should it only be treated as demand side—as effectively demand reduction or should it be treated as a potentially new and large source of power supply? We can see that there's a shift towards policies like net fits, for example, which we'll see in session seven that actually adopt that second logic, which is more about encouraging larger volumes of distributed power production and tapping into the significant potential for new supply from customer-sited renewables rather than seeing purely as demand reduction. But classic net metering is still based on that logic of demand reduction.

This chart shows roughly how this plays out over the course of the day, as a schematic. So, you can see in the early evening hours, consumption is predominantly from the grid. As the sun rises, the power production from the solar panels goes up and is actually greater than the household's electricity demand. That excess production is essentially poured into the evening hours and offsets those evening hours on a one to one basis. If you are in a significant net excess position, let's say if you go on vacation, then your load is very low. Your net injection is very high. You will then be generating net extra—net excess generation credits more than usual. That then gives you credits that you can use in future months up to the settlement period. So, that's the basic mechanics.

Now, one of the key differences here, pure key terms is the rollover period. It specifically refers to the time period over which these net excess generation credits are calculated. This is typically connected to the billing cycle, but in some cases, it can be shorter or even longer. The different rollover period can have a fundamental impact on the attractiveness of investing in a solar project. So, imagine, for example, if you had a rollover period only of one day. That means all of your excess production, for example, from 9:00 AM until 6:00 PM you need to consume before midnight. Otherwise, it'll be forfeited to the utility. That is the rollover period. That means that if you are under those kinds of tight rules with a daily rollover, you would really try to design your solar system to be as small as possible so that you never have excess generation at the end of the day. Otherwise, those excess credits would effectively be lost or forfeited.

Most jurisdictions build their rollover period on a monthly basis. So, you're allowed to carry over up to the end of the month, and then the netting is done. In many cases, that monthly generation can be carried over up to 12 future calendar months or at least up until the end of the calendar year. So, again, different design options have different impacts on the bankability and attractiveness of investing in a customer-sited solar project.

The settlement period refers, as I pointed out, to when excess generations are trued up or settled from a financial standpoint. So, typically, after 12 months, the utility will look at the balance over the course of the year and will say, "Okay, you have this many excess credits. Here's how we're going to compensate you for that." In most net metering policies, we find ourselves under option A, where effectively your net excess credits are forfeited, but a growing number of utilities, often under pressure from customer and ratepayer advocates are pushing for fairer terms. That's where we're starting to see a number of policies across the U.S. and elsewhere, including in island states where excess generation is starting to be credited or, in some cases, even remunerated. That means paid for with a cash payment instead of just being cancelled. So, this is, again, part of the ongoing evolution of net metering policies into these new policy hybrids.

Broadly speaking, net metering policies have a number of key design features. You have a compensation mechanism, who is eligible, so who can actually participate, project size caps, program size caps. In many cases, there's limits on the contract duration, whether it's a five or ten-year contract which is the case in many island regions. In the U.S., most commonly net metering is a 20-year agreement or even an unlimited agreement. It can always be renewed. A range of other options, all of which make up the package of net metering policies including things like grid interconnection rules, metering standards, permitting fees, grid impact study fees which are rare but do exist in certain cases for larger systems. So, all of these different components make up a net metering policy. Over time, net metering policies have gotten quite a bit more sophisticated in the process as their evolution has gone on over time.

This provides a quick overview of the United States, which remains the largest and most diverse net metering market in the world. You can see here the index at the bottom. NEG refers to Net Excess Generation and it refers—you can see here the different colors refer to how different states deal with the Net Excess Generation, which is really the key issue at the heart of net metering. You can see here; some states provide a full credit at the retail rate. Some provide a Net Excess Generation credit at less than the retail rate. For example, the avoided cost rate. Then, there's some, even more conservative states from a policy standpoint that actually offer no credit at all for Net Excess Generation. So, you can see it's a patchwork and there's a wide range of different approaches to this.

As we pointed out a moment ago, a number of jurisdictions are starting to pay for that Net Excess Generation including in the United States. There are some regions now, for example, in Nevada and in some of the eastern states where it's actually possible to get paid at the end of the year at the utility's avoided cost rate. So, you can actually choose to get paid a cash payment. So, every month you pay your power bill and if you have Net Excess credits at the end of the year, the utility will buy those at the avoided cost rate.

Now the problem is, in most cases, the avoided cost rate is calculated to be very low, typically under $0.10, often under or in the $0.05 range. So, nobody's getting rich here off of the avoided cost-based payment, at least not yet. Now in most cases, it is a fundamental shift, however, in that it recognizes customers who are out there with rooftops and producing power have a right to be not only compensated, have a right to be remunerated, actually receive a cash payment for their Net Excess Generation. That, in itself, is a fundamental, and some would argue, a fundamentally positive shift.

Here's a quick overview of net metering in the E.U. Some different schemes here. Things have changed a little bit since this EPIA data. But you can see here a bit of a snapshot of how different jurisdictions are structuring their policies. Europe is much like the U.S. Also, a patchwork. Every jurisdiction has different rules and often very different treatment of things like tax treatment, bill structures, project size caps. You can see in the case of Belgium, it's limited at the voltage level. A range of different approaches.

Here's a table showing snapshot of net metering policies around the world. This gives you a broader sense of some of the landscape. As you can see under Latin America, many different islands have variations on net metering.

You can see, also, even some jurisdictions in Africa and the Middle East are starting to move in this direction as well.

In the process, residential PV is starting to become a major source of new power supply. These are just data from the E.U. But you can see here in some markets, the residential slice or the residential segment is quite substantial and growing. So, in Germany, in particular, we're talking in the 10,000-megawatt range of customer-sited residential PV. So, not even including the business or commercial sector.

Now, let's take a closer look at how this actually works in practice. Obviously, power demand is dynamic and changes every day. Every time you flick on a lightbulb or turn on or off your air conditioning unit or pop the toaster down or the tea kettle on, your electricity demand profile changes. It's spikey. So, it's going up and down all the time based on the different loads in your household. Now, solar power output also changes dynamically over time. So, if there's cloud cover or any other factors, the solar output will fluctuate and may not perfectly match the arc, or the sort of parabolic form outlined here. This is sort of an idealized case, but it gives you an idea of how this works in practice.

So, we have here a real load curve from an actual office building and their peak is somewhere around nine and a half kilowatts. This shows a one-week profile. So, you can see here seven bumps for seven days of solar PV output and then what would be the net result in terms of net grid injection. So, under this sketch, net grid injection is only there on Saturday and Sunday. All other days of the week, the building, the office building is consuming all of its own solar with no net grid injection.

Now why is that? Offices often close on the weekend or close, in particular, on Sundays. So, that means the power demand is lower which leads to the situation where if you have a very sunny Sunday, there's no load onsite, there's significant net excess generation. This is why net metering is so critical for customers like this because without net metering and without a battery bank, obviously, this Sunday generation is lost. It would be essentially wasted solar power. So, with a net metering structure, the customer can connect to the grid, inject that excess on Sunday into the system and be compensated for it, and use those credits then to offset their consumption during the rest of the week. So, you can see in that sense a win/win both for the solar customer as well as for society.

The next example here shows a supermarket. This is a real supermarket curve from an actual supermarket. You can see the demand profile is fairly consistent over time, more consistent even than the office building with somewhat lower but not much lower consumption on Sunday. So, under this case with this particular supermarket load, if they installed a 300-kilowatt solar system, even then the supermarket would be consuming all of the solar because they have air conditioning and chillers for their freezers and refrigeration units as well as basic lighting and other pumps and functions, air circulation. All of those systems are still functioning on the weekend even if no customers are there.

So, the load is a bit lower but not much, which means supermarkets are actually very well-positioned to invest in commercial net metering projects because during most times they'll actually be consuming most of the power themselves. That's why we're actually seeing a growing number of supermarkets do so even without net metering policies in place because they dimension the system purely to supply their own needs and not inject—without even needing to inject any—to—any electricity to the grid. This is because supermarkets have what we call a high self-consumption ratio. Most of the power they produce can effectively be consumed in real time onsite. Now, taking a step back, you can see how this plays out over the course of the day. So, you can see here the contribution of solar over the entire electricity demand profile of a particular jurisdiction.

Now, let's take a look at some advantages and challenges with net metering before we wrap up. First, net metering is obviously positive in so far as it allows customers to develop onsite generation and connect to the grid. As we saw at the beginning, in the past, net metering customer-sited generation was not allowed. Monopoly—utilities had a monopoly over generation and it was effectively illegal to connect to the grid. That remains the case in certain jurisdictions in the world where the rules allowing you to connect a self-generation system to the grid are not—simply do not exist. So, net metering in that sense is definitely a step in that right direction.

Another advantage is that it provides a simple compensation formula if you know essentially what your retail rate is and, if you develop a solar system, you know effectively what your compensation is going to be, and you also have a sense of how your power rate has been changing over time. In most cases, going up over time. That gives you a good basis to make your investment decision. Net metering is easy to understand, although there are a number of nuances and it gets quite more advanced. Net metering policies get quite sophisticated. They're typically easy to understand and typically easy to participate in.

Another advantage is the decreasing PV costs are now making net metering increasingly attractive. As we saw in the 1980s and '90s, it was not particularly attractive, and we saw very little development. But now, things are really starting to pick up and customers can effectively use the grid as a battery, export their surplus, and avoid the need to invest in costly storage. So, that's another significant benefit effectively provided by the public or utility-owned grid.

Net metering can also be easily combined with new business models and often is. So, business models like leasing, virtual net metering, community solar. These different options are—there's a special training session in this ISA/Clean Energy Solutions Center training session specifically looking at these new business models. So, you can have a closer look there and see how to better understand how those business models are currently developing.

Now, some challenges. Net metering is typically limited to small and medium-sized projects. Under two megawatts is emerging as a common size cap. This arguably artificially limits the project's size. I was recently working quite closely with a government in Southeast Asia where a large clothing facility was looking to install six and a half megawatts of solar PV on their roof, on their various rooftops of their various facilities all connected. They couldn't connect under the net metering program because the cap was at one megawatt. So, they had enough to build a six and a half megawatt project but were constrained by this artificial limit. So, this points to one potential challenge.

The second is that the compensation rate is arguably arbitrary. The retail rate has no relationship to the cost of customer-sited generation and it also has no bearing on the actual value of solar to the grid. So, using the retail rate is a bit arbitrary. In that sense, it's also arbitrary in so far as different residential customers fall into different classes and different commercial customers fall into different rate classes and different industrial customers, the same.

So, if you had all of these different customers participating under a net metering scheme, they would be getting a different rate effectively for their Net Excess Generation because it's effectively connected to the price they pay for power. So, that is one reason why some jurisdictions are starting to differentiate between different project sizes. So, they have a net metering policy for projects under 100 kilowatts, for example, and they have other kinds of policies like net billing or net fits for projects above 100 kilowatts or above a megawatt that allow more interesting and more favorable conditions for projects developed at that size.

Another common criticism is that net metering is mostly for the rich or mostly for wealthy households or large companies. This is another issue that has led to some jurisdictions establishing additional policies like low-interest loans or supporting community solar or low-income solar specifically to allow customers who may not be the wealthiest to still participate in solar. That's becoming increasingly attractive now that solar is often cheaper than the utility bill. So, we have a unique opportunity where lower income households can actually be encouraged to go solar and reduce their monthly power bill, which gives them more disposable income to spend on other things.

Another challenge is that higher value, as we pointed out, is awarded to certain customers. So, residential customers get a certain rate and commercial customers get another. That arguably has no basis in the economics of solar or in utility economics. That comes back to the point around the rate being a bit arbitrary.

A further challenge is that the value of Net Excess Generation goes up over time as electricity prices increase which may create revenue issues for the utility in the future. However, the revenue of solar or the value of solar to the grid may, in fact, decline as the share of solar grows. So, there's a number of jurisdictions now particularly in the U.S. looking at what are called value of solar tariffs where they try to determine what the actual value of solar power is to the utility grid and they use that analysis to inform the actual rate. That moves net metering away from classic net metering towards a hybrid policy like a net fit or what's sometimes called the value of solar tariff policy. So, we're seeing some innovation going on there.

A further challenge is that in islands, in particular with high retail tariffs like Hawaii and the Caribbean, Pacific Islands where power rates are often over $0.35 or $0.40 a kilowatt hour, compensation at the full retail rate as implied under classic or traditional net metering may actually be considered overcompensation. If the levelized cost of solar is only $0.12 and you're able to offset your utility bill which is at $0.40, offering the full traditional net metering may actually be resulting in overcompensation. That's an argument that utilities, particularly in the Caribbean but also in the Pacific Islands region have started to make and apply. That's one of the further drivers towards different policies like net billing.

Further challenges; I pointed out briefly that net metering can affect utility cost recovery. So, if utility revenues go down, this can negatively impact utilities' revenues because they're selling fewer kilowatt hours. It may lead to cross-subsidization issues between customer with solar and those without solar. There's a whole host of debates and analyses and regulatory hearings specifically looking at this issue of whether there is cross-subsidization between customers.

A further concern is around tax treatment as well as the treatment of fixed bill charges. So, in the bill, are you allowed to also erase, for example, your grid related fees in the bill or only the energy-related components of your electricity bill? So, there's a lot of nuances there that, again, more sophisticated net metering policies have really had to grapple with.

Another challenge is that because there's no cash payment, as we saw at the beginning, net metering is arguably less bankable and certainly less bankable than a feed-in tariff which is the policy that's been predominantly used to drive the rooftop development here in countries like Germany. That remains a challenge for the bankability of net metering because banks, in general, are hesitant to finance or to issue loans for net metering projects. Which means in turn that it's only wealthier households who have enough disposable income to actually invest in a net metering project, further limiting the pool of potential customers.

Finally, subsidies remain a real part of many and most electricity systems which makes customer-sited generated artificially less attractive. So, if the retail rate is subsidized, which it is, again, heavily in most parts of the world, it actually distorts the real cost of competitiveness of the market and makes solar look less cost competitive than it actually would be without subsidies. So, that's why there's an increasingly loud call for reducing subsidies to provide a more level playing field and allow more distributed generation like solar, in particular, to be able to compete on fair terms.

Now, there are some key decision points that need to be taken into consideration with net metering policies. I've provided a list of some of them here. This is more oriented at some of you in the audience who may be specifically working on net metering design or who are looking to develop or adjust your own policy. These are some of the key questions that need to be answered in any net metering framework. There are many more, but this provides a sort of basic set of key decision points.

Now, let's look at the future. We have a few minutes left so I'd like to give you a sense of where this debate and discussion is going. As we've discussed, the cost of solar PV continue their downward march. These are numbers here from the U.S. showing the breakdown between different solar costs for residential and commercial-scale system on the left. You can see that numbers continue to come down. By international standards, even the numbers here are in fact higher than they are even in many other—in many countries particularly in the Asia Pacific region as well as in Europe where significantly lower installed costs are now achievable at the residential and commercial levels.

So, you can see here, the rapid decline down below $2.00 a watt and now we're seeing even projects being installed for less than $1.00 a watt for commercial-scale rooftop systems. So, this is really—this fundamental shift is making—really risks—is going to redefine the overall cost competitiveness of customer-sited generation in the years ahead. I think there's a strong case to be made that we are just at the beginning of this transformation.

As I've pointed out and using numbers now here to really illustrate the case, the current retail price in many jurisdictions is quite high. These aren't even some of the highest in the world. But you can see here, framed in Euro sense, the different retail prices on average for the standard residential customer. Then you can see, in the middle row, approximate cost of solar on your rooftop. So, ranging from 9 to—well, even in Australia from 6.5 up to $0.13 per kilowatt hour. On the far right, you can see here the percentage of that as a share of the retail rate. So, solar is much cheaper than the retail rate. That, again, drives—is a key part, a key factor in driving the economics.

In response to this increasing competitiveness, net metering policies have started to evolve. We've seen a couple of examples. We've talked briefly about that. I encourage you, if you want to understand this evolution even better, to look at the part two of this session, session six, on net billing, as well as session seven, specifically on net fits that will give you a more in-depth look at how these policies are evolving over time and give you a sense of what the future of net metering-type policies are going to look or could potentially look like.

We sometime talk about first generation, second generation, and third generation net metering policies. So, although these have different names, many people consider them all a form of net metering. I've put their sort of—the actual terms up top. So, you can see first generation net metering. Second generation is what's commonly called net billing. What I've called here third generation is referring to a net fit.

You can see that under—as things go on, the net fit offers a cash payment, in particular, and it is a signal that distributed generation can be considered as a new and potentially major source of new power supply. That's really where a growing number of jurisdictions are starting to look. So, there's policies recently being—recently adopted in jurisdictions like Senegal, in parts of South Africa, parts of—in Vietnam as well as in some Pacific Island states that are really moving in this net fit direction and are starting to implement policies that allow self-consumption but that also pay users a cash payment for their Net Excess Generation. So, again, this is an exciting and very dynamic space.

So, a few quick words on trends. There broadly is a trend towards moving away from net metering because retail prices continue to go up and solar prices continue to go down. So, the argument that this is overcompensating solar users is growing. That's why some jurisdictions are shifting towards net billing, as we'll see in part two of this session. There's a movement towards cash settlement for Net Excess Generation instead of simply bill credits, as I pointed out. So, moving more in the direction of net fits. There is a movement also towards incorporating time of use rates into net metering policies or making it even either voluntary or mandatory to engage in a time of use rate structure if you're net metering customers. In most cases, this remains voluntary, but that's a sign of where things are potentially going.

There are also some jurisdictions like California that are exploring location-specific net metering compensation structures or rates. That's another interesting development. We're seeing ring-fencing becoming more common which is making certain components of the power bill non-bypassable or non-erasable. We're also seeing the differentiation of a policy design for solar, in particular, by size category. So, we're seeing certain policies for projects under 100 kilowatts, for example, different policies from 100 kilowatts to 1 megawatt and further—other policies for projects 1 megawatt up to 5 or 10 megawatts. That's another sign of, again, the increasing sophisticated-ness of the policy landscape to deal with distributed generation.

Finally, we're seeing the use of new technologies and new innovations like block chain and peer-to-peer power sharing as well as new business models like solar leasing and community solar to help further unlock customer-sited power generation. Again, I think we really are just at the beginning of these changes.

Now, a few words summarizing a little bit some of the points that we've touched on here to provide an indication of why net metering is changing and why it's becoming less appropriate in certain contexts. It arguably overcompensates some PV system owners. It tends to be most attractive for customers in the highest tariff classes which means it erodes revenue from the most profitable utility customers first. This is one concern that a lot of utilities are worried about and are actively trying to find solutions for. The net metering rate is arguably arbitrary, as we saw, and there's this issue of cross-subsidization. So, all of these factors are starting to drive changes in net metering policies.

Now a few concluding remarks. Most analysts agree that the genie is out of the bottle. Solar is now cheap and increasingly considered one of if not the lowest cost source of new power supply in jurisdictions around the world. It's also increasingly below the retail price that most customers pay. So, long as that fundamental relationship remains the case, it's likely that solar will continue to remain a very attractive and it will become an increasingly attractive option for households and businesses to develop. This may be one of the harbingers, one of the trends that really starts to lead us to a much more distributed and fundamentally, hopefully, much cleaner and more renewable, much more sustainable power system in the long run.

That said, there are a number of challenges that remain around grid integration, around stability, around power system equity and governing the rise of such prosumers and such net metering customers is positioned to become one of the main challenges that utilities have to deal with in the years ahead. But at the same time, for the solar sector, it's a tremendous opportunity and a very exciting time as policies continue to evolve and as the landscape continues to shift in favor of more solar on rooftops. So, with that, thank you very much for your attention. There's a list here for some future reading, a number of articles and recent analyses and reports that have been published and a question and answer series at the end to test your knowledge. Thank you very much. Wishing you all a great day.